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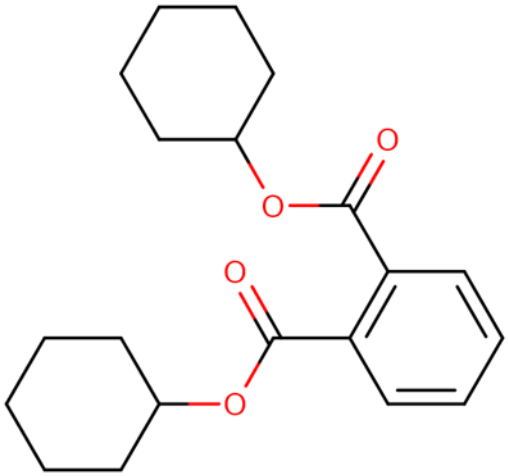
Draft Risk Evaluation for Dicyclohexyl Phthalate (DCHP)

CASRN 84-61-7



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Docket

Supporting information can be found in the public docket, Docket ID (EPA-HQ-OPPT-2018-0504).

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EXECUTIVE SUMMARY

Background

EPA has evaluated the health and environmental risks of the chemical dicyclohexyl phthalate (DCHP) under the Toxic Substances Control Act (TSCA). **In this draft risk evaluation, EPA has preliminarily determined that DCHP presents an unreasonable risk of injury to human health under the conditions of use (COUs)**. Of the 24 COUs that the Agency evaluated, 9 COUs have risk estimates that raise concerns for workers' exposure to DCHP; no COUs raise such concerns for consumers or the general population. In this draft evaluation, EPA's protective, screening-level approaches demonstrated that DCHP does not pose an unreasonable risk of injury to the environment. After this draft risk evaluation is informed by public comment and independent, expert peer review, EPA will issue a final risk evaluation that includes its determination as to whether DCHP presents unreasonable risk to human health or the environment under the TSCA COUs.

DCHP is used primarily as a plasticizer in manufacturing adhesives, paints and coatings, plastic products, rubber products, and plastic resins. It is also used as a stabilizing agent in the manufacturing of adhesives, paint and coatings, plastic products, printing ink, rubber products, as well as plastic material and resin. Other uses of DCHP include industrial use in transportation equipment, computer, and electronic product manufacturing and commercial use in building/construction materials and laboratory chemicals—all of which are COUs. Workers may be exposed to DCHP when making these products or otherwise using DCHP in the workplace. When it is manufactured or used to make products, DCHP can be released into water, where because of its properties, most will end up in the sediment at the bottom of lakes and rivers. If released into the air, DCHP will attach to dust particles and be deposited on land or into water. Indoors, DCHP has the potential over time to be released from products and adhere to dust particles. If it does, people could inhale or ingest dust that contains DCHP.

Laboratory animal studies have been conducted to study DCHP to determine whether it causes a range of non-cancer health effects on people. After reviewing the available studies, the Agency concludes that there is strong evidence that DCHP causes developmental toxicity (a non-cancer human health hazard). The most sensitive adverse developmental effects include effects on the developing male reproductive system consistent with a disruption of androgen action—what is known as *phthalate syndrome*, which results from decreased fetal testicular testosterone.

EPA is including DCHP for cumulative risk assessment (CRA) along with five other phthalate chemicals that also cause effects on laboratory animals consistent with phthalate syndrome (U.S. EPA, 2023c). Notably, assessments by Health Canada, U.S. Consumer Product Safety Commission (U.S. CPSC), European Chemicals Agency (ECHA), and the Australian National Industrial Chemicals Notification and Assessment Scheme (NICNAS) have reached similar conclusions regarding the developmental effects of DCHP. They have also conducted CRAs of phthalates based on these chemicals' shared ability to cause phthalate syndrome. Further, independent, expert peer reviewers endorsed EPA's proposal to conduct a CRA of phthalates under TSCA during the May 2023 meeting of the Science Advisory Committee on Chemicals (SACC) because doing so represents the best available science. In this draft risk evaluation, the Agency has evaluated cumulative exposure to phthalates for the U.S. civilian population using human biomonitoring data. Note that these phthalate exposures to the general civilian population cannot be attributed to specific TSCA COUs or other sources. This non-attributable cumulative exposure and risk, representing the national population, was taken into consideration by EPA in reaching its preliminary determination of unreasonable risk of injury of human health for DCHP. Had EPA not taken this into consideration, it could have understated the unreasonable risk of injury to human health for DCHP.

In December 2019, EPA designated DCHP as a high-priority substance for TSCA risk evaluation and in August 2020 released the final scope of the risk evaluation (U.S. EPA, 2020b). This draft risk evaluation assesses human health risk to workers, including occupational non-users (ONUs), consumers, and the general population exposed to environmental releases. It also assesses risk to the environment. Manufacturers report DCHP production volumes through the Chemical Data Reporting (CDR) rule under the associated CAS Registry Number (CASRN) 84-61-7. The production volume for DCHP was between 500,000 and 1,000,000 lb in 2019 based on the latest 2020 CDR data (EPA describes production volumes as a range to protect confidential business information). The Agency has evaluated DCHP across its TSCA COUs, ranging from manufacture to disposal.

Past assessments of DCHP from other government agencies that addressed a broad range of uses, which may have included TSCA and non-TSCA uses, have concluded that DCHP does not pose risk to human health or the environment based on its concentration in products and the environment. Notably, both the U.S. CPSC's and Health Canada's risk assessments included consideration of exposure from children's products as well as from other sources such as personal care products, diet, consumer products, and the environment. However, these past assessments did not specifically consider exposure to workers. In this draft assessment, EPA comes to the same general conclusions of those assessments with regard to risk to consumers and the general population—with the exception of where it evaluated and has identified risks to workers with some manufacturing and processing uses of DCHP.

In this draft risk evaluation, EPA evaluated risks resulting from exposure to DCHP from facilities that use, manufacture, or process DCHP under industrial and/or commercial COUs subject to TSCA and the products resulting from such manufacture and processing. Human or environmental exposure to DCHP through uses that are not subject to TSCA (*e.g.,* use in cosmetics, medical devices, food contact materials) were not specifically evaluated by the Agency in reaching its preliminary determination of unreasonable risk to injury of human health. This is because these uses are excluded from TSCA's definition of chemical substance. Thus, although EPA is preliminarily determining in this draft risk evaluation that nine specific TSCA COUs significantly contribute to its draft unreasonable risk finding for DCHP, this determination cannot be extrapolated to form conclusions about uses of DCHP that are not subject to TSCA and that EPA did not evaluate.

Determining Unreasonable Risk to Human Health

EPA's TSCA existing chemical risk evaluations must determine whether a chemical substance does or does not present unreasonable risk to human health or the environment under its TSCA COUs. The unreasonable risk must be informed by the best available science. The Agency, in making the finding of *presents unreasonable risk to human health*, considers risk-related factors as described in its risk evaluation framework rule. Risk-related factors beyond the levels of DCHP that can cause specific health effects include but are not limited to the type of health effect under consideration, the reversibility of the health effect being evaluated, exposure-related considerations (*e.g.,* duration, magnitude, frequency of exposure), population exposed (including any potentially exposed or susceptible subpopulations), and EPA's confidence in the information used to inform the hazard and exposure values. These considerations must be included as part of a pragmatic and holistic evaluation of hazard and exposure to DCHP. If an estimate of risk for a specific scenario exceeds the standard risk benchmarks, then the formal determination of whether those risks significantly contribute to the unreasonable risk of DCHP under TSCA must be both case-by-case and context-driven.

EPA evaluated the risks to people from being exposed to DCHP at work, indoors, and outdoors. In its human health evaluation, the Agency used a combination of screening-level and more refined approaches to assess how people might be exposed to DCHP through breathing or ingesting dust or

other particulates, as well as through skin contact. EPA has also authored a draft cumulative risk technical support document including DCHP and five other phthalate chemicals that all cause the same health effect—phthalate syndrome. The CRA takes into consideration differences in the ability of each phthalate to cause effects on the developing male reproductive system. Use of this "relative potency" across all the phthalates EPA is reviewing that cause phthalate syndrome provides a more robust risk assessment of DCHP as well as a common basis for adding risk across the six phthalates included in the cumulative assessment. Thus, risks are characterized for occupational and consumer exposures to DCHP, alone as well as in combination with the measured cumulative phthalate exposure that is experienced by the U.S. population and that cannot be attributed to a specific use.

In determining whether DCHP presents an unreasonable risk of injury to human health, EPA considered the following potentially exposed and susceptible subpopulations (PESS) in its assessment: women of reproductive age, pregnant women, infants, children and adolescents, people who frequently use consumer products and/or articles containing high concentrations of DCHP, people exposed to DCHP in the workplace, people in proximity to releasing facilities, including fenceline communities, and Tribes and subsistence fishers whose diets include large amounts of fish. These subpopulations are PESS because some have greater exposure to DCHP per body weight (*e.g.*, infants, children, adolescents) while others may experience exposure from multiple sources or higher exposures than others. EPA's robust screening analysis preliminarily finds that exposure of consumers and of the general population to DCHP does not contribute to unreasonable risk of injury to human health. However, the Agency preliminarily identified nine COUs where occupational exposure for workers significantly contributes to the unreasonable risk of injury to human health.

Summary, Considerations, and Next Steps

EPA is preliminarily determining the following COUs, based on the DCHP individual analysis and the relative potency factor analysis, significantly contribute to the unreasonable risk to workers:

- Manufacturing – domestic manufacturing;
- Processing – incorporation into formulation, mixture, or reaction product – adhesive and sealant chemicals in adhesive manufacturing;
- Processing – incorporation into formulation, mixture, or reaction product – plasticizer (adhesive manufacturing; paint and coating manufacturing; and printing ink manufacturing);
- Processing – incorporation into formulation, mixture, or reaction product – stabilizing agent (adhesive manufacturing; asphalt paving, roofing, and coating materials manufacturing; and paints and coating manufacturing);
- Industrial use – finishing agent – cellulose film production;
- Industrial use – inks, toner, and colorant products (*e.g.*, screen printing ink);
- Industrial use – paints and coatings;
- Commercial use – inks, toner, and colorant products (*e.g.*, screen printing ink); and
- Commercial use – paints and coatings.

EPA is preliminarily determining that the following COUs do *not* significantly contribute to the unreasonable risk:

- Manufacturing – importing;
- Processing – incorporation into article – plasticizer in plastics product manufacturing and rubber product manufacturing;
- Processing – repackaging (*e.g.*, laboratory chemicals);
- Processing – recycling;
- Distribution in commerce;

- Industrial use – adhesives and sealants (*e.g.*, computer and electronic product manufacturing; transportation equipment manufacturing);
- Industrial use – other articles with routine direct contact during normal use including rubber articles; plastic articles (hard) (*e.g.*, transportation equipment manufacturing);
- Commercial use – adhesives and sealants;
- Commercial use – building/construction materials not covered elsewhere;
- Commercial use – laboratory chemicals;
- Commercial use – other articles with routine direct contact during normal use including rubber articles; plastic articles (hard);
- Consumer use – adhesives and sealants;
- Consumer use – other articles with routine direct contact during normal use including rubber articles; plastic articles (hard);
- Consumer use – other consumer articles that contain dicyclohexyl phthalate from: inks, toner, and colorants; paints and coatings; adhesives and sealants (*e.g.*, paper products, textiles, products using cellulose film, etc.); and
- Disposal.

This risk evaluation has been released for public comment and will undergo independent, expert scientific peer review. EPA will issue a final DCHP risk evaluation after considering input from the public and peer reviewers. If in the final risk evaluation the Agency determines that DCHP presents unreasonable risk to human health or the environment, EPA will initiate regulatory action so that DCHP no longer presents such risk.

1 INTRODUCTION

EPA has evaluated dicyclohexyl phthalate (DCHP) under the Toxic Substances Control Act (TSCA) section 6(b). DCHP is primarily used as a plasticizer in polyvinyl chloride (PVC) in consumer, commercial, and industrial applications—although it is also used in adhesives, sealants, paints, coatings, rubbers, and non-PVC plastics as well as for other applications. Section 1.1 summarizes the scope of the draft DCHP risk evaluation and provides information on production volume, a life cycle diagram (LCD), conditions of use (COUs), and conceptual models used for DCHP. Section 1.2 presents the organization of this draft risk evaluation.

Figure 1-1 describes the major inputs, phases, and outputs/components of the TSCA risk evaluation process, from scoping to releasing the final risk evaluation.

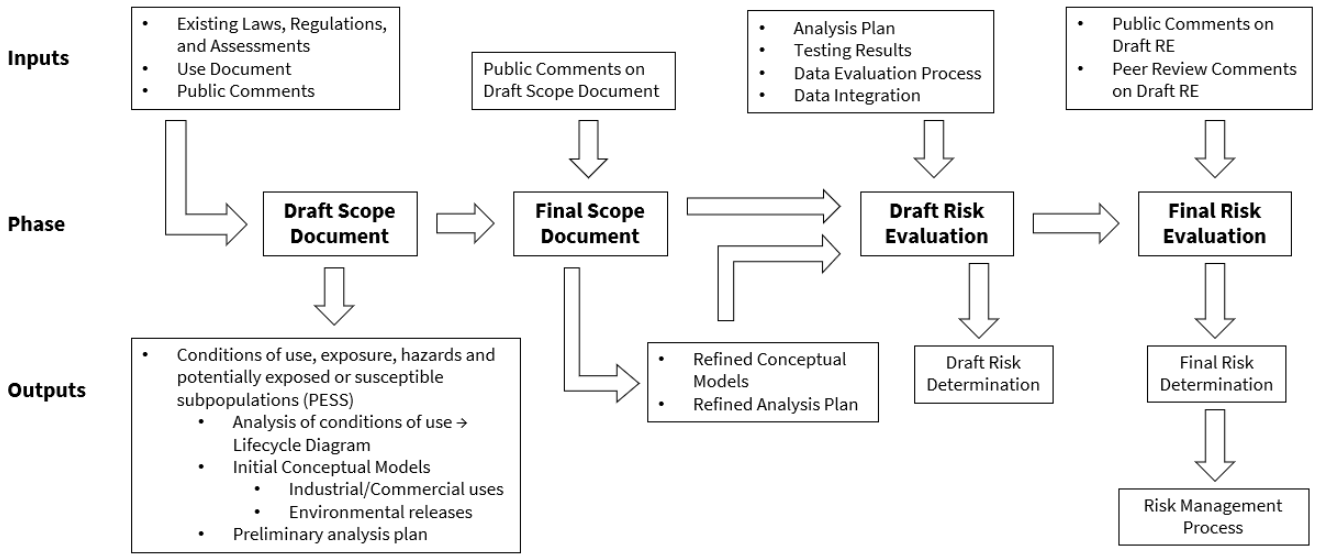

Figure 1-1. TSCA Existing Chemical Risk Evaluation Process

1.1 Scope of the Risk Evaluation

EPA evaluated risk to humans and the environment for DCHP. Specifically for human populations, the Agency evaluated risk to workers and occupational non-users (ONUs) via inhalation routes; risk to workers via dermal routes; risk to ONUs via dermal routes for occupational exposure scenarios (OESs) in mists and dusts; risk to consumers via inhalation, dermal, and oral routes; and risk to bystanders via the inhalation route. Additionally, EPA considered the following potentially exposed and susceptible populations (PESS) in its assessment—women of reproductive age, pregnant women, infants, children and adolescents, people who frequently use consumer products and/or articles containing high-concentrations of DCHP, people exposed to DCHP in the workplace, and Tribes and subsistence fishers whose diets include large amounts of fish. As described further in Section 4.1.3, EPA assessed risks to the general population, including considerations for fenceline populations, from environmental releases using a screening-level analysis, which considered risk from exposure to DCHP via oral ingestion of surface water, drinking water, fish, and soil from air to soil deposition. For environmental populations, EPA evaluated risk to aquatic species via water, sediment, and air as well as risk to terrestrial species via air, soil, sediment, and water.

Consistent with EPA's *Draft Proposed Approach for Cumulative Risk Assessment (CRA) of High-Priority Phthalates and a Manufacturer-Requested Phthalate under the Toxic Substances Control Act*

(U.S. EPA, 2023c), EPA has also authored a draft cumulative risk technical support document of DCHP and five other toxicologically similar phthalates (*i.e.,* diethylhexyl phthalate [DEHP], dibutyl phthalate [DBP], diisobutyl phthalate [DIBP], butyl benzyl phthalate [BBP], and diisononyl phthalate [DINP]) that are also being evaluated under TSCA based on a common toxicological endpoint (*i.e., phthalate syndrome*, which results from decreased fetal testicular testosterone). The cumulative analysis takes into consideration differences in phthalate potency to cause effects on the developing male reproductive system. Use of relative potency across the phthalates provides a more robust risk assessment of DCHP and a common basis for adding risk across the cumulative chemicals. Numerous other regulatory agencies—Health Canada, U.S. Consumer Product Safety Commission (U.S. CPSC), European Chemicals Agency (ECHA), and the Australian National Industrial Chemicals Notification and Assessment Scheme (NICNAS)—have assessed phthalates for cumulative risk, and EPA's proposal to conduct a CRA of phthalates under TSCA was endorsed by the Science Advisory Committee on Chemicals (SACC) as the best available science. As described further in Sections 4.4.4 and 4.4.5, cumulative risk considerations focus on acute duration exposures to the most susceptible subpopulations: female workers and consumers of reproductive age (16–49 years of age) as well as male infants and male children (3–15 years of age) exposed to consumer products and articles.

The draft DCHP risk evaluation includes a series of technical support documents (TSD). Each TSDl support document contains sub-assessments that inform adjacent, "downstream" technical support documents. A basic diagram showing the layout and relationship of these assessments is provided below in Figure 1-2. High-level summaries of each relevant technical support document are presented in this risk evaluation. Detailed information for each technical support document can be found in the corresponding documents. Appendix C incudes a list and citations for all technical support documents and supplemental files included in the draft risk evaluation for DCHP.

These technical support documents leveraged the data and information sources already identified in the *Final Scope of the Risk Evaluation for Dicyclohexyl Phthalate (1,2-Benzenedicarboxylic acid, 1,2-dicyclohexyl ester); CASRN 84-61-7* (also referred to as "final scope document") (U.S. EPA, 2020b). OPPT conducted a comprehensive search for "reasonably available information" to identify relevant DCHP data for use in the draft risk evaluation. The approach used to identify specific relevant risk assessment information was discipline-specific and is detailed in *Draft Systematic Review Protocol for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024ag), or as otherwise noted in the relevant TSDs.

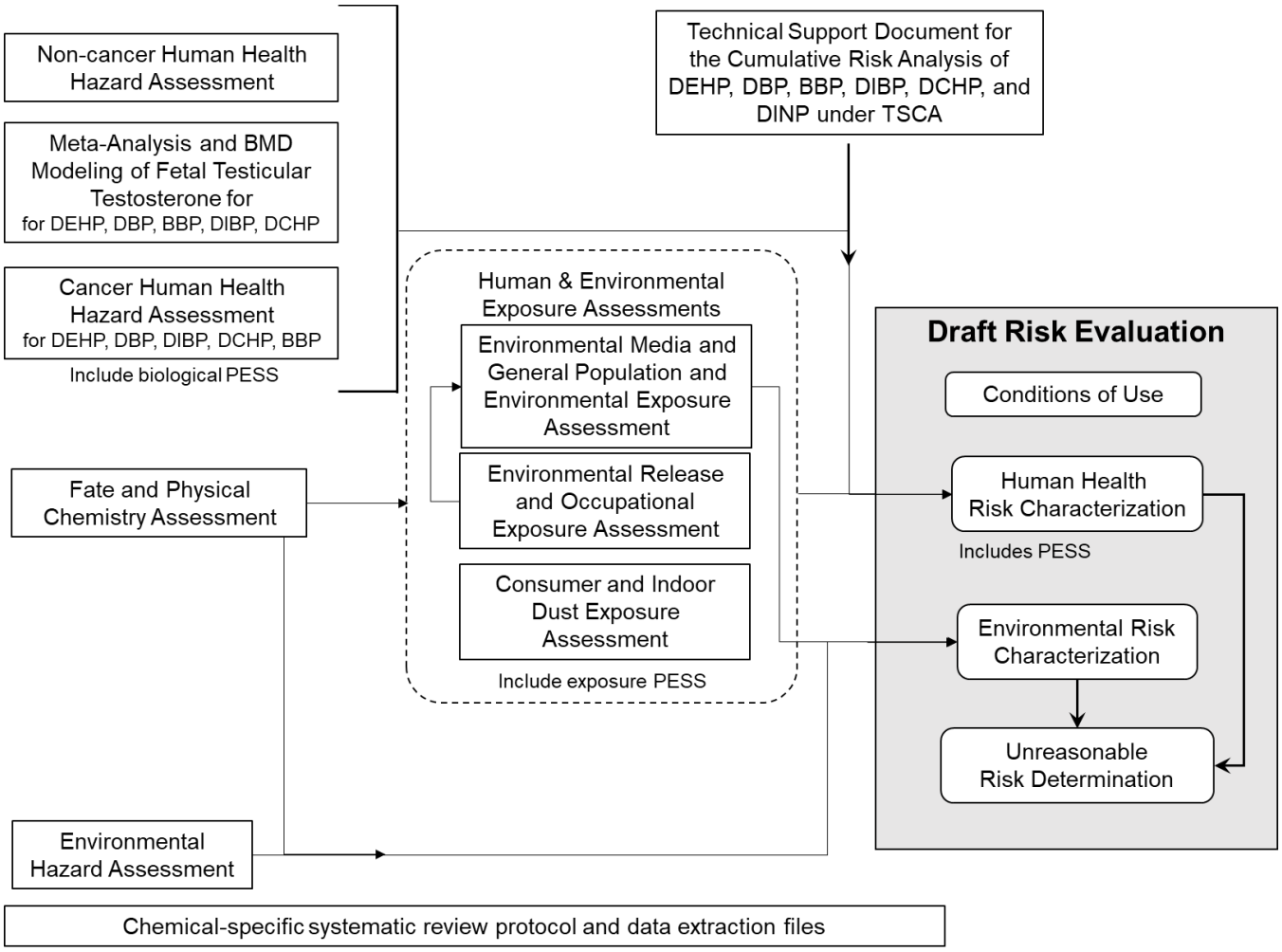

Figure 1-2. Draft Risk Evaluation Document Summary Map

1.1.1 Life Cycle and Production Volume

The LCD shown in Figure 1-3 depicts the COUs that are within the scope of the risk evaluation, during various life cycle stages, including manufacturing, processing, distribution, use (industrial, commercial, consumer), and disposal. The LCD has been updated since its inclusion in the final scope document, with consolidated and/or expanded processing and use steps. A complete list of updates and explanations of the updates made to COUs for DCHP from the final scope document to this draft risk evaluation is provided in Appendix D. The information in the LCD is grouped according to the Chemical Data Reporting (CDR) processing codes and use categories (including functional use codes for industrial uses and product categories for industrial and commercial uses). The CDR Rule under TSCA section 8(a) (see 40 CFR part 711) requires certain U.S. manufacturers (including importers) to provide EPA with information on the chemicals they manufacture or import into the United States. EPA collects CDR data approximately every four years with the latest collections occurring in 2006, 2012, 2016, and 2020.

EPA included descriptions of the industrial, commercial, and consumer use categories identified from the 2020 CDR in the LCD (Figure 1-3) (U.S. EPA, 2020a). The descriptions provide a brief overview of the use category; the *Draft Environmental Release and Occupational Exposure Assessment for Dicyclohexyl Phthalate* (U.S. EPA, 2024q) contains more detailed descriptions (*e.g.*, process

descriptions, worker activities, process flow diagrams, equipment illustrations) for each manufacturing, processing, use, and disposal category.

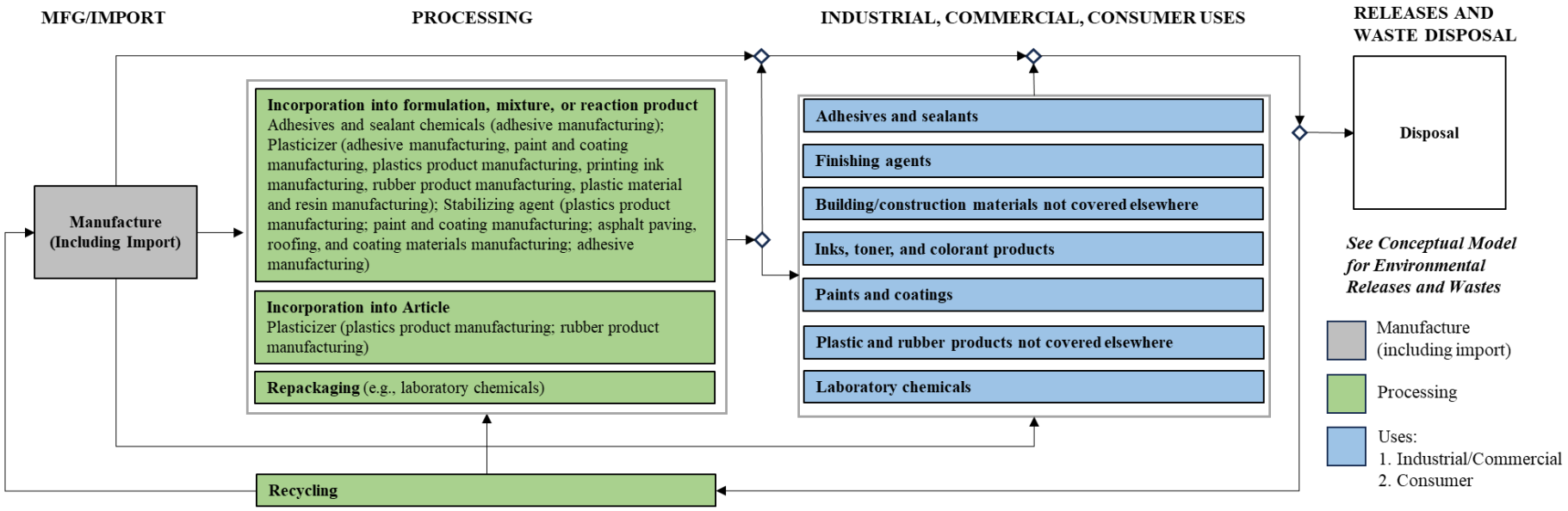

Figure 1-3. DCHP Life Cycle Diagram

See Table 1-1 for categories and subcategories of COUs. Activities related to distribution (*e.g.,* loading, unloading) will be considered throughout the DCHP life cycle, as well as qualitatively through a single distribution scenario.

The production volume for CASRN 84-61-7 in 2019 was between 500,000 and 1,000,000 pounds (lb) in 2019 based on the latest 2020 CDR data. EPA describes production volumes as a range to protect production volume data claimed as confidential business information (CBI). For the 2020 CDR cycle, collected data included the company name, volume of each chemical manufactured/imported, the number of workers at each site, and information on whether the chemical was used in the commercial, industrial, and/or consumer sector(s).

In the 2020 CDR, two sites reported production of DCHP. LANXESS reported a production volume of 17,290 lb for the 2019 CDR reporting year. The remaining site, Vertellus LLC, reported their production volumes as CBI but also reported an export volume of 410,849 lb for 2019 and that 10 percent of their PV was used as a plasticizer in adhesive manufacturing. EPA assumed that this site had no uses of DCHP that are included under the reporting threshold and that 410,849 lb represented 90 percent of their total PV. Therefore, EPA calculated the total manufactured PV from the site as 456,499 lb (410,849 ÷ 0.9 = 456,499 lb or 207,064 kg). EPA was able to use this data and the number of reporting import sites to estimate an average import volume per site.

1.1.2 Conditions of Use Included in the Risk Evaluation

The final scope document (U.S. EPA, 2020b) identified and described the life cycle stages, categories, and subcategories that comprise TSCA COUs that EPA planned to consider in the risk evaluation. All COUs for DCHP included in this draft risk evaluation are reflected in the LCD (Figure 1-3) and conceptual models (Section 1.1.2.1). Table 1-1 below presents all COUs for DCHP.

In this draft risk evaluation, EPA made updates to the COUs listed in the final scope document (U.S. EPA, 2020b). A complete list of updates and explanations of the updates made to COUs for DCHP from the final scope document to this draft risk evaluation is provided in Appendix D.

Table 1-1. Categories and Subcategories of Use and Corresponding Exposure Scenario in the Draft Risk Evaluation for DCHP

Life Cycle Stage[a]	Category[b]	Subcategory[c]	Reference(s)
Manufacturing	Domestic manufacturing	Domestic manufacturing	(U.S. EPA, 2020a, 2019a)
	Importing	Importing	(U.S. EPA, 2020a, 2019a)
Processing	Processing – incorporation into formulation, mixture, or reaction product	Adhesive and sealant chemicals in: – Adhesive manufacturing	(U.S. EPA, 2019a)
		Plasticizer in: – Adhesive manufacturing – Paint and coating manufacturing – Plastic material and resin manufacturing – Plastics product manufacturing – Printing ink manufacturing – Rubber product manufacturing	(U.S. EPA, 2020a; ACA, 2019; AIA, 2019; Carboline, 2019a, b; MEMA, 2019; U.S. EPA, 2019a, d)
		Stabilizing agent in: – Adhesive manufacturing – Asphalt paving, roofing, and coating materials manufacturing – Paint and coating manufacturing – Plastics product manufacturing	(U.S. EPA, 2024aj; Nouryon Chemicals LLC, 2020; U.S. EPA, 2020a; AIA, 2019; U.S. EPA, 2019c)

Life Cycle Stage[a]	Category[b]	Subcategory[c]	Reference(s)
	Processing – incorporation into article	Plasticizer in: – Plastics product manufacturing – Rubber product manufacturing	(AIA, 2019; MEMA, 2019; U.S. EPA, 2019a)
	Repackaging	Repackaging (*e.g.*, laboratory chemical)	(U.S. EPA, 2020d)
	Recycling	Recycling	(U.S. CPSC, 2015)
Distribution in Commerce	Distribution in commerce	Distribution in commerce	
Industrial Use	Adhesives and sealants	Adhesives and sealants (*e.g.*, computer and electronic product manufacturing; transportation equipment manufacturing)	(Henkel, 2024; AIA, 2019; Henkel, 2019; MEMA, 2019; Henkel, 2017)
	Finishing agent	Cellulose film production	(U.S. EPA, 2020c; Earthjustice, 2019)
	Inks, toner, and colorant products	Inks, toner, and colorant products (*e.g.*, screen printing ink)	(LANXESS, 2021; U.S. EPA, 2021c, 2019e; Gans Ink and Supply, 2018)
	Paints and coatings	Paints and coatings	(Carboline, 2019a, b; U.S. EPA, 2019d)
	Other articles with routine direct contact during normal use including rubber articles; plastic articles (hard)	Other articles with routine direct contact during normal use including rubber articles; plastic articles (hard) (*e.g.*, transportation equipment manufacturing)	(AIA, 2019; MEMA, 2019)
Commercial Use	Adhesives and sealants	Adhesives and sealants	
	Building/construction materials not covered elsewhere	Building/construction materials not covered elsewhere	(LANXESS, 2021; U.S. EPA, 2019a)
	Inks, toner, and colorant products	Inks, toner, and colorant products (*e.g.*, screen printing ink)	(LANXESS, 2021; U.S. EPA, 2021c, 2019e; Gans Ink and Supply, 2018)
	Laboratory chemicals	Laboratory chemicals	(Restek Corporation, 2024; Sigma-Aldrich, 2024a, b; NASA, 2020; U.S. EPA, 2020d; SPEX CertiPrep, 2019)
Commercial Use	Paints and coatings	Paints and coatings	
	Other articles with routine direct contact during normal use including rubber articles; plastic articles (hard)	Other articles with routine direct contact during normal use including rubber articles; plastic articles (hard)	(U.S. EPA, 2020a; AIA, 2019; MEMA, 2019; U.S. EPA, 2019a)
Consumer Use	Adhesives and sealants	Adhesives and sealants	(DeWalt, 2024a; ITW Permatex, 2024; Lord Corporation, 2024; Midwest Technology

Life Cycle Stage[a]	Category[b]	Subcategory[c]	Reference(s)
			Products, 2024; MKT, 2024; ITW Permatex, 2021; DeWalt, 2020; MKT, 2018; Lord Corporation, 2017)
	Other articles with routine direct contact during normal use including rubber articles; plastic articles (hard)	Other articles with routine direct contact during normal use including rubber articles; plastic articles (hard)	(U.S. EPA, 2020a; AIA, 2019; MEMA, 2019; U.S. EPA, 2019a)
	Other	Other consumer articles that contain dicyclohexyl phthalate from: inks, toner, and colorants; paints and coatings; adhesives and sealants (*e.g.*, paper products, textiles, products using cellulose film, etc.)	(Hydro-Gard, 2024; Hallstar, 2022; LANXESS, 2021; U.S. EPA, 2020c; Earthjustice, 2019; MEMA, 2019; U.S. EPA, 2019e; Gans Ink and Supply, 2018; Hydro-Gard, 2017a, b; U.S. CPSC, 2015)
Disposal	Disposal	Disposal	

[a] Life Cycle Stage Use Definitions (40 CFR 711.3)
- "Industrial use" means use at a site at which one or more chemicals or mixtures are manufactured (including imported) or processed.
- "Commercial use" means the use of a chemical or a mixture containing a chemical (including as part of an article) in a commercial enterprise providing saleable goods or services.
- "Consumer use" means the use of a chemical or a mixture containing a chemical (including as part of an article, such as furniture or clothing) when sold to or made available to consumers for their use.
- Although EPA has identified both industrial and commercial uses here for purposes of distinguishing scenarios in this document, the Agency interprets the authority over "any manner or method of commercial use" under TSCA section 6(a)(5) to reach both.

[b] These categories of COUs appear in the LCD and broadly represent COUs of DCHP in industrial and/or commercial settings.

[c] These subcategories reflect more specific COUs of DCHP.

[d] The consumer COU of "Toys, playground, and sporting equipment" was removed and not included in DCHP's final scoping document. The U.S. CPSC Chronic Hazard Advisory Panel (CHAP) report from 2014 (U.S. CPSC, 2014) that states, "DCHP is currently not found in children's toys or child care articles, and it is not widely found in the environment" (page 117); the preamble of the 2017 CPSC final rule titled "Prohibition of Children's Toys and Child Care Articles Containing Specified Phthalates," which explains that ". . . the CPSC staff has not detected DCHP in toys and child care articles during routine compliance testing thus far. . ." (U.S. CPSC, 2017); As a result, EPA has no reasonably available information demonstrating that the consumer use of DCHP in toys is intended, known, or reasonably foreseen, and has not included it in the analysis for this draft risk evaluation of DCHP.

1.1.2.1 Conceptual Models

The conceptual model in Figure 1-4 presents the exposure pathways, exposure routes, and hazards to human populations from industrial and commercial activities and uses of DCHP. There is potential for exposure to workers and/or ONUs via inhalation and via dermal contact. The conceptual model also includes potential ONU dermal exposure to DCHP in mists and dusts deposited on surfaces. EPA evaluated activities resulting in exposures associated with distribution in commerce (*e.g.*, loading, unloading) throughout the various life cycle stages and COUs (*e.g.*, manufacturing, processing, industrial use, commercial use, and disposal).

Figure 1-5 presents the conceptual model for consumer activities and uses, Figure 1-6 presents general population exposure pathways and hazards for environmental releases and wastes, and Figure 1-7 presents the conceptual model for ecological exposures and hazards from environmental releases and wastes.

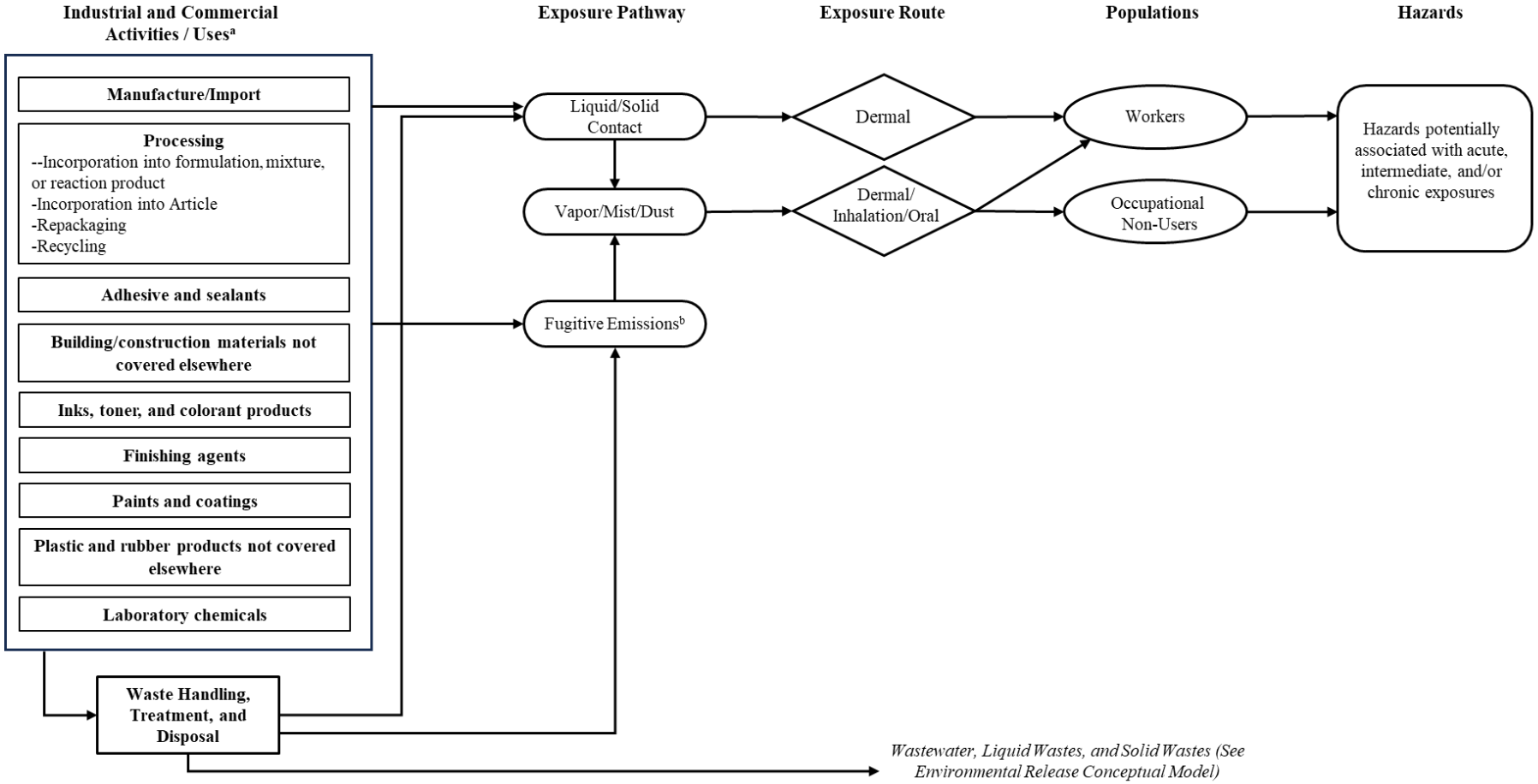

Figure 1-4. DCHP Conceptual Model for Industrial and Commercial Activities and Uses: Potential Exposure and Hazards

[a] Some products are used in both commercial and consumer applications. See Table 1-1 for categories and subcategories of COUs.

[b] Fugitive air emissions are emissions that are not routed through a stack and include fugitive equipment leaks from valves, pump seals, flanges, compressors, sampling connections and open-ended lines; evaporative losses from surface impoundment and spills; and releases from building ventilation systems.

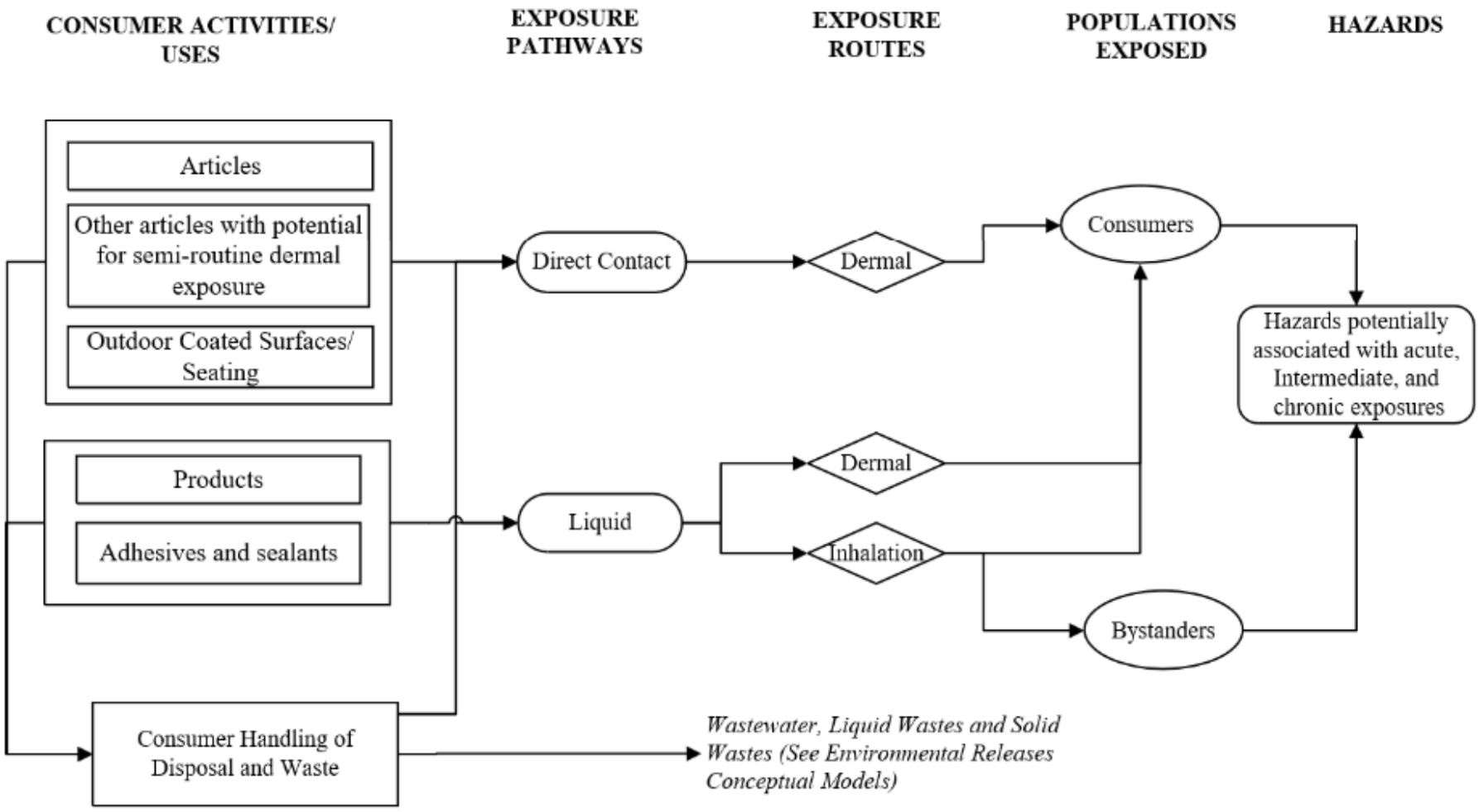

Figure 1-5. DCHP Conceptual Model for Consumer Activities and Uses: Potential Exposures and Hazards

The conceptual model presents the exposure pathways, exposure routes, and hazards to human populations from consumer activities and uses of DCHP.

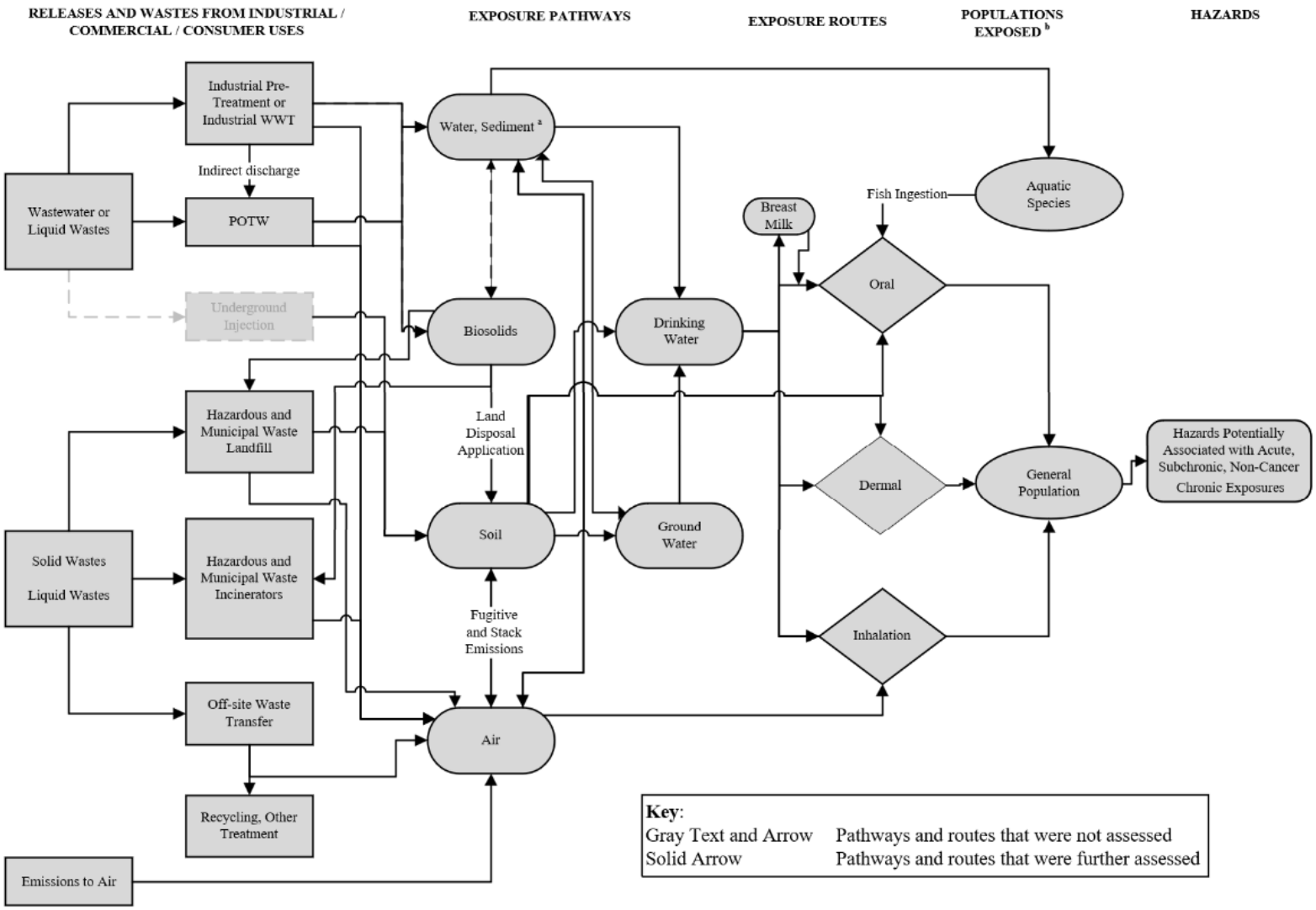

Figure 1-6. DCHP Conceptual Model for Environmental Releases and Wastes: General Population Hazards

The conceptual model presents the exposure pathways, exposure routes, and hazards to human populations from releases and wastes from industrial, commercial, and/or consumer uses of DCHP. [a] Industrial wastewater or liquid wastes may be treated on-site and then released to surface water (direct discharge), or pre-treated and released to publicly owned treatment works (POTWs) (indirect discharge). For consumer uses, such wastes may be released directly to POTW. Drinking water will undergo further treatment in drinking water treatment plant. Groundwater may also be a source of drinking water. Inhalation from drinking water may occur via showering. [b] Populations assessed include PESS.

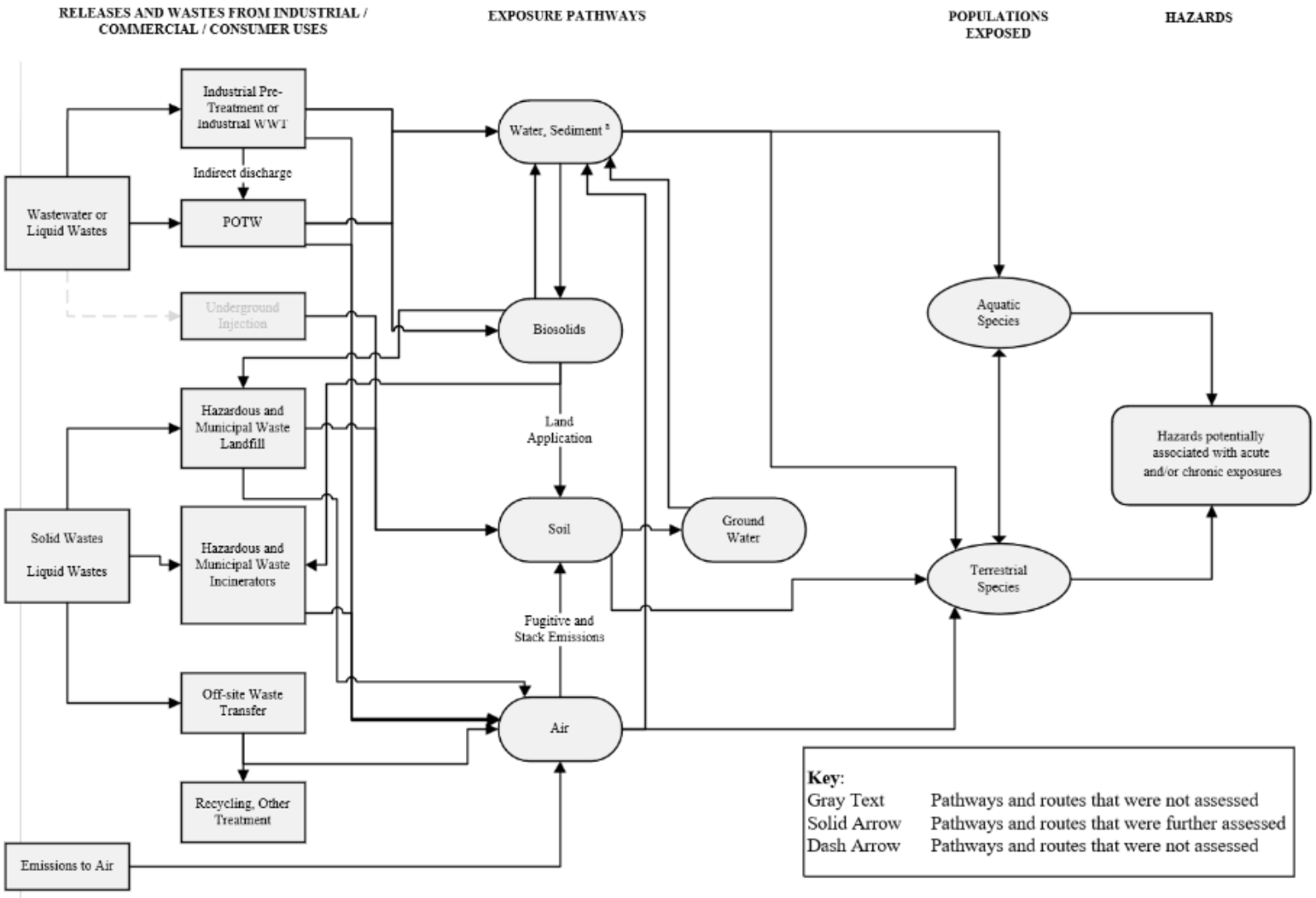

Figure 1-7. DCHP Conceptual Model for Environmental Releases and Wastes: Ecological Exposures and Hazards

The conceptual model presents the exposure pathways, exposure routes, and hazards to human populations from releases and wastes from industrial, commercial, and/or consumer uses of DCHP. [a] Industrial wastewater or liquid wastes may be treated on-site and then released to surface water (direct discharge), or pre-treated and released to POTWs (indirect discharge). For consumer uses, such wastes may be released directly to POTW. Drinking water will undergo further treatment in drinking water treatment plant. Groundwater may also be a source of drinking water. Inhalation from drinking water may occur via showering.

1.1.3 Populations and Durations of Exposure Assessed

Based on the conceptual models presented in Section 1.1.2.1, EPA evaluated risk to humans and the environment. Environmental risks were evaluated for acute and chronic exposure scenarios for aquatic and terrestrial species, as appropriate. Human health risks associated with exposure to DCHP were evaluated for acute, intermediate, and chronic exposure scenarios, as applicable based on reasonably available exposure and hazard data as well as the relevant populations for each. Human populations assessed include the following:

- Workers, including average adults and women of reproductive age;
- ONUs, including average adults;
- Consumers, including infants (<1 year), toddlers (1–2 years), children (3–5 and 6–10 years), young teens (11–15 years), teenagers (16–20 years), and adults (21+ years);
- Bystanders, including infants (<1 year), toddlers (1–2 years), and children (3–5 and 6–10 years), young teens (11–15 years), teenagers (16–20 years), and adults (21+ years);
- General population, including infants (<1 year), toddlers (1–5 years), children (6–10 years), youth (11–15 and 16–20 years), and adults (21+ years).
- The age groups for consumers, bystanders, and general population are different because each life stage used unique exposure factors (*e.g.*, mouthing, drinking water ingestion, fish consumption rates). These exposure factors are provided in EPA's *Exposure Factors Handbook: 2011 Edition* (U.S. EPA, 2011b).

Consistent with its *Draft Proposed Approach for Cumulative Risk Assessment (CRA) of High-Priority Phthalates and a Manufacturer-Requested Phthalate under the Toxic Substances Control Act* (U.S. EPA, 2023c), EPA is focusing its relative potency factor (RPF) analysis and phthalate CRA on populations most relevant to the common hazard endpoint (*i.e.*, reduced fetal testicular testosterone)—specifically women of reproductive age and male infants and male children. This approach emphasizes a common health effect for sensitive subpopulations; however, additional health endpoints are identified for broader populations and described in the individual non-cancer human health hazard assessments for DCHP (U.S. EPA, 2024v), DEHP (U.S. EPA, 2024w), DBP (U.S. EPA, 2024u), BBP (U.S. EPA, 2024t), DIBP (U.S. EPA, 2024x), and DINP (U.S. EPA, 2025b). Additionally, EPA is focusing its RPF and CRA on acute duration exposures. This is because—as described further in the *Draft Technical Support Document for the CRA of DEHP, DBP, BBP, DIBP, DCHP, and DINP under TSCA* (U.S. EPA, 2024ah)—there is evidence that effects on the developing male reproductive system consistent with a disruption of androgen action can result from a single exposure during the critical window of development.

1.1.3.1 Potentially Exposed and Susceptible Subpopulations

TSCA section 6(b)(4)(A) requires that risk evaluations "determine whether a chemical substance presents an unreasonable risk of injury to health or the environment, without consideration of costs or other non-risk factors, including an unreasonable risk to a potentially exposed or susceptible subpopulation identified as relevant to the risk evaluation by the Administrator, under the conditions of use." TSCA section 3(12) states that "the term 'potentially exposed or susceptible subpopulation' [PESS] means a group of individuals within the general population identified by the Administrator who, due to either greater susceptibility or greater exposure, may be at greater risk than the general population of adverse health effects from exposure to a chemical substance or mixture, such as infants, children, pregnant women, workers, or the elderly."

This draft risk evaluation considers PESS throughout the human health risk assessment (Section 4), including throughout the exposure assessment, hazard identification, and dose-response analysis

supporting this assessment. EPA incorporated the following PESS into its assessment—women of reproductive age; pregnant women, infants, children and adolescents; people who frequently use consumer products and/or articles containing high-concentrations of DCHP; people exposed to DCHP in the workplace; and people who may be in proximity to releasing facilities, including fenceline communities, and people whose diets include large amounts of fish (*i.e.*, subsistence fisher and Tribal populations). These subpopulations are PESS because some have greater exposure to DCHP per body weight (*e.g.*, infants, children, adolescents), while some experience aggregate or sentinel exposures. EPA also evaluated non-attributable exposures and cumulative risk to phthalates (*i.e.*, DEHP, DBP, BBP, DIBP, and DINP) for the U.S. civilian population using NHANES biomonitoring data. This non-attributable cumulative risk from exposure to DEHP, DBP, BBP, DIBP, and DINP was taken into consideration as part of EPA's cumulative risk calculations for DCHP, presented below in Sections 4.4.4 and 4.4.5 and around exposures to DCHP from both occupational and consumer COUs/OES.

Section 4.3.5 summarizes how PESS were incorporated into the risk evaluation through consideration of potentially increased exposures and/or potentially increased biological susceptibility and summarizes additional sources of uncertainty related to consideration of PESS.

1.2 Organization of the Risk Evaluation

This draft risk evaluation for DCHP includes five additional major sections, and several appendices, as listed below:

- Section 2 summarizes basic physical and chemical characteristics as well as the fate and transport of DCHP.
- Section 3 includes an overview of releases and concentrations of DCHP in the environment.
- Section 4 presents the human health risk assessment, including the exposure, hazard, and risk characterization based on the DCHP COUs. It includes a discussion of PESS based on both greater exposure and/or susceptibility as well as a description of aggregate and sentinel exposures. Section 4 also includes EPA's CRA of DCHP, DEHP, DBP, BBP, DIBP, and DINP.
- Section 5 provides a discussion and analysis of the environmental risk assessment, including the environmental exposure, hazard, and risk characterization based on the COUs for DCHP. It also discusses assumptions and uncertainties and how they impact EPA's overall confidence in risk estimates.
- Section 6 presents EPA's proposed determination of whether the chemical presents an unreasonable risk to human health or the environment as a whole chemical approach and under the assessed COUs.
- Appendix A provides a list of key abbreviations and acronyms used throughout this draft risk evaluation.
- Appendix B provides a brief summary of the federal, state, and international regulatory history of DCHP.
- Appendix C incudes a list and citations for all TSDs and supplemental files included in the draft risk evaluation for DCHP.
- Appendix D provides a summary of updates made to COUs for DCHP from the final scope document to this draft risk evaluation.
- Appendix E provides descriptions of the DCHP COUs evaluated by EPA.
- Appendix F provides the draft occupational exposure value for DCHP that was derived by EPA.

2 CHEMISTRY AND FATE AND TRANSPORT OF DCHP

Physical and chemical properties determine the behavior and characteristics of a chemical that inform its COUs, environmental fate and transport, potential toxicity, exposure pathways, routes, and hazards. Environmental fate and transport includes environmental partitioning, accumulation, degradation, and transformation processes. Environmental transport is the movement of the chemical within and between environmental media, such as air, water, soil, and sediment. Thus, understanding the environmental fate of DCHP informs the specific exposure pathways, and potential human and environmental exposed populations that EPA considered in this draft risk evaluation.

Sections 2.1 and 2.2 summarize the physical and chemical properties, and environmental fate and transport of DCHP, respectively. EPA's *Draft Physical Chemistry and Fate and Transport Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024z) provides further details.

2.1 Summary of Physical and Chemical Properties

EPA gathered and evaluated physical and chemical property data and information according to the process described in the *Draft Systematic Review Protocol for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024ag). During the evaluation of DCHP, EPA considered both measured and estimated physical and chemical property data/information summarized in Table 2-1, as applicable. Information on the full, extracted data set is available in the *Data Quality Evaluation and Data Extraction Information for Physical and Chemical Properties for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024j).

Table 2-1. Physical and Chemical Properties of DCHP

Property	Selected Value	Reference	Overall Quality Rating
Molecular Formula	$C_{20}H_{26}O_4$		
Molecular Weight	330.43 g/mol		
Physical Form	Solid, prism	(Haynes, 2014)	High
Physical Properties	White granular solid	(NLM, 2024)	High
Melting Point	66 °C	(Haynes, 2014)	High
Boiling Point	225 °C at 4 mm Hg	(Haynes, 2014)	High
Density	1.383 g/cm^3	(Haynes, 2014)	High
Vapor Pressure	8.69 ×10^{-7} mmHg	(NLM, 2024)	High
Vapor Density	No data		
Water Solubility	0.030–1.48 mg/L [a]	(U.S. EPA, 2017)	Medium
Octanol:Water Partition coefficient (log KOW)	4.82	(EC/HC, 2017)	High
Octanol:Air Partition Coefficient (log K_{OA})	10.23 [a]	(U.S. EPA, 2017)	Medium
Henry's Law Constant	9.446×10^{-8} atm·m^3/mol at 25 °C [a]	(U.S. EPA, 2017)	Medium
Flash Point	207 °C	(RSC, 2019)	Medium
Auto-Flammability	No data		
Viscosity	Solid, N/A	(NLM, 2024)	High

[a] Modeled value using EPI Suite™

2.2 Summary of Environmental Fate and Transport

Reasonably available environmental fate data—including biotic and abiotic biodegradation rates, removal during wastewater treatment, volatilization from lakes and rivers, and organic carbon:water partition coefficient (log K_{OC})—are the parameters used in this draft risk evaluation. In assessing the environmental fate and transport of DCHP, EPA considered the full range of results from the available data sources with medium and high data quality ratings collected through systematic review. Information on the full extracted data set is available in the *Data Quality Evaluation and Data Extraction Information for Physical and Chemical Properties for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024j).

Other fate estimates were based on modeling results from EPI Suite™ (U.S. EPA, 2012), a predictive tool for physical and chemical properties and environmental fate estimation.

EPA evaluated the reasonably available information to characterize the physical and chemical properties and environmental fate and transport of DCHP. The key points are summarized below; DCHP

- Is a granular, crystalline solid under environmental conditions.
- Has a tendency to partition to soil, sediment, and particulate over water or air.
- Has limited solubility in water.
- Has low volatility in water or soil.

Given consistent results from numerous high-quality studies, there is robust evidence that when present in the environment, DCHP

- May degrade through hydrolysis, photolysis, aerobic or anaerobic biodegradation.
- May transport through the air and be deposited to soil or water.
- Will sorb to particulate in the atmosphere and in water.
- Is expected to be removed in wastewater treatment processes by sorbing to particulate, biosolids, and sludge.

As a result of limited studies identified, there is moderate confidence that DCHP

- Might be partially removed in conventional drinking water treatment.
- Might accumulate in individual fish and aquatic organisms, but is not expected to move up the food chain in aquatic environments.

The following bullets summarize the key points of the partitioning analysis; DCHP

- Will remain mostly in water but may sorb to sediment when released to aquatic environments.
- Will sorb to atmospheric particulate but may end up in small amounts in soil, water, and sediment when released to air.
- Will remain exclusively in soil when released to soil.
- Will sorb to particulate phases (soil, sediment, air particulate) with a small amount ending up in water when released to all three phases (air, water, and soil).

3 RELEASES AND CONCENTRATIONS OF DCHP IN THE ENVIRONMENT

EPA estimated environmental releases and concentrations of DCHP. Section 3.1 describes the approach and methodology for estimating releases, Section 3.2 presents environmental release estimates, and Section 3.3 presents the approach and methodology for estimating environmental concentrations as well as a summary of concentrations of DCHP in the environment.

3.1 Approach and Methodology

At the time of this draft risk evaluation, releases of DCHP have not been reported to programmatic databases, including the Toxics Release Inventory (TRI), Discharge Monitoring Report (DMR), or National Emissions Inventory (NEI). Therefore, EPA utilized models to estimate environmental releases for each OES. This section provides an overview of the approach and methodology for assessing releases to the environment from industrial, commercial, and consumer uses. Specifically, Sections 3.1.1 through 3.1.3 describe the approach and methodology for estimating releases to the environment from industrial and commercial uses, and Section 3.1.4 describes the approach and methodology for assessing down-the-drain releases from consumer uses.

3.1.1 Manufacturing, Processing, Industrial and Commercial Use

This subsection describes the grouping of manufacturing, processing, industrial and commercial COUs into OESs, as well as the use of DCHP within each OES. Specifically, Section 3.1.1.1 provides a crosswalk of COUs to OESs and Section 3.1.1.2 provides descriptions for the use of DCHP within each OES.

3.1.1.1 Crosswalk of Conditions of Use to Occupational Exposure Scenarios

EPA categorized the COUs listed in Table 1-1 into OESs. Table 3-1 provides a crosswalk between the COUs and OESs. Each OES is developed based on a set of occupational activities and conditions such that similar occupational exposures and environmental releases are expected from the use(s) covered under that OES. For each OES, EPA provided occupational exposure and environmental release results, which are expected to be representative of the entire population of workers and sites for the given OES in the United States. In some cases, EPA defined only a single OES for multiple COUs, while in other cases the Agency developed multiple OESs for a single COU. EPA made this determination by considering variability in release and use conditions and whether the variability required discrete scenarios or could be captured as a distribution of exposures. The *Draft Environmental Release and Occupational Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024q) provides further information on specific OESs.

797 **Table 3-1. Crosswalk of Conditions of Use to Assessed Occupational Exposure Scenarios**

Life Cycle Stage	Category	Subcategory	OES
Manufacturing	Domestic manufacturing	Domestic manufacturing	Manufacturing
	Importing	Importing	Import and repackaging
Processing	Repackaging	Repackaging (*e.g.*, laboratory chemicals)	Import and repackaging
	Processing – incorporation into formulation, mixture, or reaction product	Adhesive and sealant chemicals in: - Adhesive manufacturing	Incorporation into adhesives and sealants
		Plasticizer in: - Adhesive manufacturing - Paint and coating manufacturing - Plastics product manufacturing - Printing ink manufacturing - Rubber product manufacturing - Plastic material and resin manufacturing	Incorporation into adhesives and sealants; Incorporation into paints and coatings; PVC plastics compounding; non-PVC material compounding
		Stabilizing agent in: - Plastics product manufacturing - Paint and coating manufacturing - Asphalt paving, roofing, and coating materials manufacturing - Adhesive manufacturing	Incorporation into adhesives and sealants; Incorporation into paints and coatings; Incorporation into other formulations, mixtures, or reaction products; PVC plastics compounding; non-PVC material compounding
	Processing – incorporation into article	Plasticizer in: - Plastics product manufacturing - Rubber product manufacturing	PVC plastics converting; non-PVC material converting
	Recycling	Recycling	Recycling
Distribution	Distribution in commerce	Distribution in commerce	Distribution in commerce
Industrial Use	Adhesives and sealants	Adhesives and sealants in: - Transportation equipment manufacturing - Computer and electronic product manufacturing	Application of adhesives and sealants
	Finishing agent	Cellulose film production	Application of paints and coatings
	Inks, toner, and colorant products	Inks, toner, and colorant products (*e.g.*, screen printing ink)	Application of paints and coatings
	Paints and coatings	Paints and coatings	Application of paints and coatings

Life Cycle Stage	Category	Subcategory	OES
	Plastic and rubber products not covered elsewhere	Plastic and rubber products not covered elsewhere in: - Transportation equipment manufacturing	Fabrication or use of final products or articles
Commercial Use	Adhesives and sealants	Adhesives and sealants	Application of adhesives and sealants
	Building/construction materials not covered elsewhere	Building/construction materials not covered elsewhere	Fabrication or use of final products or articles
	Inks, toner, and colorant products	Inks, toner, and colorant products (*e.g.*, screen printing ink)	Application of paints and coatings
	Laboratory chemical	Laboratory chemical	Use of laboratory chemicals
	Paints and coatings	Paints and coatings	Application of paints and coatings
	Other articles with routine direct contact during normal use including rubber articles; plastic articles (hard)	Other articles with routine direct contact during normal use including rubber articles; plastic articles (hard)	Fabrication or use of final products or articles
Disposal	Disposal	Disposal	Waste handling, treatment, and disposal

3.1.1.2 Description of DCHP Use for Each OES

After EPA characterized the OESs for the occupational exposure assessment of DCHP, the occupational uses of DCHP for all OESs were summarized. Brief summaries of the uses of DCHP for all OESs are presented in Table 3-2.

Table 3-2. Description of the Use of DCHP for Each OES

OES	Use of DCHP
Manufacturing	DCHP is formed through the reaction of phthalic anhydride with cyclohexane ring alcohols (cyclohexanol).
Import and repackaging	DCHP is imported domestically for use and/or may be repackaged before shipment to formulation sites.
PVC plastics compounding	DCHP is used as an additive in PVC plastics to increase flexibility.
PVC plastics converting	
Incorporation into adhesives and sealants	DCHP is a plasticizer and stabilizing agent in adhesive and sealant products for industrial and commercial use.
Incorporation into paints and coatings	DCHP is a plasticizer and stabilizing agent in paint and coating products for industrial and commercial use.
Incorporation into other formulations, mixtures, or reaction products, not covered elsewhere	DCHP is incorporated into products, such as laboratory chemicals and asphalt paving, roofing, and coating materials.

OES	Use of DCHP
Non-PVC material compounding	DCHP is used as an additive in non-PVC polymers, such as rubber and cellulose, to increase flexibility.
Non-PVC material converting	
Application of adhesives and sealants	Industrial and commercial sites often apply DCHP in powdered form to serve as a hardener, thickener, or curing agent for adhesive and sealant materials. Liquid adhesive and sealant products containing DCHP are generally thick and paste-like, and these products are applied using roll or bead application methods. Products may also be applied using a syringe or caulk gun.
Application of paints and coatings	Industrial and commercial sites apply DCHP-containing paints and coatings using roll, brush, trowel, and spray application methods.
Use of laboratory chemicals	DCHP is a laboratory chemical used for laboratory analyses in solid and liquid forms.
Recycling	A fraction of PVC plastics that contain DCHP are recycled either in-house or at PVC recycling facilities for continuous compounding of new PVC material.
Fabrication or use of final products or articles	DCHP is found in a wide array of different final articles not found in other OES such as wall coverings or other solid plastic or rubber products.
Waste handling, treatment, and disposal	DCHP-containing products or residuals are managed as waste to be treated and/or disposed.

3.1.2 Estimating the Number of Release Days per Year for Facilities in Each OES

Based on the limited data on the number of release days for the majority of the OESs, EPA developed generic estimates of the number of annual operating days (days/year) for facilities in each OES, as presented in Table 3-3. Generally, EPA does not have information on the number of operating days for facilities; however, the Agency used Generic Scenarios (GSs) or Emission Scenario Documents (ESDs) to assess the number of operating days for a given OES. EPA estimated average daily releases for facilities by assuming that the number of release days is equal to the number of operating days.

Table 3-3. Generic Estimates of Number of Operating Days per Year for Each OES

Occupational Exposure Scenario	Operating Days (days/yr)	Basis
Manufacturing	250	EPA assumed year-round site operation for 5 days each week, considering a 2-week downtime, totaling 250 days/year.
Import and repackaging	208–260	The 2022 Chemical Repackaging GS estimated the total number of operating days as one of three discrete values based on the typical shift lengths of operators over the course of a full year. Shift lengths include 8, 10, or 12 hour/day shifts, which resulted in operating day estimates of 174, 208, or 260 days/year. EPA assessed releases using Monte Carlo modeling (see *Draft Environmental Release and Occupational Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024q)), which used a 50th to 95th percentile range of 208–260 days/year (U.S. EPA, 2022a).

Occupational Exposure Scenario	Operating Days (days/yr)	Basis
Incorporation into adhesives and sealants	250	EPA assumed year-round site operation for 5 days each week, considering a 2-week downtime, totaling 250 days/year.
Incorporation into paints and coatings	250	EPA assumed year-round site operation for 5 days each week, considering a 2-week downtime, totaling 250 days/year.
Incorporation into other formulations, mixtures, and reaction products not covered elsewhere	250	EPA assumed year-round site operation for 5 days each week, considering a 2-week downtime, totaling 250 days/year.
PVC plastics compounding	223–254	The 2021 *Revised Draft GS on the Use of Additives in Plastic Compounding* estimated the number of operating days as 148–264 days/year. Release estimates that EPA assessed using Monte Carlo modeling (see *Draft Environmental Release and Occupational Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024q)) used a 50th to 95th percentile range of 223–254 days/year (U.S. EPA, 2021d, 2014c).
PVC plastics converting	219–251	The 2021 Revised Draft GS on the Use of Additives in the Thermoplastics Converting Industry estimated the number of operating days as 138–253 days/year. Release estimates that EPA assessed using Monte Carlo modeling (see *Draft Environmental Release and Occupational Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024q)) used a 50th to 95th percentile range of 219–251 days/year (U.S. EPA, 2021e).
Non-PVC material compounding	234–280	The 2021 Revised Draft GS on the Use of Additives in Plastic Compounding and the 2020 *SpERC Factsheet on Rubber Production and Processing* estimated the total number of operating days as 148–300 days/year. Release estimates that EPA assessed using Monte Carlo modeling (see *Draft Environmental Release and Occupational Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024q)) used a 50th to 95th percentile range of 234–280 days/year (U.S. EPA, 2021d; ESIG, 2020b; U.S. EPA, 2014c)
Non-PVC material converting	219–251	The 2021 *Revised Draft GS on the Use of Additives in the Thermoplastics Converting Industry* estimated the number of operating days as 137–254 days/year. Release estimates that EPA assessed using Monte Carlo modeling (see *Draft Environmental Release and Occupational Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024q)) used a 50th to 95th percentile range of 219–251 days/year (U.S. EPA, 2021e).
Application of adhesives and sealants	232–325	Based on several end use products categories, the 2015 ESD on the Use of Adhesives estimated the total number of operating days as 50–365 days/year. Release estimates that EPA assessed using Monte Carlo modeling (*Draft*

Occupational Exposure Scenario	Operating Days (days/yr)	Basis
		Environmental Release and Occupational Exposure Assessment for Dicyclohexyl Phthalate (DCHP) (U.S. EPA, 2024q)) used a 50th to 95th percentile range of 232–325 days/year (OECD, 2015b).
Application of paints and coatings	257–287	EPA assessed the total number of operating days based on the 2011 ESD on Radiation Curable Coatings, Inks and Adhesives, the 2011 ESD on Coating Application via Spray-Painting in the Automotive Finishing Industry, the 2004 GS on Spray Coatings in the Furniture Industry, and the *SpERC Factsheet for Industrial Application of Coatings and Inks by Spraying*. These sources estimated the total number of operating days as 225–300 days/year. Release estimates that EPA assessed using Monte Carlo modeling (*Draft Environmental Release and Occupational Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024q)) used a 50th to 95th percentile range of 257–287 days/year (ESIG, 2020a; OECD, 2011a, b; U.S. EPA, 2004c).
Use of laboratory chemicals	Solid and Liquid: 235–258	The 2023 Use of Laboratory Chemicals GS estimated the total number of operating days with a discrete distribution based on the shift lengths of operators over the course of a full year. Shift lengths include 8, 10, or 12 hour/day shifts, which result in a range of 174–260 days/year for operating days. Release estimates that EPA assessed using Monte Carlo modeling (*Draft Environmental Release and Occupational Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024q)) used a 50th to 95th percentile range of 235–258 days/year (U.S. EPA, 2023g).
Fabrication or use of final products or articles	250	EPA assumed year-round site operation for 5 days each week, considering a 2-week downtime, totaling 250 days/year. However, EPA was not able to perform a quantitative release assessment for this OES because the release parameters were unknown and unquantifiable.
Recycling	223–254	The 2021 Revised Draft GS on the Use of Additives in Plastic Compounding estimated the number of operating days as 148–264 days/year. Release estimates that EPA assessed using Monte Carlo modeling (see *Draft Environmental Release and Occupational Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024q)) used a 50th to 95th percentile range of 223–254 days/year (U.S. EPA, 2021d, 2014c).
Waste handling, treatment, and disposal	250	EPA assumed year-round site operation for 5 days each week, considering a 2-week downtime, totaling 250 days/year.

3.1.3 Daily Release Estimation

For each OES, EPA estimated releases to each medium of release using 2020 CDR data (U.S. EPA, 2020a), GSs and ESDs, and EPA published models as shown in Figure 3-1. Where available, EPA used GSs or ESDs to estimate number of release days, which EPA used to convert between annual release

estimates and daily release estimates. EPA used 2020 CDR, 2020 U.S. County Business Practices, and Monte Carlo modeling data to estimate the number of sites using DCHP within an OES. Generally, information for reporting sites in CDR was sufficient to accurately characterize each reporting site's OES. The *Draft Environmental Release and Occupational Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024q) describes EPA's approach and methodology for estimating daily releases and provides detailed facility level results for each OES.

For each OES, EPA estimated DCHP releases per facility to each release medium applicable to that OES. For DCHP, EPA assessed releases to water, air, or land (*i.e.*, disposal to land).

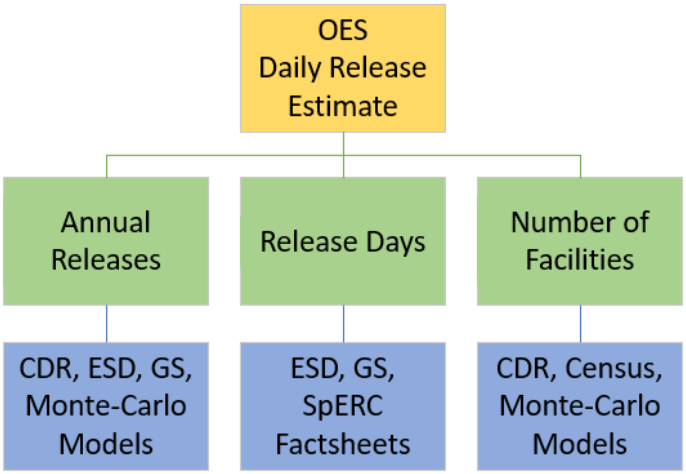

Figure 3-1. An Overview of How EPA Estimated Daily Releases for Each OES
CDR = Chemical Data Reporting; ESD = Emission Scenario Document; GS = Generic Scenario; SpERC = Specific Environmental Release Category

3.1.4 Consumer Down-the-Drain and Landfills

EPA evaluated down-the-drain releases of DCHP for consumer COUs qualitatively. Although the Agency acknowledges that there may be DCHP releases to the environment via the cleaning and disposal of adhesives and sealants, the Agency did not quantitatively assess down-the-drain and disposal scenarios of consumer products due to limited information from monitoring data as well as limited availability of modeling tools that can adequately quantify disposal. EPA provides a qualitative assessment of down-the-drain releases of DCHP using physical and chemical properties in this section. See EPA's *Draft Consumer and Indoor Dust Exposure Assessment for Dicyclohexyl phthalate (DCHP)* (U.S. EPA, 2024c) for further details. For example, adhesives and sealants can be disposed down-the-drain when people using them wash their hands, brushes, sponges, and other product-applying tools. Very limited information is available on wastewater treatment and the removal of DCHP in drinking water treatment plants. As stated in the *Draft Physical Chemistry and Fate And Transport Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024z), no data was identified by the EPA for DCHP in drinking water. Based on the low water solubility and log K_{OW}, DCHP in water is expected to mainly partition to suspended solids present in water. The available information suggest that the use of flocculants and filtering media could potentially help remove DCHP during drinking water treatment by sorption into suspended organic matter, settling, and physical removal.

In addition, adhesives and sealant products can be disposed of when users no longer have use for them or when the products have reached the product shelf life and are taken to landfills. All other solid products and articles listed in Table 4-6 can be removed and disposed of in landfills, or other waste handling locations that properly manage the disposal of products like adhesives and sealants. DCHP is

expected to be persistent as it leaches from consumer products disposed of in landfills. Due to low water solubility, DCHP is likely to be present in landfill leachate up to its aqueous limit of solubility (1.48 mg/L). However, due to its affinity for organic carbon, DCHP is expected to be immobile in groundwater. Even in cases where landfill leachate containing DCHP were to migrate to groundwater, DCHP would likely partition from groundwater to organic carbon present in the subsurface (U.S. EPA, 2024p).

3.2 Summary of Environmental Releases

3.2.1 Manufacturing, Processing, Industrial and Commercial

EPA combined its estimates for total production volume, release days, number of facilities, and hours of release per day to estimate a range of daily releases for each OES. Table 3-4 presents a summary of these ranges across facilities. See the *Draft Environmental Release and Occupational Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024q) for additional detail on deriving the overall confidence score for each OES. EPA was not able to estimate site-specific releases for the fabrication or use of final products or articles OES. Disposal sites handling post-consumer, end-use DCHP were not quantifiable due to the wide and disperse use of DCHP in PVC and other products. Pre-consumer waste handling, treatment, and disposal are assumed to be captured in upstream OESs.

Table 3-4. Summary of EPA's Daily Release Estimates for Each OES and EPA's Overall Confidence in these Estimates

OES	Estimated Daily Release across Sites (kg/site-day)		Type of Discharge,[a] Air Emission,[b] or Transfer for Disposal[c]	Estimated Release Frequency across Sites (days)[d]		Number of Facilities[e]	Weight of Scientific Evidence Rating[f]	Sources
	Central Tendency	High-End		Central Tendency	High-End			
Manufacturing	9.4E–02	0.42	Stack Air	250		1 – LANXESS Corporation, Pittsburgh, PA	Moderate	CDR, Peer-reviewed literature (GS/ESD)
	0.12	0.55	Fugitive Air, Water, Incineration, or Landfill					
	0.94		Water, Incineration, or Landfill					
	0.15	0.57	Incineration or Landfill					
	2.5	11	Stack Air	250		1 – Vertellus LLC, Indianapolis, IN	Moderate	CDR, Peer-reviewed literature (GS/ESD)
	3.2	15	Fugitive Air, Water, Incineration, or Landfill					
	12		Water, Incineration, or Landfill					
	4.0	15	Incineration or Landfill					
Import and repackaging	1.5	9.3	Stack Air	208	260	2 – United Initiators, Inc., Elyria, OH; Nouryon Chemicals LLC, Chicago, IL	Moderate	CDR, Peer-reviewed literature (GS/ESD)
	1.9	12	Fugitive Air, Water, Incineration, or Landfill					
	4.0	8.2	Water, Incineration, or Landfill					
	2.4	13	Incineration or Landfill					

OES	Estimated Daily Release across Sites (kg/site-day)		Type of Discharge,[a] Air Emission,[b] or Transfer for Disposal[c]	Estimated Release Frequency across Sites (days)[d]		Number of Facilities[e]	Weight of Scientific Evidence Rating[f]	Sources
	Central Tendency	High-End		Central Tendency	High-End			
Incorporation into adhesives and sealants	0.11	0.70	Stack Air	250		5–9 generic sites	Moderate	CDR, Peer-reviewed literature (GS/ESD)
	0.14	0.93	Fugitive Air, Water, Incineration, or Landfill					
	2.6	4.9	Water, Incineration, or Landfill					
	0.18	0.99	Incineration or Landfill					
Incorporation into paints and coatings	1.2E–02	0.10	Stack Air	250		20–34 generic sites	Moderate	CDR, Peer-reviewed literature (GS/ESD)
	1.6E–02	0.14	Fugitive Air, Water, Incineration, or Landfill					
	1.1	3.0	Water, Incineration, or Landfill					
	2.0E–02	0.15	Incineration or Landfill					
Incorporation into other formulations, mixtures, and reaction products	8.3E–02	0.78	Stack Air	250		11–22 generic sites	Moderate	CDR, Peer-reviewed literature (GS/ESD)
	0.11	1.0	Fugitive Air, Water, Incineration, or Landfill					
	0.13	1.2	Water, Incineration, or Landfill					
	0.13	1.2	Incineration or Landfill					

OES	Estimated Daily Release across Sites (kg/site-day)		Type of Discharge,[a] Air Emission,[b] or Transfer for Disposal[c]	Estimated Release Frequency across Sites (days)[d]		Number of Facilities[e]	Weight of Scientific Evidence Rating[f]	Sources
	Central Tendency	High-End		Central Tendency	High-End			
PVC plastics compounding	0.12	4.1	Fugitive or Stack Air	223	254	5–9 generic sites	Moderate	CDR, Peer-reviewed literature (GS/ESD)
	0.83	7.9	Fugitive Air, Water, Incineration, or Landfill					
	3.5	18	Water, Incineration, or Landfill					
	1.1	6.1	Water					
	1.4	11	Incineration or Landfill					
PVC plastics converting	7.2E–03	0.19	Fugitive or Stack Air	219	251	42–67 generic sites	Moderate	CDR, Peer-reviewed literature (GS/ESD)
	4.7E–02	0.35	Fugitive Air, Water, Incineration, or Landfill					
	0.96	1.9	Water, Incineration, or Landfill					
	0.13	0.41	Water					
	0.43	1.4	Incineration or Landfill					
Non-PVC material compounding	3.1E–02	0.88	Fugitive or Stack Air	234	280	2–4 generic sites	Moderate	CDR, Peer-reviewed literature (GS/ESD)
	0.25	1.6	Fugitive Air, Water, Incineration, or Landfill					
	1.5	2.9	Water, Incineration, or Landfill					
	0.30	0.90	Water					
	0.41	2.1	Incineration or Landfill					

OES	Estimated Daily Release across Sites (kg/site-day)		Type of Discharge,[a] Air Emission,[b] or Transfer for Disposal[c]	Estimated Release Frequency across Sites (days)[d]		Number of Facilities[e]	Weight of Scientific Evidence Rating[f]	Sources
	Central Tendency	High-End		Central Tendency	High-End			
Non-PVC material converting	2.0E–02	0.47	Fugitive or Stack Air	219	251	2–4 generic sites	Moderate	CDR, Peer-reviewed literature (GS/ESD)
	0.13	0.86	Fugitive Air, Water, Incineration, or Landfill					
	1.1	2.9	Water, Incineration, or Landfill					
	0.32	0.96	Water					
	1.1	3.3	Incineration or Landfill					
Application of paints and coatings with overspray controls (no overspray controls)	5.8E–09 [5.8E–09]	1.3E–08 [1.3E–08]	Fugitive Air	257	287	1–14 generic sites [1–14 generic sites]	Moderate	CDR, Peer-reviewed literature (GS/ESD)
	1.4 [7.4E–02]	5.1 [0.63]	Stack Air					
	9.4E–02 [13]	0.82 [47]	Fugitive Air, Water, Incineration, or Landfill					
	1.3 [1.3]	3.3 [3.3]	Water, Incineration, or Landfill					
	11 [0.12]	42 [0.88]	Incineration or Landfill					
Application of adhesives and sealants	5.7E–10	1.5E–09	Fugitive Air	232	325	6–80 generic sites	Moderate	CDR, Peer-reviewed literature (GS/ESD)
	4.2E–02	0.46	Stack Air					
	5.3E–02	0.61	Fugitive Air, Water, Incineration, or Landfill					
	0.33	1.6	Water, Incineration, or Landfill					
	0.67	3.6	Incineration or Landfill					

OES	Estimated Daily Release across Sites (kg/site-day)		Type of Discharge,[a] Air Emission,[b] or Transfer for Disposal[c]	Estimated Release Frequency across Sites (days)[d]		Number of Facilities[e]	Weight of Scientific Evidence Rating[f]	Sources
	Central Tendency	High-End		Central Tendency	High-End			
Use of laboratory chemicals – liquid	1.5E–12	2.6E–12	Fugitive or Stack Air	235	258	36,873 generic sites	Moderate	CDR, Peer-reviewed literature (GS/ESD)
	4.0E–03	5.0E–03	Water, Incineration, or Landfill					
Use of laboratory chemicals – solid	1.2E–04	1.0E–03	Stack Air	235	258	1,978–25,643 generic sites	Moderate	
	2.3E–04	2.0E–03	Unknown Media (Air, Water, Incineration, or Landfill)					
	6.6E–02	0.27	Water, Incineration, or Landfill					
	3.1E–04	3.0E–03	Incineration or Landfill					
Recycling	7.4E–04	4.3E–03	Stack Air	223	254	58 generic sites	Moderate	CDR, Peer-reviewed literature (GS/ESD)
	2.8E–03	9.2E–03	Fugitive Air, Water, Incineration, or Landfill					
	1.9E–03	3.9E–03	Water					
	1.3	1.8	Water, Incineration, or Landfill					

[a] Direct discharge to surface water; indirect discharge to non-POTWs; indirect discharge to POTWs
[b] Emissions via fugitive air or stack air, or treatment via incineration
[c] Transfer to surface impoundment, land application, or landfills
[d] Where available, EPA used industry provided information, ESDs, or GSs to estimate the number of release days for each COU.
[e] Where available, EPA used 2020 CDR (U.S. EPA, 2020a), 2020 U.S. County Business Practices (U.S. Census Bureau, 2022), and Monte Carlo models to estimate the number of sites that use DCHP for each COU.
[f] See Section 3.2.2 for details on EPA's determination of the weight of scientific evidence rating.

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3.2.2 Weight of Scientific Evidence Conclusions for Environmental Releases from Industrial and Commercial Sources

For each OES, EPA considered the assessment approach, the quality of the data and models, and the uncertainties in the assessment results to determine a level of confidence for the environmental release estimates. Table 3-5 provides the Agency's weight of scientific evidence rating for each OES.

EPA integrated numerous evidence streams across systematic review sources to develop environmental estimates for DCHP. The Agency made a judgment on the weight of scientific evidence supporting the release estimates based on the strengths, limitations, and uncertainties associated with the release estimates. EPA described this judgment using the following confidence descriptors: robust, moderate, slight, or indeterminate.

In determining the strength of the overall weight of scientific evidence, EPA considered factors that increase or decrease the strength of the evidence supporting the release estimate (whether measured or estimated)—including quality of the data/information, relevance of the data to the release scenario (including considerations of temporal and spatial relevance), and the use of surrogate data when appropriate. In general, higher rated studies (as determined through data evaluation) increase the weight of scientific evidence when compared to lower rated studies, and EPA gave preference to chemical- and scenario-specific data over surrogate data (*e.g.*, data from a similar chemical or scenario). For example, a conclusion of moderate weight of scientific evidence is appropriate where there is measured release data from a limited number of sources, such that there is a limited number of data points that may not cover most or all the sites within the OES. A conclusion of slight weight of scientific evidence is appropriate where there is limited information that does not sufficiently cover all sites within the COU, and the assumptions and uncertainties are not fully known or documented. See EPA's *Draft Systematic Review Protocol Supporting TSCA Risk Evaluations for Chemical Substances, Version 1.0: A Generic TSCA Systematic Review Protocol with Chemical-Specific Methodologies* (also called "Draft Systematic Review Protocol") (U.S. EPA, 2021a) for additional information on weight of scientific evidence conclusions.

Table 3-5 summarizes EPA's overall weight of scientific evidence conclusions for its release estimates for each OES. In general, modeled data had data quality ratings of medium. As a result, for releases that used GSs/ESDs, the weight of scientific evidence conclusion was moderate, when used in tandem with Monte Carlo modeling.

Table 3-5. Summary of Overall Confidence in Environmental Release Estimates by Occupational Exposure Scenario

OES	Weight of Scientific Evidence Conclusion in Release Estimates
Manufacturing	EPA found limited chemical specific data for the manufacturing OES and assessed environmental releases using models and model parameters derived from CDR, the *2023 Methodology for Estimating Environmental Releases from Sampling Wastes* (U.S. EPA, 2023e), and sources identified through systematic review (including surrogates DINP and DIDP industry-supplied data). EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment, with media of release assessed using assumptions from EPA/OPPT models and industry supplied data. EPA believes a strength of the Monte Carlo modeling approach is that variation in model input values allows for estimation of a range of potential release values that are more likely to capture actual releases than a discrete value. Additionally, Monte Carlo modeling uses a large number of data points (simulation runs) and considers the full distributions of input parameters. EPA used facility-specific DCHP manufacturing volumes for all facilities that reported this information to CDR and non-DCHP-specific operating parameters derived using data from a current U.S. manufacturing site for DIDP and DINP that is assumed to operate using similar operating parameters as DCHP manufacturing. This information was used to provide more accurate estimates than the generic values provided by the EPA/OPPT models. These strengths increase the weight of evidence. The primary limitation of EPA's approach is the uncertainty in the representativeness of release estimates toward the true distribution of potential releases. In addition, one DCHP manufacturing site claimed their DCHP production volume as CBI for the purpose of CDR reporting; therefore, DCHP throughput estimates for this site are based on the site's reported export volume and their reported PV percentage for industrial use. Additional limitations include uncertainties in the representativeness of the surrogate industry-provided operating parameters from DIDP and DINP and the generic EPA/OPPT models for DCHP manufacturing sites. These limitations decrease the weight of evidence. Based on this information, EPA concluded that the weight of scientific evidence for this assessment is moderate, and the assessment provides a plausible estimate of releases considering the strengths and limitations of the reasonably available data.
Import and repackaging	EPA found limited chemical specific data for the import and repackaging OES and assessed releases to the environment using the assumptions and values from the Chemical Repackaging Generic Scenario (U.S. EPA, 2022a), which the systematic review process rated high for data quality. EPA also referenced the *2023 Methodology for Estimating Environmental Releases from Sampling Wastes* (U.S. EPA, 2023e). EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment. EPA assessed the media of release using assumptions from the GS and EPA/OPPT models. EPA believes a strength of the Monte Carlo modeling approach is that variation in model input values allows for estimation of a range of potential release values that are more likely to capture actual releases than a discrete value. Additionally, Monte Carlo modeling uses a large number of data points (simulation runs) and the full distributions of input parameters. These strengths increase the weight of evidence. The primary limitation of EPA's approach is the uncertainty in the representativeness of estimated release values toward the true distribution of potential releases at all sites in this OES. Specifically, because the default values in the GS are generic, there is uncertainty in the representativeness of these generic site estimates in characterizing actual releases from real-world sites that import and repackage DCHP. In addition, EPA lacks DCHP facility import volume data for all CDR-reporting import and repackaging sites due to claims of CBI; therefore, throughput estimates for these sites are based on the CDR reporting threshold of 25,000 lb and an annual DCHP national aggregate production volume range from CDR. These limitations decrease the weight of evidence.

OES	Weight of Scientific Evidence Conclusion in Release Estimates
	Based on this information, EPA concluded that the weight of scientific evidence for this assessment is moderate, and the assessment provides a plausible estimate of releases, considering the strengths and limitations of the reasonably available data.
Incorporation into adhesives and sealants	EPA found limited chemical specific data for the incorporation into adhesives and sealants OES and assessed releases to the environment using the ESD on the Formulation of Adhesives (OECD, 2009a), which has a high data quality rating based on the systematic review process. EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment and assessed the media of release using assumptions from the ESD and EPA/OPPT models. EPA believes a strength of the Monte Carlo modeling approach is that variation in model input values allows for estimation of a range of potential release values that are more likely to capture actual releases than a discrete value. Monte Carlo modeling also considers a large number of data points (simulation runs) and the full distributions of input parameters. Additionally, EPA used DCHP-specific data on concentrations in adhesive and sealant products in the analysis to provide more accurate estimates than the generic values provided by the ESD. The safety and product data sheets that EPA obtained these values from have high and medium data quality ratings based on the systematic review process. These strengths increase the weight of evidence. The primary limitation of EPA's approach is the uncertainty in the representativeness of estimated release values toward the true distribution of potential releases at all sites in this OES. Specifically, the default values in the ESD may not be representative of actual releases from real-world sites that incorporate DCHP into adhesives and sealants. In addition, EPA lacks data on DCHP-specific facility production volume and number of formulation sites, which are needed to estimate site throughput of DCHP. EPA based throughput on the CDR reporting threshold of 25,000 lb, an annual DCHP national aggregate production volume range, and ranges of downstream sites. These limitations decrease the weight of evidence. Based on this information, EPA concluded that the weight of scientific evidence for this assessment is moderate, and the assessment provides a plausible estimate of releases, considering the strengths and limitations of the reasonably available data.
Incorporation into paints and coatings	EPA found limited chemical specific data for the incorporation into paints and coatings OES and assessed releases to the environment using the Draft GS for the Formulation of Waterborne Coatings (U.S. EPA, 2014a), which has a medium data quality rating based on systematic review. EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment and assessed the media of release using assumptions from the GS and EPA/OPPT models. EPA believes a strength of the Monte Carlo modeling approach is that variation in model input values allows for estimation of a range of potential release values that are more likely to capture actual releases than a discrete value. Monte Carlo modeling also considers a large number of data points (simulation runs) and the full distributions of input parameters. Additionally, EPA used DCHP-specific data on concentrations in paint and coating products to provide more accurate estimates of DCHP concentrations than the generic values provided by the GS. The safety and product data sheets that EPA obtained these values from have medium to high data quality ratings based on the systematic review process. These strengths increase the weight of evidence. The primary limitation of EPA's approach is the uncertainty in the representativeness of estimated release values toward the true distribution of potential releases at all sites in this OES. Specifically, the generic default values in the GS are specific to waterborne coatings and may not be representative of releases from real-world sites that incorporate DCHP into paints and coatings, particularly for

OES	Weight of Scientific Evidence Conclusion in Release Estimates
	sites formulating other coating types (*e.g.*, solvent-borne coatings). In addition, EPA lacks data on DCHP-specific facility production volume and number of formulation sites; therefore, EPA based throughput and production volume estimates on CDR which has a reporting threshold of 25,000 lb, an annual DCHP production national aggregate production volume range, and ranges of downstream sites. These limitations decrease the weight of evidence. Based on this information, EPA concluded that the weight of scientific evidence for this assessment is moderate, and the assessment provides a plausible estimate of releases, considering the strengths and limitations of the reasonably available data.
Incorporation into other formulations, mixtures, and reaction products	EPA found limited chemical specific data for the incorporation into other formulations, mixtures, and reaction products not covered elsewhere OES and assessed releases to the environment using the Draft GS for the Formulation of Waterborne Coatings (U.S. EPA, 2014a), which has a medium data quality rating based on systematic review process. EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment, and media of release using assumptions from the GS and EPA/OPPT models. EPA believes a strength of the Monte Carlo modeling approach is that variation in model input values allows for estimation of a range of potential release values that are more likely to capture actual releases than a discrete value. Monte Carlo modeling also considers a large number of data points (simulation runs) and the full distributions of input parameters. Additionally, EPA used DCHP-specific data on concentrations in other formulation, mixture, and reaction products in the analysis to provide more accurate estimates than the generic values provided by the GS. The safety and product data sheets that EPA obtained these values from have high and medium data quality ratings based on the systematic review process. These strengths increase the weight of evidence. The primary limitation of EPA's approach is the uncertainty in the representativeness of estimated release values toward the true distribution of potential releases at all sites in this OES. Specifically, the generic default values in the GS are based on the formulation of paints and coatings and may not represent releases from real-world sites that incorporate DCHP into other formulations, mixtures, or reaction products. In addition, because no entries in CDR indicated a use relevant to this formulation OES, and there were no other sources to estimate the volume of DCHP used in this OES, EPA developed a high-end bounding estimate for production volume based on the CDR reporting threshold of 25,000 lb or 5% of total product volume for a given use, which by definition is expected to over-estimate the average release case. For DCHP facility throughputs, EPA used a range of generic default values in the GS. These limitations decrease the weight of evidence. Based on this information, EPA concluded that the weight of scientific evidence for this assessment is moderate, and the assessment provides a plausible estimate of releases, considering the strengths and limitations of the reasonably available data.
PVC plastics compounding	EPA found limited chemical specific data for the plastics compounding OES and assessed releases to the environment using the Revised Draft GS for the Use of Additives in Plastic Compounding (U.S. EPA, 2021d), which has a medium data quality rating based on systematic review. EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment, and media of release using assumptions from the GS and EPA/OPPT models. EPA believes a strength of the Monte Carlo modeling approach is that variation in model input values allows for estimation of a range of potential release values that are more likely to capture actual releases than a discrete value. Monte Carlo modeling also considers a large number of data points (simulation runs) and the full distributions of input parameters. These strengths increase the weight of evidence.

OES	Weight of Scientific Evidence Conclusion in Release Estimates
	The primary limitation of EPA's approach is the uncertainty in the representativeness of estimated release values toward the true distribution of potential releases at all sites in this OES. The generic default concentration values in the GS consider all types of plastic compounding and may not represent releases from real-world sites that compound DCHP into specific types of plastic raw material. In addition, EPA lacks data on DCHP-specific facility production volume and number of compounding sites; therefore, EPA estimated throughput and production volume based on CDR which has a reporting threshold of 25,000 lb and an annual DCHP production national aggregate production volume range. These limitations decrease the weight of evidence. Based on this information, EPA concluded that the weight of scientific evidence for this assessment is moderate, and the assessment provides a plausible estimate of releases, considering the strengths and limitations of the reasonably available data.
PVC plastics converting	EPA found limited chemical specific data for the plastics converting OES and assessed releases to the environment using the Revised Draft GS on the Use of Additives in the Thermoplastics Converting Industry, which has a medium data quality rating based on systematic review (U.S. EPA, 2021e). EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment, and media of release using assumptions from the GS and EPA/OPPT models. EPA believes a strength of the Monte Carlo modeling approach is that variation in model input values allows for estimation of a range of potential release values that are more likely to capture actual releases than a discrete value. Monte Carlo also considers a large number of data points (simulation runs) and the full distributions of input parameters. These strengths increase the weight of evidence. The primary limitation of EPA's approach is the uncertainty in the representativeness of estimated release values toward the true distribution of potential releases at all sites in this OES. Specifically, the generic default values in the ESD are based on all types of thermoplastics converting sites and processes and may not represent actual releases from real-world sites that convert DCHP-containing raw material into plastic articles using a variety of methods, such as extrusion or calendering. In addition, EPA lacks data on DCHP-specific facility production volume and number of converting sites; therefore, EPA estimated throughput based on CDR which has a reporting threshold of 25,000 lb, an annual DCHP national aggregate production volume range, and ranges of downstream sites. These limitations decrease the weight of evidence. Based on this information, EPA concluded that the weight of scientific evidence for this assessment is moderate, and the assessment provides a plausible estimate of releases, considering the strengths and limitations of the reasonably available data.
Non-PVC material compounding	EPA found limited chemical specific data for the non-PVC material compounding OES and assessed releases to the environment using the Revised Draft GS for the Use of Additives in Plastic Compounding and the ESD on Additives in the Rubber Industry (U.S. EPA, 2021d; OECD, 2004). Both sources have a medium data quality rating based on the systematic review process. EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment, and media of release using assumptions from the GS, ESD, and EPA/OPPT models. EPA believes a strength of the Monte Carlo modeling approach is that variation in model input values allows for estimation of a range of potential release values that are more likely to capture actual releases than a discrete value. Monte Carlo modeling also considers a large number of data points (simulation runs) and the full distributions of input parameters. These strengths increase the weight of evidence.

OES	Weight of Scientific Evidence Conclusion in Release Estimates
	The primary limitation of EPA's approach is the uncertainty in the representativeness of estimated release values toward the true distribution of potential releases at all sites in this OES. Specifically, there was a lack of concentration data for specific products that contained DCHP; EPA relied on the GS and ESD to generate concentration estimates. These values may not be representative of actual values from real-world sites that compound DCHP into non-PVC material. In addition, because no entries in CDR indicated a use relevant to compounding or converting non-PVC material, and there were no other sources to estimate the volume of DCHP used in this OES, EPA developed a high-end bounding estimate based on the CDR reporting threshold of 25,000 lb or 5% of total product volume for a given use, which by definition is expected to over-estimate the average release case. These limitations decrease the weight of evidence. Based on this information, EPA concluded that the weight of scientific evidence for this assessment is moderate, and the assessment provides a plausible estimate of releases, considering the strengths and limitations of the reasonably available data.
Non-PVC material converting	EPA found limited chemical specific data for the non-PVC material converting OES and assessed releases to the environment using the Revised Draft GS on the Use of Additives in the Thermoplastics Converting Industry and the ESD on Additives in the Rubber Industry (U.S. EPA, 2021e; OECD, 2004). Both documents have a medium data quality rating based on systematic review. EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment, and media of release using assumptions from the GS, ESD, and EPA/OPPT models. EPA believes a strength of the Monte Carlo modeling approach is that variation in model input values allows for estimation of a range of potential release values that are more likely to capture actual releases than a discrete value. Monte Carlo modeling also considers a large number of data points (simulation runs) and the full distributions of input parameters. These strengths increase the weight of evidence. The primary limitation of EPA's approach is the uncertainty in the representativeness of estimated release values toward the true distribution of potential releases at all sites in this OES. Specifically, there was a lack of concentration data for specific products that contained DCHP; EPA relied on the GS and ESD to generate concentration estimates. These values may not be representative of actual values from real-world sites that convert DCHP into non-PVC articles. In addition, because no entries in CDR indicated a use relevant to compounding or converting non-PVC material, and there were no other sources to estimate the volume of DCHP or number of sites used in this OES, EPA developed a range of high-end bounding estimates based on the CDR reporting thresholds, or 25,000 lb of 5% of total product volume for a given use, which by definition is expected to over-estimate the average release case. These limitations decrease the weight of evidence. Based on this information, EPA concluded that the weight of scientific evidence for this assessment is moderate, and the assessment provides a plausible estimate of releases, considering the strengths and limitations of the reasonably available data.
Application of adhesives and sealants	EPA found limited chemical specific data for the application of adhesives and sealants OES and assessed releases to the environment using the *esd on the use of adhesives* (OECD, 2015a), which has a medium data quality rating based on systematic review. EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment, and media of release using assumptions from the ESD and EPA/OPPT models. EPA believes a strength of the Monte Carlo modeling approach is that variation in model input values allows for estimation of a range of potential release values that are more likely to capture actual releases than a discrete value. Monte Carlo modeling also considers a large number of data points (simulation runs) and the full distributions of input

OES	Weight of Scientific Evidence Conclusion in Release Estimates
	parameters. Additionally, EPA used DCHP-specific data on concentration and application methods for different DCHP-containing adhesives and sealant products in the analysis. These data provide more accurate estimates than the generic values provided by the ESD. The safety and product data sheets from which these values were obtained have high and medium data quality ratings from the systematic review process. These strengths increase the weight of evidence. The primary limitation of EPA's approach is the uncertainty in the representativeness of estimated release values toward the true distribution of potential releases at all sites in this OES. Specifically, the generic default values in the ESD may not represent releases from real-world sites that incorporate DCHP into adhesives and sealants. The overall production volume of DCHP for this OES was based on CDR data using the same assumptions as the Incorporation into adhesives and sealants OES. EPA lacks data on DCHP-specific facility use volume and number of use sites; therefore, EPA based facility throughput estimates and number of sites on industry-specific default facility throughputs from the ESD, DCHP product concentrations, and the overall production volume range from CDR data which has a reporting threshold of 25,000 lb. EPA also had minimal data for solid additives in adhesives, and had to base the DCHP concentration range for solid additives on the SDS for one product. These limitations decrease the weight of evidence. Based on this information, EPA concluded that the weight of scientific evidence for this assessment is moderate, and the assessment provides a plausible estimate of releases, considering the strengths and limitations of reasonably available data.
Application of paints and coatings	EPA found limited chemical specific data for the application of paints and coatings OES and assessed releases to the environment using the ESD on the Application of Radiation Curable Coatings, Inks and Adhesives and the GS on Coating Application via Spray Painting in the Automotive Refinishing Industry (U.S. EPA, 2014b; OECD, 2011b). These documents have a medium data quality rating based on the systematic review process. EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment. EPA assessed media of release using assumptions from the ESD, GS, and EPA/OPPT models and a default assumption that all paints and coatings are applied via spray application. EPA believes a strength of the Monte Carlo modeling approach is that variation in model input values allows for estimation of a range of potential release values that are more likely to capture actual releases than a discrete value. Monte Carlo modeling also considers a large number of data points (simulation runs) and the full distributions of input parameters. Additionally, EPA used DCHP-specific data on concentration for different DCHP-containing paints and coatings in the analysis. These data provide more accurate estimates than the generic values provided by the GS and ESD. The safety and product data sheets that EPA obtained these values from have high and medium data quality ratings based on the systematic review process. These strengths increase the weight of evidence. The primary limitation of EPA's approach is the uncertainty in the representativeness of estimated release values toward the true distribution of potential releases at all sites in this OES. Specifically, the generic default values in the GS and ESD may not represent releases from real-world sites that incorporate DCHP into paints and coatings. Additionally, EPA assumes spray applications of the coatings, which may not be representative of other coating application methods. In addition, EPA lacks data on DCHP-specific facility use volume and number of use sites; therefore, EPA based throughput estimates on values from ESD, GS, and CDR data which has a reporting threshold of 25,000 lb and an annual DCHP production volume range. EPA also lacked data for ready-to-apply coatings, and consequently assumed a concentration range for liquid coatings based on the SDS for one product. These limitations decrease the weight of evidence.

OES	Weight of Scientific Evidence Conclusion in Release Estimates
	Based on this information, EPA concluded that the weight of scientific evidence for this assessment is moderate, and the assessment provides a plausible estimate of releases, considering the strengths and limitations of reasonably available data.
Use of laboratory chemicals	EPA found limited chemical specific data for the use of laboratory chemicals OES and assessed releases to the environment using the Draft GS on the Use of Laboratory Chemicals (U.S. EPA, 2023g), which has a high data quality rating based on systematic review. EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment, and media of release using assumptions from the GS and EPA/OPPT models for solid and liquid DCHP materials. EPA believes a strength of the Monte Carlo modeling approach is that variation in model input values allows for estimation of a range of potential release values that are more likely to capture actual releases than a discrete value. Monte Carlo modeling also considers a large number of data points (simulation runs) and the full distributions of input parameters. EPA used SDSs from identified laboratory DCHP products to inform product concentration and material states. These strengths increase the weight of evidence. EPA believes the primary limitation to be the uncertainty in the representativeness of values toward the true distribution of potential releases. In addition, EPA lacks data on DCHP-specific laboratory chemical throughput and number of laboratories; therefore, EPA based the number of laboratories and throughput estimates on stock solution throughputs from the GS on the Use of Laboratory Chemicals (U.S. EPA, 2023c) and on CDR reporting thresholds. Additionally, because no entries in CDR indicate a laboratory use and there were no other sources to estimate the volume of DCHP used in this OES, EPA developed a high-end bounding estimate based on the CDR reporting threshold of 25,000 lb or 5% of total product volume for a given use, which by definition is expected to over-estimate the average release case. These limitations decrease the weight of evidence. Based on this information, EPA concluded that the weight of scientific evidence for this assessment is moderate, and the assessment provides a plausible estimate of releases, considering the strengths and limitations of reasonably available data.
Fabrication or use of final products or articles	No data were available to estimate releases for this OES and there were no suitable surrogate release data or models. This release is described qualitatively.
Recycling	EPA found limited chemical specific data for the recycling OES. EPA assessed releases to the environment from recycling activities using the Revised Draft GS for the Use of Additives in Plastic Compounding (U.S. EPA, 2021d) as surrogate for the recycling process. The GS has a medium data quality rating based on systematic review. EPA/OPPT models were combined with Monte Carlo modeling to estimate releases to the environment. EPA believes the strength of the Monte Carlo modeling approach is that variation in model input values and a range of potential release values are more likely to capture actual releases than discrete values. Monte Carlo modeling also considers a large number of data points (simulation runs) and the full distributions of input parameters. EPA referenced the *Quantification and Evaluation of Plastic Waste in the United States,* which has a medium quality rating based on systematic review (Milbrandt et al., 2022), to estimate the rate of PVC recycling in the United States. EPA estimated the DCHP PVC market share (based on the surrogate market shares from DINP and DIDP) to define an approximate recycling volume of PVC containing DCHP. These strengths increase the weight of evidence.

OES	Weight of Scientific Evidence Conclusion in Release Estimates
	The primary limitation of EPA's approach is the uncertainty in the representativeness of estimated release values toward the true distribution of potential releases at all sites in this OES. Specifically, the generic default values and release points in the GS represent all types of plastic compounding sites and may not represent sites that recycle PVC products containing DCHP. In addition, EPA lacks DCHP-specific PVC recycling rates and facility production volume data; therefore, EPA based throughput estimates on PVC plastics compounding data and U.S. PVC recycling rates, which are not specific to DCHP, and may not accurately reflect current U.S. recycling volume. DCHP may also be present in non-PVC plastics that are recycled; however, EPA was unable to identify information on these recycling practices. These limitations decrease the weight of evidence. Based on this information, EPA concluded that the weight of scientific evidence for this assessment is moderate, and the assessment provides a plausible estimate of releases, considering the strengths and limitations of the reasonably available data.
Waste handling, treatment, and disposal	No data were available to estimate releases for this OES and there were no suitable surrogate release data or models. This release is described qualitatively.
Distribution in commerce	These releases are assessed as part of individual OESs where the relevant activities occur.

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3.2.3 Strengths, Limitations, Assumptions, and Key Sources of Uncertainty for the Environmental Release Assessment

Manufacturers and importers of DCHP submit CDR data to EPA if they meet reporting threshold requirements. Sites are only required to load production data into CDR if their yearly production volume exceeds 25,000 lb. Sites can claim their production volume as CBI, further limiting the production volume information in CDR. As a result, some sites that produce or use DCHP may not be included in the CDR data set and the total production volume for a given OES may be under or overestimated. The extent to which sites that are not captured in the CDR reports release DCHP into the environment is unknown. The media of release for these sites is also unknown.

CDR information on the downstream use of DCHP at facilities is also limited; therefore, there is some uncertainty as to the production volume attributed to a given OES. For OES with limited CDR data, EPA developed potential production volume ranges given reported CDR data, known reporting thresholds, and the national aggregate production volume of 500,000 to less than 1,000,000 lb for DCHP in 2019. The Agency used the potential production volume ranges as uniform distributions in Monte Carlo modeling when assessing releases for each OES. Due to the wide range of potential production volumes attributable to certain OES, the overall releases may be over or underestimated. DCHP releases at each site may vary from day to day, such that on any given day the actual daily release rate may be higher or lower than the estimated average daily release rate.

The EPA has further identified the following additional uncertainties that contribute to the overall uncertainty in the environmental release assessment:

- **Use of Census Bureau data for Number of Facilities –** In some cases, EPA determined the maximum number of facilities for a given OES (for use in Monte Carlo modeling) from industry data from the U.S. Census Bureau, County and Business Patterns data set (U.S. Census Bureau, 2022).
- **Uncertainties Associated with Facility Throughputs –** EPA estimated facility throughputs of DCHP or DCHP-containing products using various methods, including using generic industry data presented in the relevant GS or ESD, or by calculation based on estimated number of facilities and overall production volume of DCHP from CDR for the given OES. In either case, the values used for facility throughputs may encompass a wide range of possible values. Due to these uncertainties, the facility throughputs may be under or overestimated.
- **Uncertainties Associated with Number of Release Days –** For most OESs, EPA estimated the number of release days using data from GSs, ESDs, or SpERC factsheets. In such cases, EPA used applicable sources to estimate a range of release days over the course of an operating year. Due to uncertainty in DCHP-specific facility operations, release days may be under or overestimated.
- **Uncertainties Associated with DCHP-Containing Product Concentrations –** In most cases, the number of identified products for a given OES were limited. In such cases, EPA estimated a range of possible DCHP concentrations for products in the OES. However, the extent to which these products represent all DCHP-containing products within the OES is uncertain. For OESs with little-to-no product data, EPA estimated DCHP concentrations from GSs or ESDs. Due to these uncertainties, the average product concentrations may be under or overestimated.

3.3 Summary of Concentrations of DCHP in the Environment

Based off the environmental release assessment summarized in Section 3.2 and detailed in EPA's *Draft Environmental Release and Occupational Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024q), DCHP is expected to be released to the environment via air, water, biosolids, and disposal to landfills. Environmental media concentrations were quantified in ambient air, sediment, and surface water. Additional analysis of surface water used as drinking water was conducted for the Human Health Risk Assessment (see Section 4.1.3). EPA relied on its fate assessment to determine which environmental pathways to consider for its screening level analysis of environmental exposure and general population exposure to environmental releases. Details on the environmental partitioning and media assessment can be found in *Draft Physical Chemistry and Fate and Transport Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024z). Briefly, based on DCHP's fate parameters (*e.g.*, Henry's Law constant, log Koc, water solubility, fugacity modeling), EPA anticipated DCHP to be predominantly in water, soil, and sediment. Soil concentration of DCHP from land applications were not quantitatively assessed in the screening level analysis as DCHP was expected to have limited persistence potential and mobility in soils receiving biosolids.

Further detail on the screening-level assessment of each environmental pathway can be found in EPA's *Draft Environmental Media, General Population, and Environmental Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024p). Because of limited environmental monitoring data and lack of location data for DCHP releases, EPA began its environmental and general population exposure assessment with a screening-level approach using the highest modeled environmental media concentrations for the environmental pathways expected to be of greatest concern. The highest environmental media concentrations were estimated using the release estimates for an OES associated with a COU that, paired with conservative assumption of environmental conditions, resulted in the greatest modeled concentration of DCHP in a given environmental medium type. Therefore, EPA did not estimate environmental concentrations of DCHP resulting from all OES presented in Table 3-1.

The OES resulting in the highest environmental concentration of DCHP varied by environmental media as shown in Table 3-6. PVC plastics compounding with or without consideration of wastewater treatment efficiency yielded the highest water concentrations using a 7Q10 flow,[1] 30Q5 flow,[2] and harmonic mean.[3] The Application of paints, coatings, adhesives, and sealants OES yielded the highest ambient air concentration. The summary table also indicates whether the high-end estimate was used for environmental or general population exposure assessment. For the screening-level analysis, if the high-end environmental media concentrations did not result in potential environmental or human health risk, no further OESs were assessed and no further refinements were pursued. For the surface water and ambient air pathways, only the OESs resulting in the highest estimated water column or ambient air concentrations were carried forward to the human health risk assessment (*i.e.*, Plastic compounding for water and Application of paints, coatings, adhesives, and sealants for ambient air).

[1] 7Q10 is defined as 7 consecutive days of lowest flow over a 10-year period. These flows are used to calculate estimates of chronic surface water concentrations to compare with the COCs for aquatic life (Versar, 2014).
[2] 30Q5 is defined as 30 consecutive days of lowest flow over a 5-year period. These flows are used to determine acute human exposures via drinking water (Versar, 2014).
[3] Harmonic mean is defined as the inverse mean of reciprocal daily arithmetic mean flow values. These flows represent a long-term average and are used to generate estimates of chronic human exposures via drinking water and fish ingestion.

Table 3-6. Summary of High-End DCHP Concentrations in Various Environmental Media from Environmental Releases

OES [a]	Release Media	Environmental Media	DCHP Concentration	Environmental or General Population
PVC plastics compounding *without wastewater treatment*	Water	Total water column (7Q10,[b] median flow)	165 µg/L	Environmental
		Total water column (7Q10, p75 flow)	5.56 µg/L	Environmental
		Total water column (7Q10, p90 flow)	0.57 µg/L	Environmental
		Median 7Q10 (benthic pore water)	95.3 µg/L	Not carried forward to environmental risk assessment[c]
		Median 7Q10 (benthic sediment)	112,000 µg/kg	Not carried forward to environmental risk assessment[c]
PVC plastics compounding *without wastewater treatment*	Water	Surface water (30Q5,[d] median flow)	126 µg/L	General population
		Surface water (harmonic mean,[e] median flow)	87.7 µg/L	General Population
PVC plastics compounding *with wastewater treatment*	Water	Surface water (30Q5, median flow)	39.6 µg/L	General population
		Surface water (harmonic mean, median flow)	27.5 µg/L	General population
Application of paints, and coatings	Fugitive air	Daily-averaged total (fugitive and stack, 100 m)	67.57 µg/m^3	General population
		Annual-averaged total (fugitive and stack, 100 m)	46.28 µg/m^3	General population

[a] Table 3-1 provides the crosswalk of OES to COUs.
[b] 7Q10 is the 7 consecutive days of lowest flow over a 10-year period.
[c] See Section 4.4 for further details.
[d] 30Q5 is defined as 30 consecutive days of lowest flow over a 5-year period
[e] Harmonic mean is defined as the inverse mean of reciprocal daily arithmetic mean flow values. These flows represent a long-term average.

3.3.1 Weight of Scientific Evidence Conclusions

Detailed discussion of the strengths, limitations, and sources of uncertainty for modeled environmental media concentration leading to a weight of scientific evidence conclusion can be found in EPA's *Draft Environmental Media, General Population, and Environmental Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024p). However, the weight of scientific evidence conclusion is summarized below for the modeled DCHP concentrations in surface water, sediment, and ambient air.

3.3.1.1 Surface Water

Due to the lack of release data for facilities discharging DCHP to surface water, releases to water were modeled as described in Section 3.2. The high-end estimate of releases to water for each COU was applied for surface water modeling as part of a conservative screening-level assessment. Additionally, due to a lack of site-specific release information, a generic distribution of hydrologic flows was developed from facilities which had been classified under relevant North American Industry Classification System (NAICS) codes, and which had National Pollutant Discharge Elimination System

(NPDES) permits. The flow rates were selected from the generated distributions and coupled with high-end (95th percentile) release scenarios. EPA assumed higher releases are generally correlated with higher receiving water body flows. *EPA generally has moderate confidence in the modeled concentrations as being representative of actual releases, with greater confidence in the modeled scenarios where high-end release amounts are paired with high-end flow rates. Additionally, EPA has robust confidence that no surface water release scenarios exceed the high-end concentrations presented in this evaluation, which have been applied as screening values*. Other model inputs were derived from reasonably available literature collected and evaluated through EPA's systematic review process for TSCA risk evaluations. All monitoring and experimental data included in this analysis were from articles rated "medium" or "high" quality from this process.

The high-end modeled concentrations in the surface water and sediment identified through systematic review exceeded the highest values available from monitoring studies by more than three orders of magnitude. This confirms EPA's expectation that modeled concentrations presented here are biased toward overestimation, and thus appropriate to be applied as a screening-level evaluation in the environmental and general population exposure to environmental releases assessment.

3.3.1.2 Ambient Air

Similar to the surface water analysis, due to the lack of release data, releases to ambient air were modeled using generic scenarios, and the high-end estimates of releases to ambient air for each COU were applied for ambient air modeling. The uncertainties associated with the release data are detailed in the *Draft Environmental Release and Occupational Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024q). However, EPA has robust confidence in using the IIOAC (Integrated Indoor-Outdoor Air Calculator) modeling in the ambient air exposure assessment because its approach and methodology were derived from peer-reviewed models and incorporate extensive feedback received from the Science Advisory Committee on Chemicals. Due to the conservative assumptions made with the use of high-end estimates, EPA has robust confidence that its modeled releases used for estimating ambient air concentrations are appropriately conservative for a screening-level analysis.

4 HUMAN HEALTH RISK ASSESSMENT

DCHP – Human Health Risk Assessment (Section 4): Key Points

EPA evaluated all reasonably available information to support human health risk characterization of DCHP for workers, ONUs, consumers, bystanders, and the general population, including PESS. Exposures to workers, ONUs, consumers, bystanders, and the general population are described in Section 4.1. Human health hazards are described in Section 4.2. Human health risk characterization is described in Section 4.3.

Exposure Key Points

- EPA assessed inhalation and dermal exposures for workers and ONUs, as appropriate, for each OES (Section 4.1.1). The primary route of exposure was inhalation.
- EPA assessed inhalation, dermal, and oral exposures for consumers and bystanders, as appropriate, for each TSCA COU (Section 4.1.2) in scenarios that represent a range of use patterns and behaviors. The primary route of exposure was dermal for most products, followed by inhalation.
- EPA assessed inhalation, oral, and dermal exposures for the general population via ambient air, surface water, drinking water, and fish ingestion for Tribal populations and determined that all exposures assessed for the general population were not of concern (Sections 4.1.3 and 4.3.4).
- EPA assessed non-attributable cumulative exposure to DEHP, DBP, BBP, DIBP, and DINP for the U.S. civilian population using NHANES urinary biomonitoring data and reverse dosimetry (Section 4.4.2).

Hazard Key Points

- EPA identified effects on the developing male reproductive system consistent with a disruption of androgen action, leading to phthalate syndrome, as the most sensitive and robust non-cancer hazard associated with oral exposure to DCHP in experimental animal models (Section 4.2).
- A non-cancer POD of 2.4 mg/kg-day was selected to characterize non-cancer risks for acute, intermediate, and chronic durations of exposure. A total uncertainty factor of 30 was selected for use as the benchmark margin of exposure.
- EPA derived draft relative potency factors (RPFs) based on a common hazard endpoint (*i.e.*, reduced fetal testicular testosterone). Draft RPFs were derived via meta-analysis and benchmark dose (BMD) modeling (Section 4.4.1). Given its limited toxicological data set, scaling by the RPF and application of the index chemical POD provides a more sensitive and robust dose-response assessment than the DCHP-specific POD.

Risk Assessment Key Points

- Dermal and ingestion exposures were not a risk driver for any duration of exposure or population.
- Inhalation exposures drive acute non-cancer risks to workers in occupational settings (Section 4.3.2).
- No potential non-cancer risk was identified for consumers (Section 4.3.3).
- No potential non-cancer risk was identified for the general population.
- EPA considered combined exposure across all routes of exposure for each individual occupational and consumer COU to calculate aggregate risks (Sections 4.3.2 and 4.3.3). No potential aggregate risk was identified for consumer COUs.
- EPA considered cumulative risk to workers and consumers through exposure to DCHP from individual COUs in combination with cumulative non-attributable national exposure to DEHP, DBP, BBP, DIBP, and DINP as estimated from NHANES biomonitoring data (Sections 4.4.4 and 4.4.5).
- EPA considered PESS throughout the exposure assessment, hazard identification, and dose-response analysis supporting this draft risk evaluation (Section 4.3.5).

4.1 Summary of Human Exposures

4.1.1 Occupational Exposures

The following subsections briefly describe EPA's approach to assessing occupational exposures and provide exposure assessment results for each OES. As stated in the final scope document (U.S. EPA, 2020b), the Agency evaluated exposures to workers and ONUs via the inhalation route—including incidental ingestion of inhaled dust and exposures to workers via the dermal route from direct contact with DCHP. Also, EPA accounted for dermal exposure to workers and ONUs from mist and dust deposited on surfaces. The *Draft Environmental Release and Occupational Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024q) provides additional details on the development of approaches and the exposure assessment results.

4.1.1.1 Approach and Methodology

As described in the final scope document for DCHP (U.S. EPA, 2020b), EPA distinguished exposure levels among potentially exposed employees for workers and ONUs. In general, the primary difference between workers and ONUs is that workers may handle DCHP and have direct contact with DCHP, while ONUs work in the general vicinity of DCHP but do not handle DCHP. Where possible, for each COU, EPA identified job types and categories for workers and ONUs.

As discussed in Section 3.1.1.1, EPA established OESs to assess the exposure scenarios within each COU. Table 3-1 provides a crosswalk between COUs and OESs. EPA did not identify relevant chemical-specific inhalation exposure monitoring data for the OESs. In the absence of inhalation monitoring data, EPA used inhalation exposure models to estimate both central tendency and high-end exposures. For inhalation exposure to dust in occupational settings, EPA used the data and approaches from the *Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR)* (U.S. EPA, 2021b). In all cases of occupational dermal exposure to DCHP, EPA used a flux-limited dermal absorption model to estimate high-end and central tendency dermal exposures for workers in each OES, as described in the *Draft Environmental Release and Occupational Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024q).

EPA evaluated the quality of the models and data sources using the data quality review evaluation metrics and the rating criteria described in the Draft Systematic Review Protocol (U.S. EPA, 2021a). The Agency assigned an overall quality level of high, medium, or low to the relevant data. In addition, EPA established an overall confidence level for the data when integrated into the occupational exposure assessment. The Agency considered the assessment approach, the quality of the data and models, and uncertainties in assessment results to assign an overall weight of scientific evidence rating of robust, moderate, or slight.

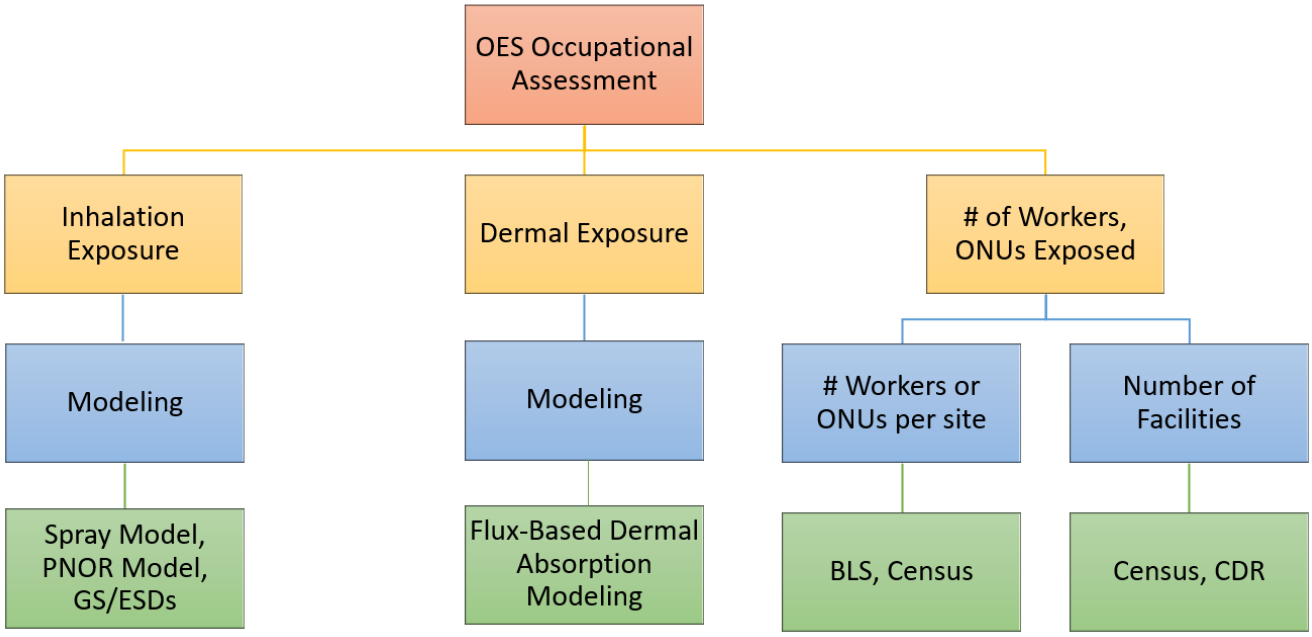

Figure 4-1. Approaches Used for Each Component of the Occupational Assessment for Each OES
CDR = Chemical Data Reporting; GS = Generic Scenario; ESD = Emission Scenario Document; BLS = Bureau of Labor Statistics; PNOR = Particulates not Otherwise Regulated.

For inhalation and dermal exposure routes, EPA provides occupational exposure results representative of both central tendency and high-end exposure conditions. The central tendency is expected to represent occupational exposures in the center of the distribution for a given COU. For this risk evaluation, EPA used the 50th percentile (median), mean (arithmetic or geometric), mode, or midpoint value of a distribution to represent the central tendency scenario. Although the Agency preferred to report the 50th percentile of the distribution, if the full distribution was unknown, EPA used either the mean, mode, or midpoint of the distribution to represent the central tendency depending on the statistics available for the distribution. The high-end exposure is expected to represent occupational exposures that occur at probabilities above the 90th percentile, but below the highest exposure for any individual (U.S. EPA, 1992). For this draft risk evaluation, EPA reported high-end results at the 95th percentile. If the 95th percentile was not reasonably available, the Agency used a different percentile greater than or equal to the 90th percentile but less than or equal to the 99th percentile—depending on the data that was available for the distribution. If the full distribution is not known and the preferred statistics were not reasonably available, EPA estimated a maximum or bounding estimate in lieu of the high-end. Table 4-1 provides a summary of the approach used to assess worker and ONU exposures and the Agency's weight of scientific evidence rating for the given exposure assessments.

Table 4-1. Summary of Exposure Monitoring and Modeling Data for Occupational Exposure Scenarios

OES	Inhalation Exposure									Dermal Exposure			
	Monitoring					Modeling		Weight of Scientific Evidence Conclusion		Modeling		Weight of Scientific Evidence Conclusion	
	Worker	# Data Points	ONU	# Data Points	Data Quality Ratings	Worker	ONU	Worker	ONU	Worker	ONU	Worker	ONU
Manufacturing	✗	N/A	✗	N/A	N/A	✓	✓	Moderate	Moderate	✓	✓	Moderate	Moderate
Import and repackaging	✗	N/A	✗	N/A	N/A	✓	✓	Moderate	Moderate	✓	✓	Moderate	Moderate
Incorporation into adhesives and sealants	✗	N/A	✗	N/A	N/A	✓	✓	Moderate	Moderate	✓	✓	Moderate	Moderate
Incorporation into paints and coatings	✗	N/A	✗	N/A	N/A	✓	✓	Moderate	Moderate	✓	✓	Moderate	Moderate
Incorporation into other formulations, mixtures, and reaction products not covered elsewhere	✗	N/A	✗	N/A	N/A	✓	✓	Moderate	Moderate	✓	✓	Moderate	Moderate
PVC plastics compounding	✗	N/A	✗	N/A	N/A	✓	✓	Moderate	Moderate	✓	✓	Moderate	Moderate
PVC plastics converting	✗	N/A	✗	N/A	N/A	✓	✓	Moderate	Moderate	✓	✓	Moderate	Moderate
Non-PVC material compounding	✗	N/A	✗	N/A	N/A	✓	✓	Moderate	Moderate	✓	✓	Moderate	Moderate
Non-PVC material converting	✗	N/A	✗	N/A	N/A	✓	✓	Moderate	Moderate	✓	✓	Moderate	Moderate
Application of adhesives and sealants	✗	N/A	✗	N/A	N/A	✓	✓	Moderate	Moderate	✓	✓	Moderate	Moderate
Application of paints and coatings	✗	N/A	✗	N/A	N/A	✓	✓	Moderate	Moderate	✓	✓	Moderate	Moderate
Use of laboratory chemicals	✗	N/A	✗	N/A	N/A	✓	✓	Moderate	Moderate	✓	✓	Moderate	Moderate

OES	Inhalation Exposure									Dermal Exposure			
	Monitoring					Modeling		Weight of Scientific Evidence Conclusion		Modeling		Weight of Scientific Evidence Conclusion	
	Worker	# Data Points	ONU	# Data Points	Data Quality Ratings	Worker	ONU	Worker	ONU	Worker	ONU	Worker	ONU
Fabrication or use of final products or articles	✗	N/A	✗	N/A	N/A	✓	✓	Moderate	Moderate	✓	✓	Moderate	Moderate
Recycling	✗	N/A	✗	N/A	N/A	✓	✓	Moderate	Moderate	✓	✓	Moderate	Moderate
Waste handling, treatment, and disposal	✗	N/A	✗	N/A	N/A	✓	✓	Moderate	Moderate	✓	✓	Moderate	Moderate
Distribution in Commerce [a]	✗	N/A	✗	N/A	N/A	✗	✗	N/A	N/A	✗	✗	N/A	N/A

[a] Activities related to distribution (*e.g.*, loading, unloading) are considered throughout the DCHP life cycle, as well as qualitatively through a single distribution scenario.

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4.1.1.2 Summary of Number of Workers and ONUs

The *Draft Environmental Release and Occupational Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024q) provides a summary of the estimates of the number of exposed workers and ONUs for each OES. To prepare these estimates, EPA first identified relevant NAICS Codes for each OES. For these NAICS codes, the Standard Occupational Classification (SOC) codes from the Bureau of Labor Statistics (BLS) were used to classify SOC codes as either workers or ONUs. The Agency assumed that all other SOC codes represent occupations where exposure is unlikely. EPA also estimated the total number of facilities associated with the relevant NAICS Codes based on data from the U.S. Census Bureau. To estimate the average number of potentially exposed workers and ONUs per site, the total number of workers and ONUs were divided by the total number of facilities. The *Draft Environmental Release and Occupational Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024q) provides additional details on the approach and methodology for estimating the number of facilities using DCHP as well as the number of potentially exposed workers and ONUs.

Table 4-2 summarizes the number of facilities and total number of exposed workers for all OESs. For scenarios in which the results are expressed as a range, the low end of the range is based on the 50th percentile estimate of the number of sites and the upper end of the range is based on the 95th percentile estimate of the number of sites.

Table 4-2. Summary of Total Number of Workers and ONUs Potentially Exposed to DCHP for Each OES

OES	Total Exposed Workers [a b]	Total Exposed ONUs [a b]	Number of Facilities [a b]	Notes
Manufacturing	77	36	2	Number of workers and ONU estimates based on the BLS and U.S. Census Bureau data (U.S. BLS, 2016; U.S. Census Bureau, 2015).
Import and repackaging	40	18	2	Number of workers and ONU estimates based on the BLS and U.S. Census Bureau data (U.S. BLS, 2016; U.S. Census Bureau, 2015). Averaged for two NAICS codes identified.
Incorporation into adhesives and sealants	90–162	35–126	5–9	Number of workers and ONU estimates based on the BLS and U.S. Census Bureau data (U.S. BLS, 2016; U.S. Census Bureau, 2015).
Incorporation into paints and coatings	280–476	70–170	20–34	Number of workers and ONU estimates based on the BLS and U.S. Census Bureau data (U.S. BLS, 2016; U.S. Census Bureau, 2015).
Incorporation into other formulations, mixtures, and reaction products not covered elsewhere	561–1,122	264–528	11–21	Number of workers and ONU estimates based on the BLS and U.S. Census Bureau data (U.S. BLS, 2016; U.S. Census Bureau,

OES	Total Exposed Workers [a b]	Total Exposed ONUs [a b]	Number of Facilities [a b]	Notes
				2015). Averaged for two NAICS codes identified.
PVC plastics compounding	135–243	60–108	5–9	Number of workers and ONU estimates based on the BLS and U.S. Census Bureau data (U.S. BLS, 2016; U.S. Census Bureau, 2015).
PVC plastics converting	756–1,206	210–335	42–67	Number of workers and ONU estimates based on the BLS and U.S. Census Bureau data (U.S. BLS, 2016; U.S. Census Bureau, 2015).
Non-PVC material compounding	46–92	12–24	2–4	Number of workers and ONU estimates based on the BLS and U.S. Census Bureau data (U.S. BLS, 2016; U.S. Census Bureau, 2015). Averaged for three NAICS codes identified.
Non-PVC material converting	46–92	12–24	2–4	Number of workers and ONU estimates based on the BLS and U.S. Census Bureau data (U.S. BLS, 2016; U.S. Census Bureau, 2015). Averaged for three NAICS codes identified.
Application of adhesives and sealants	336–4,480	108–1,440	6–80	Number of workers and ONU estimates based on the BLS and U.S. Census Bureau data (U.S. BLS, 2016; U.S. Census Bureau, 2015). Averaged for 18 NAICS codes identified.
Application of paints and coatings	12–168	6–84	1–14	Number of workers and ONU estimates based on the BLS and U.S. Census Bureau data (U.S. BLS, 2016; U.S. Census Bureau, 2015). Averaged for 10 NAICS codes identified.
Use of laboratory chemicals (liquid)	36,873	331,857	36,873	Number of workers and ONU estimates based on the BLS and U.S. Census Bureau data (U.S. BLS, 2016; U.S. Census Bureau, 2015). Averaged for two NAICS codes identified.
Use of laboratory chemicals (solid)	1,978–25,643	17,802–230,787	1,978–25,643	Number of workers and ONU estimates based on the BLS and U.S. Census Bureau data (U.S. BLS, 2016; U.S. Census Bureau, 2015). Averaged for two NAICS codes identified.

OES	Total Exposed Workers [a] [b]	Total Exposed ONUs [a] [b]	Number of Facilities [a] [b]	Notes
Fabrication or use of final products or articles	N/A			Number of sites data was unavailable for this OES. Based on the BLS and U.S. Census Bureau data (U.S. BLS, 2016; U.S. Census Bureau, 2015), the average exposed workers per site was 9, and the average exposed ONUs per site was 3.
Recycling	754	432	58	Number of workers and ONU estimates based on the BLS and U.S. Census Bureau data (U.S. BLS, 2016; U.S. Census Bureau, 2015). Averaged for three NAICS codes identified.
Waste handling, treatment, and disposal	754	432	58	Number of workers and ONU estimates based on the BLS and U.S. Census Bureau data (U.S. BLS, 2016; U.S. Census Bureau, 2015). Averaged for three NAICS codes identified.

[a] EPA's approach and methodology for estimating the number of facilities using DCHP and the number of workers and ONUs potentially exposed to DCHP can be found in the *Draft Environmental Release and Occupational Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024q).
[b] When there is a range, the low end of the range is based on the 50th percentile estimate of the number of sites and the upper end is based on the 95th percentile estimate of the number of sites.

4.1.1.3 Summary of Inhalation Exposure Assessment

Table 4-3 presents a summary of inhalation exposure results based on exposure modeling for each OES. This tables provides a summary of the 8-hour time weighted average (8-hour TWA) inhalation exposure estimates for the average adult worker, as well as the Acute Dose (AD), the Intermediate Average Daily Dose (IADD), and the Chronic Average Daily Dose (ADD). The *Draft Environmental Release and Occupational Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024q) provides exposure results specific to women of reproductive age and ONUs. The *Draft Environmental Release and Occupational Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* also provides additional details regarding AD, IADD, and ADD calculations along with EPA's approach and methodology for estimating inhalation exposures.

Table 4-3. Summary of Average Adult Worker Inhalation Exposure Results for Each Occupational Exposure Scenario

OES	Inhalation Estimates (Average Adult Worker)									
	Mist 8-h TWA (mg/m^3)		PNOR 8-h TWA (mg/m^3)		AD (mg/kg/day)		IADD (mg/kg/day)		ADD (mg/kg/day)	
	HE	CT	HE	CT	HE	CT	HE	CT	HE	CT
Manufacturing	N/A	N/A	5.0	0.48	0.63	6.0E−02	0.46	4.4E−02	0.43	4.1E−02
Import and repackaging	N/A	N/A	3.0	0.13	0.38	1.6E−02	0.28	1.2E−02	0.26	9.3E−03
Incorporation into adhesives and sealants	N/A	N/A	5.0	0.48	0.63	6.0E−02	0.46	4.4E−02	0.43	4.1E−02
Incorporation into paints and coatings	N/A	N/A	5.0	0.48	0.63	6.0E−02	0.46	4.4E−02	0.43	4.1E−02
Incorporation into other formulations, mixtures, or reaction products	N/A	N/A	5.0	0.48	0.63	6.0E−02	0.46	4.4E−02	0.43	4.1E−02
PVC plastics compounding	N/A	N/A	4.7	0.23	0.59	2.9E−02	0.43	2.1E−02	0.40	1.8E−02
PVC plastics converting	N/A	N/A	2.1	0.10	0.26	1.3E−02	0.19	9.5E−03	0.18	7.8E−03
Non-PVC materials compounding	N/A	N/A	2.8	0.14	0.35	1.7E−02	0.26	1.3E−02	0.24	1.1E−02
Non-PVC materials converting	N/A	N/A	0.94	4.6E−02	0.12	5.8E−03	8.6E−02	4.2E−03	8.0E−02	3.5E−03
Application of paints and coatings (liquids)	8.84	0.422	N/A	N/A	1.11	5.3E−02	0.81	3.9E−02	0.76	3.6E−02
Application of paints and coatings (solids)	N/A	N/A	4.9	0.28	0.61	3.5E−02	0.45	2.6E−02	0.42	2.4E−02
Application of adhesives and sealants (liquids)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Application of adhesives and sealants (solids)	N/A	N/A	2.7	0.15	0.34	1.9E−02	0.25	1.4E−02	0.23	1.2E−02
Use of laboratory chemicals (liquids)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Use of laboratory chemicals (solids)	N/A	N/A	2.7	0.19	0.34	2.4E−02	0.25	1.7E−02	0.23	1.5E−02
Recycling	N/A	N/A	1.6	0.11	0.20	1.4E−02	0.14	9.9E−03	0.13	8.2E−03
Fabrication or use of final products or articles	N/A	N/A	0.81	0.09	0.10	1.1E−02	7.4E−02	8.3E−03	6.9E−02	7.7E−03
Waste handling, treatment, and disposal	N/A	N/A	1.6	0.11	0.20	1.4E−02	0.14	9.9E−03	0.13	8.2E−03

Abbreviations: AD = acute dose; ADD = average daily dose; CT = central tendency; HE = high-end; IADD = intermediate average daily dose; PNOR = particulates not otherwise regulated; TWA = time-weighted average

4.1.1.4 Summary of Dermal Exposure Assessment

Table 4-4 presents a summary of dermal exposure results for the average adult worker, which are based on both empirical dermal absorption data and dermal absorption modeling. The table includes the Acute Potential Dose Rate (APDR) for occupational dermal exposure estimates, as well as the AD, IADD, and Chronic ADD for the average adult worker. The *Draft Environmental Release and Occupational Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024q) provides exposure results for women of reproductive age and ONUs. The *Draft Environmental Release and Occupational Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* provides additional details regarding AD, IADD, and ADD calculations along with EPA's approach and methodology for estimating dermal exposures.

Table 4-4. Summary of Average Adult Worker Dermal Exposure Results for Each OES

OES	Dermal Estimates (Average Adult Worker)									
	Exposure Type		APDR (mg/day)		AD (mg/kg/day)		IADD (mg/kg/day)		ADD (mg/kg/day)	
	Liquid	Solid	HE	CT	HE	CT	HE	CT	HE	CT
Manufacturing; Incorporation into adhesives and sealants; Incorporation into paints and coatings; Incorporation into other formulations, mixtures, or reaction products; Application of paints and coatings (solids); Use of laboratory chemicals (solids); Fabrication or use of final products or articles		X	0.36	0.18	4.5E−03	2.3E−03	3.3E−03	1.7E−03	3.1E−03	1.5E−03
Import and repackaging		X	0.36	0.18	4.5E−03	2.3E−03	3.3E−03	1.7E−03	3.1E−03	1.3E−03
PVC plastics compounding; PVC plastics converting; non-PVC materials compounding; non-PVC materials converting; Application of adhesives and sealants (solids); Recycling; Waste handling, treatment, and disposal		X	0.36	0.18	4.5E−03	2.3E−03	3.3E−03	1.7E−03	3.1E−03	1.4E−03
Application of paints and coatings (liquids); Use of laboratory chemicals (liquids)	X		0.36	0.18	4.5E−03	2.3E−03	3.3E−03	1.7E−03	3.1E−03	1.5E−03
Application of adhesives and sealants (liquids)	X		0.36	0.18	4.5E−03	2.3E−03	3.3E−03	1.7E−03	3.1E−03	1.4E−03

Abbreviations: AD = acute dose; ADD = average daily dose; APDR = Acute Potential Dose Rate; CT = central tendency; HE = high-end; IADD = intermediate average daily dose

4.1.1.5 Weight of Scientific Evidence Conclusions for Occupational Exposure

Judgment on the weight of scientific evidence is based on the strengths, limitations, and uncertainties associated with the exposure estimates. The Agency considers factors that increase or decrease the strength of the evidence supporting the exposure estimate—including quality of the data/information, applicability of the exposure data to the COU (including considerations of temporal and locational relevance) and the representativeness of the estimate for the whole industry. The best professional judgment is summarized using the descriptors of robust, moderate, slight, or indeterminant, in accordance with the Draft Systematic Review Protocol (U.S. EPA, 2021a). For example, a conclusion of moderate is appropriate where exposure data is generated from a generic model with high quality data and some chemical-specific or industry-specific inputs, such that the exposure estimate is a reasonable representation of potential sites within the OES. A conclusion of slight weight of scientific evidence is appropriate where there is limited information that does not sufficiently cover all potential exposures within the COU, and the assumptions and uncertainties are not fully known or documented. See the Draft Systematic Review Protocol for additional information on weight of scientific evidence conclusions. Table 4-5 provides a summary of EPA's overall confidence in its occupational exposure estimates for each of the OESs assessed.

Table 4-5. Summary of Assumptions, Uncertainty, and Overall Confidence in Exposure Estimates by OES

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
Manufacturing	EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 8-hour TWA inhalation exposure estimates for the manufacturing OES. EPA utilized the PNOR Model (U.S. EPA, 2021b) to estimate worker inhalation exposure to solid particulate. The respirable particulate concentrations used by the generic model were rated high for data quality from the systematic review process, and the model was built using OSHA CEHD data (OSHA, 2020). EPA used a subset of the respirable particulate data from the generic model identified with the Chemical Manufacturing NAICS code (NAICS code 325) to assess this OES, which EPA expects to be the most representative subset of the particulate data in the absence of chemical-specific data. EPA estimated the highest expected concentration of DCHP in particulates during manufacturing using DCHP concentration information from CDR reporters, which was also rated high for data quality in the systematic review process (U.S. EPA, 2020a). These strengths increase the weight of scientific evidence. The primary limitation is the uncertainty in the representativeness of values toward the true distribution of potential inhalation exposures. Specifically, EPA lacks facility-specific particulate concentrations in air, and the representativeness of the data set used in the model towards sites that actually handle DCHP is uncertain. Further, the model lacks metadata on worker activities. EPA also assumed eight exposure hours per day and 250 exposure days per year based on continuous DCHP exposure each working day for a typical worker schedule; it is uncertain whether this captures actual worker schedules and exposures. EPA did not account for vapor inhalation exposures, but vapor exposures are not expected to significantly contribute to overall inhalation exposure when compared to particulate exposures. This is based on DCHP's vapor pressure, and the solid physical form assessed for this OES. These limitations decrease the weight of evidence. Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of exposures.
Import and repackaging	EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 8-hour TWA inhalation exposure estimates for the import and repackaging OES. EPA utilized the PNOR Model (U.S. EPA, 2021b) to estimate worker inhalation exposure to solid particulate. The respirable particulate concentrations used by the generic model were rated high for data quality from the systematic review process, and the model was built using OSHA CEHD data (OSHA, 2020). EPA used a subset of the respirable particulate data from the generic model identified with the Wholesale and Retail Trade NAICS codes (NAICS codes 42 through 45) to assess this OES, which EPA expects to be the most representative subset of the particulate data in the absence of chemical-specific data. EPA estimated the highest expected concentration of DCHP in particulates during import and repackaging using DCHP concentration information from CDR reporters, which was also rated high for data quality in the systematic review process (U.S. EPA, 2020a). These strengths increase the weight of evidence. The primary limitation is the uncertainty in the representativeness of values toward the true distribution of potential inhalation exposures. Specifically, EPA lacks facility-specific particulate concentrations in air, and the representativeness of the data set used in the model towards sites that actually handle DCHP is uncertain. Further, the model lacks metadata on worker activities. EPA also assumed eight exposure hours per day and 208 to 250 exposure days per year based on continuous DCHP exposure each working

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
	day for a typical worker schedule; it is uncertain whether this captures actual worker schedules and exposures. EPA did not account for vapor inhalation exposures, but vapor exposures are not expected to significantly contribute to overall inhalation exposure compared to particulate exposures based on DCHP's vapor pressure and the solid physical form assessed for this OES. These limitations decrease the weight of evidence. Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of exposures.
Incorporation into adhesives and sealants	EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 8-hour TWA inhalation exposure estimates for the incorporation into adhesives and sealants OES. EPA utilized the PNOR Model (U.S. EPA, 2021b) to estimate worker inhalation exposure to solid particulate. The respirable particulate concentrations used by the generic model were rated high for data quality from the systematic review process, and the model was built using OSHA CEHD data (OSHA, 2020). EPA used a subset of the respirable particulate data from the generic model identified with the Chemical Manufacturing NAICS code (NAICS code 325) to assess this OES, which EPA expects to be the most representative subset of the particulate data for chemical product manufacturing in the absence of DCHP-specific data. EPA estimated the highest expected concentration of DCHP in particulates during adhesive and sealant manufacturing using DCHP concentration information from CDR reporters, which was also rated high for data quality in the systematic review process (U.S. EPA, 2020a). These strengths increase the weight of evidence. The primary limitation is the uncertainty in the representativeness of values toward the true distribution of potential inhalation exposures. Specifically, EPA lacks facility-specific particulate concentrations in air, and the representativeness of the data set used in the model towards sites that actually handle DCHP is uncertain. Further, the model lacks metadata on worker activities. EPA also assumed eight exposure hours per day and 250 exposure days per year based on continuous DCHP particulate exposure while unpacking DCHP received on site each working day for a typical worker schedule; it is uncertain whether this captures actual worker schedules and exposures. EPA did not account for vapor inhalation exposures, but vapor exposures are not expected to significantly contribute to overall inhalation exposure compared to particulate exposures based on DCHP's vapor pressure and the solid physical form assessed for this OES. These limitations decrease the weight of evidence. Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of exposures.
Incorporation into paints and coatings	EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 8-hour TWA inhalation exposure estimates for the incorporation into paints and coatings OES. EPA utilized the PNOR Model (U.S. EPA, 2021b) to estimate worker inhalation exposure to solid particulate. The respirable particulate concentrations used by the generic model were rated high for data quality from the systematic review process, and the model was built using OSHA CEHD data (OSHA, 2020). EPA used a subset of the respirable particulate data from the generic model identified with the Chemical Manufacturing NAICS code (NAICS code 325) to assess this OES, which EPA expects to be the most representative subset of the particulate data for chemical product manufacturing in the absence of DCHP-specific data. EPA estimated the highest expected concentration of DCHP in particulates during paint and coating manufacturing using DCHP

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
	concentration information from CDR reporters, which was also rated high for data quality in the systematic review process (U.S. EPA, 2020a). These strengths increase the weight of evidence. The primary limitation is the uncertainty in the representativeness of values toward the true distribution of potential inhalation exposures. Specifically, EPA lacks facility-specific particulate concentrations in air, and the representativeness of the data set used in the model towards sites that actually handle DCHP is uncertain. Further, the model lacks metadata on worker activities. EPA also assumed eight exposure hours per day and 250 exposure days per year based on continuous DCHP particulate exposure while unpacking DCHP received on site each working day for a typical worker schedule; it is uncertain whether this captures actual worker schedules and exposures. EPA did not account for vapor inhalation exposures, but vapor exposures are not expected to significantly contribute to overall inhalation exposure compared to particulate exposures based on DCHP's vapor pressure and the solid physical form assessed for this OES. These limitations decrease the weight of evidence. Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of exposures.
Incorporation into other formulations, mixtures, and reaction products not covered elsewhere	EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 8-hour TWA inhalation exposure estimates for the incorporation into other formulations, mixtures, and reaction products not covered elsewhere OES. EPA utilized the PNOR Model (U.S. EPA, 2021b) to estimate worker inhalation exposure to solid particulate. The respirable particulate concentrations used by the generic model were rated high for data quality from the systematic review process, and the model was built using OSHA CEHD data (OSHA, 2020). EPA used a subset of the respirable particulate data from the generic model identified with the Chemical Manufacturing NAICS code (NAICS code 325) to assess this OES, which EPA expects to be the most representative subset of the particulate data for chemical product manufacturing in the absence of DCHP-specific data. EPA estimated the highest expected concentration of DCHP in particulates during formulation, mixture or other chemical product manufacturing using DCHP concentration information from CDR reporters, which was also rated high for data quality in the systematic review process (U.S. EPA, 2020a). These strengths increase the weight of evidence. The primary limitation is the uncertainty in the representativeness of values toward the true distribution of potential inhalation exposures. Specifically, EPA lacks facility-specific particulate concentrations in air, and the representativeness of the data set used in the model towards sites that actually handle DCHP is uncertain. Further, the model lacks metadata on worker activities. EPA also assumed eight exposure hours per day and 250 exposure days per year based on continuous DCHP particulate exposure while unpacking DCHP received on site each working day for a typical worker schedule; it is uncertain whether this captures actual worker schedules and exposures. EPA did not account for vapor inhalation exposures, but vapor exposures are not expected to significantly contribute to overall inhalation exposure compared to particulate exposures based on DCHP's vapor pressure and the solid physical form assessed for this OES. These limitations decrease the weight of evidence. Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of exposures.

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
PVC plastics compounding	EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 8-hour TWA inhalation exposure estimates for PVC plastics compounding OES. EPA utilized the PNOR Model (U.S. EPA, 2021b) to estimate worker inhalation exposure to solid particulate. The respirable particulate concentrations used by the generic model were rated high for data quality from the systematic review process, and the model was built using OSHA CEHD data (OSHA, 2020). EPA used a subset of the respirable particulate data from the generic model identified with the Plastics and Rubber Manufacturing NAICS code (NAICS code 326) to assess this OES, which EPA expects to be the most representative subset of the particulate data for PVC plastic manufacturing in the absence of DCHP-specific data. EPA estimated the highest expected concentration of DCHP in particulates during PVC plastic compounding using DCHP concentration information from CDR reporters, which was also rated high for data quality in the systematic review process (U.S. EPA, 2020a). These strengths increase the weight of evidence. The primary limitation is the uncertainty in the representativeness of values toward the true distribution of potential inhalation exposures. Specifically, EPA lacks facility-specific particulate concentrations in air, and the representativeness of the data set used in the model towards sites that actually handle DCHP is uncertain. Further, the model lacks metadata on worker activities. EPA also assumed eight exposure hours per day based on continuous DCHP particulate exposure while unpacking DCHP received on site each working day for a typical worker schedule; it is uncertain whether this captures actual worker schedules and exposures. EPA set the number of exposure days based on Monte Carlo modeling of the operating days from the release assessment, with a maximum number of working days capped at 250 days per year based on EPA default assumptions. The high-end exposures are based on 250 days per year as the exposure frequency since the 95th percentile of operating days in the release assessment exceeded 250 days per year. The central tendency exposures use 223 days per year as the exposure frequency based on the 50th percentile of operating days from the release assessment. EPA did not account for vapor inhalation exposures, but vapor exposures are not expected to significantly contribute to overall inhalation exposure compared to particulate exposures based on DCHP's vapor pressure and the solid physical form assessed for this OES. These limitations decrease the weight of evidence. Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of exposures.
PVC plastics converting	EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 8-hour TWA inhalation exposure estimates for PVC plastics converting OES. EPA utilized the PNOR Model (U.S. EPA, 2021b) to estimate worker inhalation exposure to solid particulate. The respirable particulate concentrations used by the generic model were rated high for data quality from the systematic review process, and the model was built using OSHA CEHD data (OSHA, 2020). EPA used a subset of the respirable particulate data from the generic model identified with the Plastics and Rubber Manufacturing NAICS code (NAICS code 326) to assess this OES, which EPA expects to be the most representative subset of the particulate data for PVC plastics product manufacturing in the absence of DCHP-specific data. EPA estimated the highest expected concentration of DCHP in particulates during PVC plastic converting using plasticizer additive concentration information from the Use of Additives in Plastic Converting Generic Scenario that was rated medium for data quality in the systematic review process (U.S. EPA, 2004a). These strengths increase the weight of evidence.

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
	The primary limitation is the uncertainty in the representativeness of values toward the true distribution of potential inhalation exposures. Specifically, EPA lacks facility-specific particulate concentrations in air, and the representativeness of the data set used in the model towards sites that actually handle DCHP is uncertain. Further, the model lacks metadata on worker activities. EPA also assumed eight exposure hours per day based on continuous DCHP particulate exposure while handling DCHP-containing plastics on site each working day for a typical worker schedule; it is uncertain whether this captures actual worker schedules and exposures. EPA set the number of exposure days based on Monte Carlo modeling of the operating days from the release assessment, with a maximum number of working days capped at 250 days per year based on EPA default assumptions. The high-end exposures are based on 250 days per year as the exposure frequency since the 95th percentile of operating days in the release assessment exceeded 250 days per year. The central tendency exposures use 219 days per year as the exposure frequency based on the 50th percentile of operating days from the release assessment. EPA did not account for vapor inhalation exposures, but vapor exposures are not expected to significantly contribute to overall inhalation exposure compared to particulate exposures based on DCHP's vapor pressure and the solid physical form assessed for this OES. These limitations decrease the weight of evidence. Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of exposures.
Non-PVC material compounding	EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 8-hour TWA inhalation exposure estimates for non-PVC material compounding OES. EPA utilized the PNOR Model (U.S. EPA, 2021b) to estimate worker inhalation exposure to solid particulate. The respirable particulate concentrations used by the generic model were rated high for data quality from the systematic review process, and the model was built using OSHA CEHD data (OSHA, 2020). EPA used a subset of the respirable particulate data from the generic model identified with the Plastics and Rubber Manufacturing NAICS code (NAICS code 326) to assess this OES, which EPA expects to be the most representative subset of the particulate data for non-PVC plastic or rubber manufacturing in the absence of DCHP-specific data. EPA estimated the highest expected concentration of DCHP in particulates during non-PVC material compounding using DCHP concentration information from CDR reporters, which was also rated high for data quality in the systematic review process (U.S. EPA, 2020a). These strengths increase the weight of evidence. The primary limitation is the uncertainty in the representativeness of values toward the true distribution of potential inhalation exposures. Specifically, EPA lacks facility-specific particulate concentrations in air, and the representativeness of the data set used in the model towards sites that actually handle DCHP is uncertain. Further, the model lacks metadata on worker activities. EPA also assumed eight exposure hours per day based on continuous DCHP particulate exposure while unpacking DCHP received on site each working day for a typical worker schedule; it is uncertain whether this captures actual worker schedules and exposures. EPA set the number of exposure days based on Monte Carlo modeling of the operating days from the release assessment, with a maximum number of working days capped at 250 days per year based on EPA default assumptions. The high-end exposures are based on 250 days per year as the exposure frequency since the 95th percentile of operating days in the release assessment exceeded 250 days per year. The central tendency exposures use 227 days per year as the exposure frequency based on the 50th percentile of operating days from the release assessment. EPA did not account for vapor inhalation exposures, but vapor exposures are not expected to significantly contribute to overall inhalation exposure compared to particulate exposures based on DCHP's vapor pressure and the solid physical form assessed for this OES. These limitations decrease the weight of evidence.

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
	Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of exposures.
Non-PVC material converting	EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 8-hour TWA inhalation exposure estimates for non-PVC material converting OES. EPA utilized the PNOR Model (U.S. EPA, 2021b) to estimate worker inhalation exposure to solid particulate. The respirable particulate concentrations used by the generic model were rated high for data quality from the systematic review process, and the model was built using OSHA CEHD data (OSHA, 2020). EPA used a subset of the respirable particulate data from the generic model identified with the Plastics and Rubber Manufacturing NAICS code (NAICS code 326) to assess this OES, which EPA expects to be the most representative subset of the particulate data for non-PVC plastic and rubber product manufacturing in the absence of DCHP-specific data. EPA estimated the highest expected concentration of DCHP in particulates during non-PVC material converting using rubber plasticizer concentration information from the Emission Scenario Document on Additives in Rubber Industry which has a medium rating for data quality in the systematic review process (OECD, 2004). These strengths increase the weight of evidence. The primary limitation is the uncertainty in the representativeness of values toward the true distribution of potential inhalation exposures. Specifically, EPA lacks facility-specific particulate concentrations in air, and the representativeness of the data set used in the model towards sites that actually handle DCHP is uncertain. Further, the model lacks metadata on worker activities. EPA also assumed eight exposure hours per day based on continuous DCHP particulate exposure while handling DCHP-containing plastics or rubbers on site each working day for a typical worker schedule; it is uncertain whether this captures actual worker schedules and exposures. EPA set the number of exposure days based on Monte Carlo modeling of the operating days from the release assessment, with a maximum number of working days capped at 250 days per year based on EPA default assumptions. The high-end exposures are based on 250 days per year as the exposure frequency since the 95th percentile of operating days in the release assessment exceeded 250 days per year. The central tendency exposures use 219 days per year as the exposure frequency based on the 50th percentile of operating days from the release assessment. EPA did not account for vapor inhalation exposures, but vapor exposures are not expected to significantly contribute to overall inhalation exposure compared to particulate exposures based on DCHP vapor pressure and the solid physical form assessed for this OES. These limitations decrease the weight of evidence. Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of exposures.
Application of adhesives and sealants	EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 8-hour TWA inhalation exposure estimates for the application of adhesives and sealants OES. EPA utilized the PNOR Model (U.S. EPA, 2021b) to estimate worker inhalation exposure to solid particulate. The respirable particulate concentrations used by the generic model were rated high for data quality from the systematic review process, and the model was built using OSHA CEHD data (OSHA, 2020). EPA used the entire respirable particulate data set from the generic model to assess this OES, since adhesives and sealants containing DCHP may be used in a variety of end-use industries. EPA estimated the highest expected concentration of DCHP in particulates during application of adhesives and sealants using SDSs and product data sheets from identified DCHP-containing adhesives and sealant products in solid form. These strengths increase the weight of evidence.

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
	The primary limitation is the uncertainty in the representativeness of values toward the true distribution of potential inhalation exposures. Specifically, EPA lacks facility-specific particulate concentrations in air, and the representativeness of the data set used in the model towards sites that actually handle DCHP is uncertain. Further, the model lacks metadata on worker activities. EPA also assumed eight exposure hours per day based on continuous DCHP particulate exposure while handling DCHP-containing products on site each working day for a typical worker schedule; it is uncertain whether this captures actual worker schedules and exposures. EPA set the number of exposure days based on Monte Carlo modeling of the operating days from the release assessment, with a maximum number of working days capped at 250 days per year based on EPA default assumptions. The high-end exposures are based on 250 days per year as the exposure frequency since the 95th percentile of operating days in the release assessment exceeded 250 days per year. The central tendency exposures use 232 days per year as the exposure frequency based on the 50th percentile of operating days from the release assessment. EPA did not account for vapor inhalation exposures, but vapor exposures are not expected to significantly contribute to overall inhalation exposure compared to particulate exposures based on DCHP's vapor pressure and the solid physical form assessed for this OES. These limitations decrease the weight of evidence. Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of exposures.
Application of paints and coatings	EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 8-hour TWA inhalation exposure estimates. EPA used surrogate monitoring data from the ESD on Coating Application via Spray-Painting in the Automotive Refinishing Industry, which the systematic review process rated high for data quality, to estimate inhalation exposures to DCHP in the liquid form (OECD, 2011a). EPA also used the PNOR Model (U.S. EPA, 2021b) to estimate worker inhalation exposure to solid particulate, since DCHP may be received on site in solid form. The respirable particulate concentrations used by the generic model were rated high for data quality from the systematic review process, and the model was built using OSHA CEHD data (OSHA, 2020). EPA used the entire respirable particulate data set from the generic model to assess this OES, since paints and coatings containing DCHP may be used in a variety of end-use industries. EPA used SDSs and product data sheets from identified DCHP-containing products to identify product concentrations for the liquid spray and the solid particulate assessments. A strength of this approach is that both models (for solid particulate and for mist exposure) resulted in exposure estimates within an order of magnitude of each other. These strengths increase the weight of evidence. The primary limitation is the lack of DCHP-specific monitoring data. Specifically, the ESD serves as a surrogate source of monitoring data representing the level of exposure that could be expected at a typical work site for the given spray application method, and the generic model data represents particulate concentrations in air for solids handling exposures. EPA assumes spray applications of the coatings, so the estimates may not be representative of exposure during other coating application methods. Additionally, it is uncertain whether the substrates coated, and products used to generate the surrogate data are representative of those associated with DCHP-containing coatings. EPA only assessed mist or solid exposures to DCHP over a full 8-hour work shift to estimate the level of exposure, though other activities may result in exposures other than mist or solid particulate and application duration may be variable depending on the job site. EPA assessed 250 days of exposure per year based on workers applying coatings on every working day, however, application sites may use DCHP-containing coatings at much lower or variable frequencies. These limitations decrease the weight of evidence.

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
	Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of exposures.
Use of laboratory chemicals	EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 8-hour TWA inhalation exposure estimates for use of laboratory chemicals OES. EPA utilized the PNOR Model (U.S. EPA, 2021b) to estimate worker inhalation exposure to solid particulate. The respirable particulate concentrations used by the generic model were rated high for data quality from the systematic review process, and the model was built using OSHA CEHD data (OSHA, 2020). EPA used a subset of the respirable particulate data from the generic model identified with the Professional, Scientific, and Technical Services NAICS code (NAICS code 54) to assess this OES, which EPA expects to be the most representative subset of the particulate data for use of laboratory chemicals in the absence of DCHP-specific data. EPA estimated the highest expected concentration of DCHP in particulates during laboratory use using SDSs and product data sheets from identified lab-grade chemicals. These strengths increase the weight of evidence. The primary limitation is the uncertainty in the representativeness of values toward the true distribution of potential inhalation exposures. Specifically, EPA lacks facility-specific particulate concentrations in air, and the representativeness of the data set used in the model towards sites that actually handle DCHP is uncertain. Further, the model lacks metadata on worker activities. EPA also assumed eight exposure hours per day based on continuous DCHP particulate exposure while handling DCHP-containing products on site each working day for a typical worker schedule; it is uncertain whether this captures actual worker schedules and exposures. EPA set the number of exposure days based on Monte Carlo modeling of the operating days from the release assessment, with a maximum number of working days capped at 250 days per year based on EPA default assumptions. The high-end exposures are based on 250 days per year as the exposure frequency since the 95th percentile of operating days in the release assessment exceeded 250 days per year. The central tendency exposures use 232 days per year as the exposure frequency based on the 50th percentile of operating days from the release assessment. EPA did not account for vapor inhalation exposures, but vapor exposures are not expected to significantly contribute to overall inhalation exposure compared to particulate exposures based on DCHP's vapor pressure and the solid physical form assessed for this OES. These limitations decrease the weight of evidence. Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of exposures.
Fabrication or use of final products or articles	EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 8-hour TWA inhalation exposure estimates for the fabrication or use of final products or articles OES. EPA utilized the PNOR Model (U.S. EPA, 2021b) to estimate worker inhalation exposure to solid particulate. The respirable particulate concentrations used by the generic model were rated high for data quality from the systematic review process, and the model was built using OSHA CEHD data (OSHA, 2020). EPA used a subset of the respirable particulate data from the generic model identified with the Furniture and Related Product Manufacturing NAICS code (NAICS code 337) to assess this OES, which EPA expects to be the most representative subset of the particulate data for this OES. EPA estimated the highest expected concentration of DCHP in particulates during product fabrication using plasticizer additive concentration information from the Use of Additives in Plastic Converting Generic Scenario that has a medium rating for data quality from the systematic review process (U.S. EPA, 2004a). These strengths increase the weight of evidence.

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
	The primary limitation is the uncertainty in the representativeness of values toward the true distribution of potential inhalation exposures. Specifically, EPA lacks facility-specific particulate concentrations in air, and the representativeness of the data set used in the model towards sites that actually handle DCHP is uncertain. Further, the model lacks metadata on worker activities. EPA also assumed eight exposure hours per day based on continuous DCHP particulate exposure while handling DCHP-containing products on site each working day for a typical worker schedule; it is uncertain whether this captures actual worker schedules and exposures. EPA set the number of exposure days based on Monte Carlo modeling of the operating days from the release assessment, with a maximum number of working days capped at 250 days per year based on EPA default assumptions. The high-end exposures are based on 250 days per year as the exposure frequency since the 95th percentile of operating days in the release assessment exceeded 250 days per year. The central tendency exposures use 232 days per year as the exposure frequency based on the 50th percentile of operating days from the release assessment. EPA did not account for vapor inhalation exposures, but vapor exposures are not expected to significantly contribute to overall inhalation exposure compared to particulate exposures based on DCHP vapor pressure and the solid physical form assessed for this OES. These limitations decrease the weight of evidence. Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of exposures.
Recycling	EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 8-hour TWA inhalation exposure estimates for the recycling OES. EPA utilized the PNOR Model (U.S. EPA, 2021b) to estimate worker inhalation exposure to solid particulate. The respirable particulate concentrations used by the generic model were rated high for data quality from the systematic review process, and the model was built using OSHA CEHD data (OSHA, 2020). EPA used a subset of the respirable particulate data from the generic model identified with the Administrative and Support and Waste Management and Remediation Services NAICS code (NAICS code 56) to assess this OES, which EPA expects to be the most representative subset of the particulate data for this OES. EPA estimated the highest expected concentration of DCHP in plastic using plasticizer additive concentration information from the Use of Additives in Plastic Converting Generic Scenario that has a medium rating for data quality from the systematic review process (U.S. EPA, 2004a). These strengths increase the weight of evidence. The primary limitation is the uncertainty in the representativeness of values toward the true distribution of potential inhalation exposures. Specifically, EPA lacks facility-specific particulate concentrations in air, and the representativeness of the data set used in the model towards sites that actually handle DCHP is uncertain. Further, the model lacks metadata on worker activities. The high-end exposures use 250 days per year as the exposure frequency since the 95th percentile of operating days in the release assessment exceeded 250 days per year, which is the expected maximum number of working days. The central tendency exposures use 223 days per year as the exposure frequency based on the 50th percentile of operating days from the release assessment. Also, it was assumed that each worker is potentially exposed for 8 hours per workday; however, it is uncertain whether this captures actual worker schedules and exposures. These limitations decrease the weight of evidence. Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of exposures.

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
Waste handling, treatment, and disposal	EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 8-hour TWA inhalation exposure estimates for the waste handling, treatment, and disposal OES. EPA utilized the PNOR Model (U.S. EPA, 2021b) to estimate worker inhalation exposure to solid particulate. The respirable particulate concentrations used by the generic model were rated high for data quality from the systematic review process, and the model was built using OSHA CEHD data (OSHA, 2020). EPA used a subset of the respirable particulate data from the generic model identified with the Administrative and Support and Waste Management and Remediation Services NAICS code (NAICS code 56) to assess this OES, which EPA expects to be the most representative subset of the particulate data for this OES. EPA estimated the highest expected concentration of DCHP in plastic using plasticizer additive concentration information from the Use of Additives in Plastic Converting Generic Scenario that has a medium rating for data quality from the systematic review process (U.S. EPA, 2004a). These strengths increase the weight of evidence. The primary limitation is the uncertainty in the representativeness of values toward the true distribution of potential inhalation exposures. Specifically, EPA lacks facility-specific particulate concentrations in air, and the representativeness of the data set used in the model towards sites that actually handle DCHP is uncertain. Further, the model lacks metadata on worker activities. The high-end exposures use 250 days per year as the exposure frequency since the 95th percentile of operating days in the release assessment exceeded 250 days per year, which is the expected maximum number of working days. The central tendency exposures use 223 days per year as the exposure frequency based on the 50th percentile of operating days from the release assessment. Also, it was assumed that each worker is potentially exposed for 8 hours per workday; however, it is uncertain whether this captures actual worker schedules and exposures. These limitations decrease the weight of evidence. Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of exposures.
Distribution in commerce	These exposures are assessed as part of individual OESs where the relevant activities occur.
Dermal	EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the dermal exposure estimates. EPA used dermal modeling of aqueous materials (U.S. EPA, 2023b, 2004b) to estimate occupational dermal exposures of DCHP to workers and ONUs. The modeling approach for determining the aqueous permeability coefficient was within the range of applicability given the physical and chemical parameters of DCHP, and the modeling approach received a medium rating through EPA's systematic review process. Additionally, the neat form of DCHP is a solid, the concentrated formulations are paste-like, and any liquid containing DCHP has very low concentrations; therefore, it is reasonable to assume that flux-limited absorption of aqueous DCHP serves as a reasonable upper bound for the dermal absorption of DCHP from occupational scenarios. Additionally, EPA assumed a standard 8-hour workday and that the chemical is contacted at least once per day. Because DCHP has low volatility and low absorption, it is possible that the chemical remains on the surface of the skin after a dermal contact until the skin is washed. Therefore, absorption of DCHP from occupational dermal contact with materials containing DCHP may extend up to 8 hours per day (U.S. EPA, 1991). For average adult workers, the surface area of contact was assumed equal to the area of one hand (*i.e.*, 535 cm^2) for central tendency, or two hands (*i.e.*, 1,070 cm^2) for high-end

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
	exposures (U.S. EPA, 2011a). The standard sources for exposure duration and area of contact received high ratings through EPA's systematic review process. These strengths increase the weight of evidence. EPA acknowledges that variations in chemical concentration and co-formulant components affect the rate of dermal absorption, and that these variations were not considered in the occupational dermal exposure assessment in favor of an upper bound dermal absorption estimate from flux-limited absorption of aqueous DCHP. Additionally, worker activity metadata used in the model, such as surface area of skin contact and exposure duration, are not facility or industry-specific and are meant to address generic dermal exposures in all OESs assessed. These limitations decrease the weight of evidence. The occupational dermal exposure assessment for contact with materials containing DCHP was based on dermal absorption modeling of aqueous DCHP, as well as standard occupational inputs for exposure duration and area of contact, as described above. Based on the strengths and limitations of these inputs, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of occupational dermal exposures.

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4.1.1.5.1 Strengths, Limitations, Assumptions, and Key Sources of Uncertainty for the Occupational Exposure Assessment

EPA assigned overall confidence descriptions of high, medium, or low to the exposure assessments, based on the strength of the underlying scientific evidence. When the assessment is supported by robust evidence, the Agency's overall confidence in the exposure assessment is high; when supported by moderate evidence, EPA's overall confidence is medium; when supported by slight evidence, the Agency's overall confidence is low.

Strengths

The exposure scenarios and exposure factors underlying the inhalation and dermal assessment are supported by moderate to robust evidence. Occupational inhalation exposure scenarios were informed by moderate or robust sources of surrogate monitoring data or GSs/ESDs used to model the inhalation exposure concentration. Exposure factors for occupational inhalation exposure include duration of exposure, body weight, and breathing rate, which were informed by moderate to robust data sources.

A strength of the modeling assessment includes the consideration of variable model input parameters as opposed to using a single static value. Parameter variation increases the likelihood that the true occupational inhalation exposures fall within the range of modeled estimates. An additional strength is that all data that EPA used to inform the modeling parameter distributions have overall data quality ratings of either high or medium from EPA's systematic review process. Strengths associated with dermal exposure assessment are described in Table 4-5.

Limitations

The principal limitation of the exposure assessments is uncertainty in the representativeness of the data and models used, as there is no direct exposure monitoring data for DCHP in the literature from systematic review. A limitation of the modeling methodologies is that most of the model input data from GSs/ESDs, such as air speed or loss factors, are generic for the OESs and not specific to the use of DCHP within the OESs. Additionally, the selected generic models and data may not be representative of all chemical- or site-specific work practices and engineering controls. Limitations associated with dermal exposure assessment are described in Table 4-5.

Assumptions

When determining the appropriate model for assessing exposures to DCHP, EPA considered the physical form of DCHP during different OESs. DCHP may be present in various physical forms such as a powder, mist, paste, or in solution during the various OESs. EPA assessed each respective OES assuming the physical form of DCHP based on available product data, CDR data, and information from applicable GSs/ESDs. The physical form of DCHP can influence exposures substantially, so EPA assumed DCHP is present in the physical form that is most prevalent and/or most protective for the given OES when assessing the exposures.

EPA calculated ADD values assuming workers and ONUs are regularly exposed during their entire working lifetime, which likely results in an overestimate. Individuals may change jobs during the course of their career such that they are no longer exposed to DCHP, and the actual ADD values become lower than the estimates presented. Assumptions associated with dermal exposure assessment are described in Table 4-5.

Uncertainties

EPA addressed variability in inhalation models by identifying key model parameters and applying statistical distributions that mathematically define the parameter's variability. The Agency defined statistical distributions for parameters using documented statistical variations where available. Where the statistical variation was unknown, EPA made assumptions to estimate the parameter distribution using available literature data, such as GSs and ESDs. However, there is uncertainty as to the representativeness of the parameter distributions because these data are often not specific to sites that use DCHP. In general, the effects of these uncertainties on the exposure estimates are unknown as the uncertainties may result in either overestimation or underestimation of exposures depending on the actual distributions of each of the model input parameters. Uncertainties associated with dermal exposure assessment are described in Table 4-5.

There are several uncertainties surrounding the estimated number of workers potentially exposed to DCHP. First, BLS' OES employment data for each industry/occupation combination are only available at the 3-, 4-, or 5-digit NAICS level, rather than the full 6-digit NAICS level. This lack of granularity could result in an overestimate of the number of exposed workers if some 6-digit NAICS are included in the less granular BLS estimates but are not likely to use DCHP for the assessed applications. EPA addressed this issue by refining the OES estimates using total employment data from the U.S. Census' Statistics of U.S. Businesses (SUSB). However, this approach assumes that the distribution of occupation types (SOC codes) in each 6-digit NAICS is equal to the distribution of occupation types at the parent 5-digit NAICS level. If the distribution of workers in occupations with DCHP exposure differs from the overall distribution of workers in each NAICS, then this approach will result in inaccuracy.

4.1.2 Consumer Exposures

The following subsections briefly describe EPA's approach to assessing consumer exposures and provide exposure assessment results for each COU. The *Draft Consumer and Indoor Dust Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024c) provides additional details on the development of approaches and the exposure assessment results. The consumer exposure assessment evaluated exposures from individual COUs while the indoor dust assessment uses a subset of consumer articles with large surface area and presence in indoor environments to garner COU specific contributions to the total exposures from dust.

4.1.2.1 Summary of Consumer and Indoor Dust Exposure Scenarios and Modeling Approach and Methodology

The main steps in performing a consumer exposure assessment are summarized below:

- Identification and mapping of product and article examples following the consumer COU table (Table 1-1), product, and article identification.
- Compilation of products and articles manufacturing use instructions to determine patterns of use.
- Selection of exposure routes and exposed populations according to product/article use descriptions.
- Identification of data gaps and further search to fill gaps with studies, chemical surrogates or product and article proxies, or professional judgement.
- Selection of appropriate modeling tools based on available information and chemical properties.
- Gathering of input parameters per exposure scenario.
- Parameterization of selected modeling tools.

Consumer products or articles containing DCHP were matched with the identified consumer COUs. Table 4-6 summarizes the consumer exposure scenarios by COU for each product example(s), the exposure routes, which scenarios are also used in the indoor dust assessment, and whether the analysis was conducted qualitatively or quantitatively. The indoor dust assessment uses consumer products and articles information for selected items with the goal of recreating the indoor environment. The subset of consumer products and articles that can be used in the indoor dust assessment are selected for their potential to have large surface area for dust collection, roughly larger than one square meter. Using these criteria, EPA did not identify articles in the modeling exposure estimates to include in the indoor assessment.

When a quantitative analysis was conducted, exposure from the consumer COUs was estimated by modeling. Exposure via inhalation and ingestion routes were modeled using EPA's Consumer Exposure Model (CEM), Version 3.2 (U.S. EPA, 2023b). Dermal exposures were estimated using a computational framework implemented within a spreadsheet environment. For each exposure route, EPA used the 10th percentile, average, and 95th percentile value of an input parameter (*e.g.*, weight fraction, surface area) where possible to characterize low, medium, and high exposure scenarios for a given COU. If only a range was reported, EPA used the minimum and maximum of the range as the low and high values, respectively. The average of the reported low and high values from the reported range was used for the medium exposure scenario. See *Draft Consumer and Indoor Dust Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024c) for details about the consumer modeling approaches, sources of data, model parameterization, and assumptions.

Exposure via the inhalation route occurs from inhalation of DCHP gas-phase emissions or when DCHP partitions to suspended particulate from direct use or application of products. However, DCHP's low volatility is expected to result in negligible gas-phase inhalation exposures. Sorption to suspended and settled dust is likely to occur based on monitoring data (see indoor dust monitoring data in Section 4.1.2.1) and its affinity for organic matter which is typically present in household dust. Thus, inhalation and ingestion of suspended and settled dust is considered in this assessment. Exposure via the dermal route can occur from direct contact with products and articles. Exposure via ingestion depends on the product or article use patterns. Exposure can occur via direct mouthing (*i.e.*, directly putting product in mouth) in which the person can ingest settled dust with DCHP, or directly ingesting DCHP from migration to saliva. Additionally, ingestion of suspended dust can occur when DCHP migrates from product to dust or partitions from gas-phase to suspended dust.

EPA labeled CEM lifestages to match those listed in the U.S. Centers for Disease Control and Prevention (CDC) guidelines (CDC, 2021) and the Agency's *A Framework for Assessing Health Risks of Exposures to Children* (U.S. EPA, 2006). CEM lifestages were re-labeled as follows:

- Adult (21+ years) → Adult
- Youth 2 (16–20 years) → Teenager
- Youth 1 (11–15 years) → Young teen
- Child 2 (6–10 years) → Middle childhood
- Child 1 (3–5 years) → Preschooler
- Infant 2 (1–2 years) → Toddler
- Infant 1 (<1 year) → Infant

EPA assessed acute, intermediate, and chronic exposures to DCHP from consumer COUs. For the acute dose rate calculations, an averaging time of 1 day is used representing the maximum time-integrated dose over a 24-hour period during the exposure event. The chronic dose rate is calculated iteratively at a 30-second interval during the first 24 hours and every hour after that for 60 days. Intermediate dose is

the exposure to continuous or intermittent (depending on product) use during a 30-day period, which is roughly a month. Professional judgment and product use descriptions were used to estimate events per day and per month/year for the calculation of the intermediate/chronic dose.

Table 4-6. Summary of Consumer COUs, Exposure Scenarios, and Exposure Routes

Consumer COU Category	Consumer COU Subcategory	Product/Article	Exposure Scenario and Route	Evaluated Routes					
				Suspended Dust & Vapor Inhalation	Dermal	Ingestion			Qualitative / Quantitative [d]
						Suspended Dust	Settled Dust	Mouthing	
Adhesives and sealants	Adhesives and sealants	Auto or construction bonding adhesive	Use of product in DIY[a] large-scale home repair activities. Direct contact during use; inhalation of emissions during use	✓	✓	✗	✗	✗	Quantitative
Adhesives and sealants	Adhesives and sealants	Adhesives for small repairs	Use of product in DIY[a] small-scale home repair activities. Direct contact during use	✗	✓	✗	✗	✗	Quantitative
Other articles with routine direct contact during normal use including rubber articles; plastic articles (hard)	Other articles with routine direct contact during normal use including rubber articles; plastic articles (hard)	Small articles with the potential for semi-routine contact: labels, nitrocellulose; ethylcellulose; chlorinated rubber; PVAc; PVC	Direct contact during use	✗[b]	✓	✗	✗	✗	Quantitative
Other	Other consumer articles that contain dicyclohexyl phthalate from: inks, toner, and colorants; paints and coatings; adhesives and sealants (*e.g.*, paper products, textiles, products using cellulose film, etc.)	Outdoor coated surfaces/seating	Direct contact during use	✗[c]	✓	✗	✗	✗	Quantitative

Consumer COU Category	Consumer COU Subcategory	Product/Article	Exposure Scenario and Route	Evaluated Routes					
				Suspended Dust & Vapor Inhalation	Dermal	Ingestion			Qualitative / Quantitative [d]
						Suspended Dust	Settled Dust	Mouthing	
Other	Other consumer articles that contain dicyclohexyl phthalate from: inks, toner, and colorants; paints and coatings; adhesives and sealants (*e.g.*, paper products, textiles, products using cellulose film, etc.)	Small articles with the potential for semi-routine contact: labels, and packaging adhesives, foil and cellophane lacquers, and printing inks	Direct contact during use	✗[b]	✓	✗	✗	✗	Quantitative
Other	Other consumer articles that contain dicyclohexyl phthalate from: inks, toner, and colorants; paints and coatings; adhesives and sealants (*e.g.*, paper products, textiles, products using cellulose film, etc.)	Electronics containing dye adhesive	No exposures expected	✗	✗	✗	✗	✗	Qualitative
Disposal	Disposal	Down the drain products and articles	Down the drain and releases to environmental media	✗	✗	✗	✗	✗	Qualitative
Disposal	Disposal	Residential end-of-life disposal, product demolition for disposal	Product and article end-of-life disposal and product demolition for disposal	✗	✗	✗	✗	✗	Qualitative

DIY [a] – Do-it-Yourself
✓ Scenario is considered either qualitatively or quantitatively in this assessment.
✗ Scenario was deemed unlikely based on low volatility and small surface area, likely negligible gas and particle phase concentration for inhalation, low possibility of mouthing based on product use patterns and targeted population age groups, and/or low possibility of dust on surface due to barriers or low surface area for dust ingestion.
✗[b] Scenario was deemed unlikely based on low volatility and small surface area and likely negligible gas and suspended particle phase concentration.
✗[c] Outdoor use with significantly higher ventilation minimizes inhalation.
[d] Quantitative applies to green check marks and qualitative applies to red "x" marks for the routes that were deemed unlikely.

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Inhalation and Ingestion Exposure Routes Modeling Approaches

Key parameters for articles modeled in CEM 3.2 are summarized in detail in Section 2 in the *Draft Consumer and Indoor Dust Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024c). Calculations, information and data sources, input parameters, and results are available in the *Draft Consumer Exposure Analysis for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024d). Generally, and when possible, model parameters were determined based on specific articles identified in this assessment and CEM defaults were only used where specific information was not available. A list of some of the most sensitive input parameters for exposure from articles and products are listed below:

- weight fraction (articles and products);
- density (articles and products);
- duration of use (products);
- frequency of use for chronic, acute, and intermediate (products);
- product mass used (products);
- article surface area (articles);
- chemical migration rate to saliva (articles);
- area mouthed (articles); and
- use environment volume (articles and products).

Low, medium, and high intensity use exposure scenarios correspond to the use of reported statistics, or single values. When different values are reported for low, medium, and high, the corresponding statistics are the reported minimum for the low intensity use scenarios, calculated average from maximum and minimum for the medium intensity use scenarios and reported maximum for the high intensity use scenarios. Each input parameter listed above was parameterized according to the article-specific data found via systematic review. If article-specific data were not available, CEM default parameters were used., or an assumption based on article use descriptions by manufactures always leaning on the health protective values. For example, for all scenarios, the near-field modeling option was selected to account for a small personal breathing zone around the user during product use in which concentrations are higher, rather than employing a single well-mixed room. A near-field volume of 1 m^3 was selected. See Section 2.1 for weight fraction selection and Section 2.2.3 for parameterization details in the *Draft Consumer and Indoor Dust Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024c).

Dermal Exposure Routes Modeling Approaches

Dermal modeling was done outside of CEM. The use of the CEM model for dermal absorption, which relies on total concentration rather than aqueous saturation concentration, would greatly overestimate exposure to DCHP in liquid and solid products and articles. See (U.S. EPA, 2024c) for more details. The dermal dose of DCHP associated with use of both liquid products and solid articles was calculated in a spreadsheet outside of CEM. See the *Draft Consumer Exposure Analysis for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024d) for details. For each product or article, high, medium, and low exposure scenarios were developed. Values for duration of dermal contact and area of exposed skin were determined based on the reasonably expected use for each item. In addition, high, medium, and low estimates for dermal exposures using a flux-limited approach were calculated and applied in the corresponding exposure scenario. Key parameters for the dermal model are shown in Section 2.3 in (U.S. EPA, 2024c).

4.1.2.2 Modeling Dose Results by COU for Consumer and Indoor Dust

This section summarizes the dose estimates from inhalation, ingestion, and dermal exposure to DCHP in consumer products and articles. Detailed tables of the dose results for acute, intermediate, and chronic exposures are available in *Draft Consumer Risk Calculator for Dicyclohexyl Phthalate (DCHP)* (U.S.

EPA, 2024e). Modeling dose results for acute, intermediate, and chronic exposures and data patterns are described in Section 3 in the *Draft Consumer and Indoor Dust Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024c). Generally, dermal exposures were overall highest followed by inhalation across scenarios, COUs and lifestages. The range of inhalation doses for each scenario and lifestage covered several orders of magnitude due to the wide range of DCHP content (weight fractions) for adhesives, wide range of article exposure durations, and various skin contact surface area options for the low, medium, and high scenarios. The dermal dose range was smaller for all scenarios driven primarily by exposure durations and frequencies.

The spread of values estimated for each product or article reflects the aggregate effects of variability and uncertainty in key modeling parameters for each item; acute dose rate for some products and articles covers a larger range than others primarily due to a wider distribution of DCHP weight fraction values and behavioral factors such as duration of use or contact time and mass of product used as described in Section 2 in (U.S. EPA, 2024c). Key differences in exposures among lifestages include designation as a product user or bystander; behavioral differences such as hand to mouth contact times, and time spent on the floor; and dermal contact expected from touching specific articles which may not be appropriate for some lifestages.

4.1.2.3 Weight of Scientific Evidence Conclusions for Consumer Exposure

Key sources of uncertainty for evaluating exposure to DCHP in consumer goods and strategies to address those uncertainties are described in detail in Section 5.1 of *Draft Consumer and Indoor Dust Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024c). Generally, designation of robust confidence suggests thorough understanding of the scientific evidence and uncertainties. The supporting weight of scientific evidence outweighs the uncertainties to the point where it is unlikely that the uncertainties could have a significant effect on the exposure estimate. The designation of moderate confidence suggests some understanding of the scientific evidence and uncertainties. More specifically, the supporting scientific evidence weighed against the uncertainties is reasonably adequate to characterize exposure estimates. The designation of slight confidence is assigned when the weight of scientific evidence may not be adequate to characterize the scenario, and when the assessor is making the best scientific assessment possible in the absence of complete information and there are additional uncertainties that may need to be considered. While the uncertainty for some of the scenarios and parameters ranges from slight to robust the overall confidence to use the results for risk characterization ranges from moderate to robust, depending on COU scenario. The basis for the moderate to robust confidence in the overall exposure estimates is a balance between using parameters that will represent various populations use patterns and lean on protective assumptions that are not excessive or unreasonable.

4.1.2.3.1 Strength, Limitations, Assumptions, and Key Sources of Uncertainty for the Consumer Exposure Assessment

The exposure assessment of chemicals from consumer products and articles has inherent challenges due to many sources of uncertainty in the analysis, including variations in product formulation, patterns of consumer use, frequency, duration, and application methods. Variability in environmental conditions may also alter physical and/or chemical behavior of the product or article. Table 4-7 summarizes the overall uncertainty per COU and provides a discussion of rationale used to assign the overall uncertainty. The subsections ahead of the table describe sources of uncertainty for several parameters used in consumer exposure modeling that apply across COUs and provide an in depth understanding of sources of uncertainty and limitations and strengths within the analysis. The confidence to use the results for risk characterization ranges from moderate to robust (Table 4-7).

Product Formulation and Composition

Variability in the formulation of consumer products—including changes in ingredients, concentrations, and chemical forms—can introduce uncertainty in exposure assessments. In addition, data were limited for weight fractions of DCHP in consumer goods. EPA obtained DCHP weight fractions in various products and articles from material safety sheets, databases, and existing literature. Where possible, the Agency obtained multiple values for weight fractions for similar products or articles. The lowest value was used in the low exposure scenario, the highest value in the high exposure scenario, and the average of all values in the medium exposure scenario. EPA decreased uncertainty in exposure and subsequent risk estimates in the high, medium, and low intensity use scenarios by capturing the weight fraction variability and obtaining a better characterization of the products' and articles' varying composition within one COU. Overall weight fraction confidence is *moderate* for products/articles with only one source with descriptions on chemical testing, *robust* for products/articles with more than one source, and *slight* for articles with only one source with unconfirmed content or little understanding on how the information was produced. For example, when a source does not provide a description of the analysis or the concentrations are derived from product production approaches rather than product testing.

Product Use Patterns

Consumer use patterns like frequency of use, duration of use, and methods of application are expected to differ. Where possible, high, medium, and low default values from CEM 3.2's prepopulated scenarios were selected for mass of product used, duration of use, and frequency of use. In instances where no prepopulated scenario was appropriate for a specific product, low, medium, and high values for each of these parameters were estimated based on the manufacturers' product descriptions. EPA decreased uncertainty by selecting use pattern inputs that represent product and article use descriptions and furthermore capture the range of possible use patterns in the high to low intensity use scenarios. Exposure and risk estimates are considered representative of product use patterns and well characterized. Most use patterns' overall confidence is rated *robust.*

Article Surface Area

The surface area of an article directly affects the potential for DCHP emissions to the environment. For each article modeled for inhalation exposure, low, medium, and high estimates for surface area were calculated (see Section 2 in (U.S. EPA, 2024c)). Overall, confidence in surface area is *robust* for articles because there is a good understanding of the dimensions of articles and their presence in indoor environments.

Human Behavior

CEM 3.2 has three different human activity patterns: stay-at-home, part-time out-of-the home (daycare, school, or work), and full-time out-of-the-home. The activity patterns were developed based on the Consolidated Human Activity Database (CHAD). For all products and articles modeled, the stay-at-home activity pattern was selected as it is the most protective assumption.

Modeling Tool

Confidence in the model used considers whether the model has been peer-reviewed, as well as whether it is being applied in a manner appropriate to its design and objective. The model used, CEM 3.2, has been peer-reviewed (ERG, 2016), is publicly available, and has been applied in the manner intended by estimating exposures associated with uses of household products and/or articles. This also considers the default values data source(s) such as building and room volumes, interzonal ventilation rates, and air exchange rates. Overall confidence in the proper use of CEM and the consumer exposure estimates results modeled is *robust*.

Dermal Modeling for DCHP

Experimental dermal data was identified via the systematic review process to characterize consumer dermal exposures to liquids or mixtures and formulations containing DCHP (see Section 2.3.1 in (U.S. EPA, 2024c). EPA has moderate understanding of the scientific evidence and the uncertainties. The identification of uncertainties within the dermal approach is reasonably adequate to characterize exposure estimates. The Agency has a *moderate* confidence in the dermal exposure to liquid and solid products or articles modeling approach.

A source of uncertainty regarding the dermal absorption of DCHP from products or formulations stems from the varying concentrations and co-formulants that exist in products or formulations containing DCHP. For purposes of this draft risk evaluation, EPA assumes that the absorptive flux of DCHP serves as an upper bound of chemical into and through the skin for dermal contact with all liquid products or formulations and solid products/articles. Dermal contact with products or formulations that have lower concentrations of DCHP might exhibit lower rates of flux since there is less material available for absorption. Conversely, co-formulants or materials within the products or formulations may lead to enhanced dermal absorption, even at lower concentrations. Therefore, it is uncertain whether the products or formulations containing DCHP would result in decreased or increased dermal absorption. Based on the available dermal absorption data for DCHP, EPA has made assumptions that result in exposure assessments that are the most human health protective in nature.

Lastly, EPA notes that there is uncertainty with respect to the modeling of dermal absorption of DCHP from solid matrices or articles and liquid products and formulations. Because there were no available data related to the dermal absorption of DCHP from solid matrices or articles and liquid products, EPA has assumed that dermal absorption of DCHP from solid objects would be limited by aqueous solubility of DCHP. Therefore, to determine the maximum steady-state aqueous flux of DCHP, EPA utilized CEM (U.S. EPA, 2023b) to first estimate the steady-state aqueous permeability coefficient of DCHP. The estimation of the steady-state aqueous permeability coefficient within CEM (U.S. EPA, 2023b) is based on a quantitative structure-activity relationship (QSAR) model presented by ten Berge (2009), which considers chemicals with log(K_{ow}) ranging from −3.70 to 5.49 and molecular weights ranging from 18 to 584.6. The molecular weight of DCHP falls within the range suggested by ten Berge (2009), as does the log(K_{ow}) of DCHP. Therefore, there is a low to medium (due to assumptions used in migration of DCHP from solid to aqueous media) uncertainty regarding the accuracy of the QSAR model used to predict the steady-state aqueous permeability coefficient for DCHP.

Table 4-7. Weight of Scientific Evidence Summary per Consumer Condition of Use

Consumer COU Category and Subcategory	Weight of Scientific Evidence	Overall Confidence
Adhesives and sealants	Two different scenarios were assessed under this COU for products with differing use patterns for which each scenario had a varying number of identified product examples (in parentheses): adhesives for small repairs (2) and automotive adhesives (3). The two scenarios and the products within capture the variability in product formulation and are represented in the high, medium, and low intensity use estimates. The overall confidence in this COU inhalation exposure estimate is robust because the CEM default parameters represent actual use patterns and location of use. For dermal exposure EPA used a dermal flux approach; moderate confidence was selected for this approach because uncertainty in the	Inhalation – Robust Dermal – Moderate

Consumer COU Category and Subcategory	Weight of Scientific Evidence	Overall Confidence
	partitioning from product to skin and subsequent dermal absorption is not well characterized or confirmed with experimental results. However, other parameters like frequency and duration of use, and surface area in contact are well understood and representative, making the overall confidence in a health protective estimate moderate.	
Other articles with routine direct contact during normal use including rubber articles; plastic articles (hard)	One scenario was assessed under this COU. The scenario considered multiple articles and routine dermal contact with similar use patterns. The scenario for small articles of routine dermal contact was assessed for dermal exposures only because inhalation and ingestion would have low exposure potential due to the small surface area of the articles. The articles with routine contact scenario considered multiple input parameters used in the high, medium, and low intensity use scenarios. The dermal absorption estimate assumes that dermal absorption of DCHP from solid objects would be limited by the aqueous solubility of DCHP. EPA has slight confidence in the aspects of the exposure estimate for solid articles because of the high uncertainty in the assumption of partitioning from solid to liquid, and because subsequent dermal absorption is not well characterized. However, other parameters, such as frequency and duration of use as well as surface area in contact, are well understood and representative, resulting in an overall confidence of moderate in a health protective estimate.	Dermal – Moderate
Other; Other consumer articles that contain dicyclohexyl phthalate from: inks, toner, and colorants; paints and coatings; adhesives and sealants (*e.g.*, paper products, textiles, products using cellulose film, etc.)	Two different scenarios were assessed under this COU for articles with differing use patterns. The scenarios of outdoor seating (single article in use), and small articles with potential for routine contact (multiple articles) were evaluated. These two scenarios were assessed for dermal exposures. Dermal absorption estimates assumed that dermal absorption of DCHP from solid objects would be limited by the aqueous solubility of DCHP. EPA has slight confidence in the aspects of the exposure estimate for solid articles because of the high uncertainty in the assumption of partitioning from solid to liquid, and because subsequent dermal absorption is not well characterized. However, other parameters such as frequency and duration of use, and surface area in contact, are well understood and representative, resulting in an overall confidence of moderate in a health protective estimate.	Dermal – Moderate

4.1.3 General Population Exposures to Environmental Releases

General population exposures occur when DCHP is released into the environment and the environmental media are then a pathway for exposure. As described in the *Draft Environmental Release and Occupational Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024q), releases of DCHP are expected in air, water, and disposal to landfills. Figure 4-2 provides a graphic representation of where and in which media DCHP is estimated to be found due to environmental releases and the corresponding route of exposure for the general population.

EPA took a screening-level approach to assess DCHP exposure to environmental releases for the general population. Screening level assessments are useful when there is little facility location- or scenario-specific information available. EPA began its DCHP general population exposure assessment using a screening-level approach because of limited environmental monitoring data for DCHP and lack of

location data for DCHP releases. A screening-level analysis relies on conservative assumptions, including default input parameters for modeling exposure, to assess exposures that would be expected to be on the high end of the expected exposure distribution. Details on the use of screening-level analyses in exposure assessment can be found in EPA's *Guidelines for Human Exposure Assessment* (U.S. EPA, 2019b).

EPA considered fenceline populations in proximity to releasing facilities as part of the ambient air exposure assessment by utilizing pre-screening methodology described in EPA's *Draft TSCA Screening Level Approach for Assessing Ambient Air and Water Exposures to Fenceline Communities (Version 1.0)* (U.S. EPA, 2022b). For other exposure pathways, EPA's screening method assessing high-end exposure scenarios used release data that reflect exposures expected to occur in proximity to releasing facilities, which would include fenceline populations.

EPA evaluated the reasonably available information for releases of DCHP from facilities that use, manufacture, or process DCHP under industrial and/or commercial COUs subject to TSCA regulations detailed in the *Draft Environmental Release and Occupational Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024q). As described in Section 3.3, using the release data, EPA modeled predicted concentrations of DCHP in surface water, sediment, drinking water, and ambient air in the United States. Table 3-6 summarizes the high-end DCHP concentrations in environmental media from environmental releases. The reason for assessing different pathways qualitatively or quantitatively is discussed briefly in Section 3.3, and additional detail can be found in *Draft Environmental Media, General Population, and Environmental Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024p).

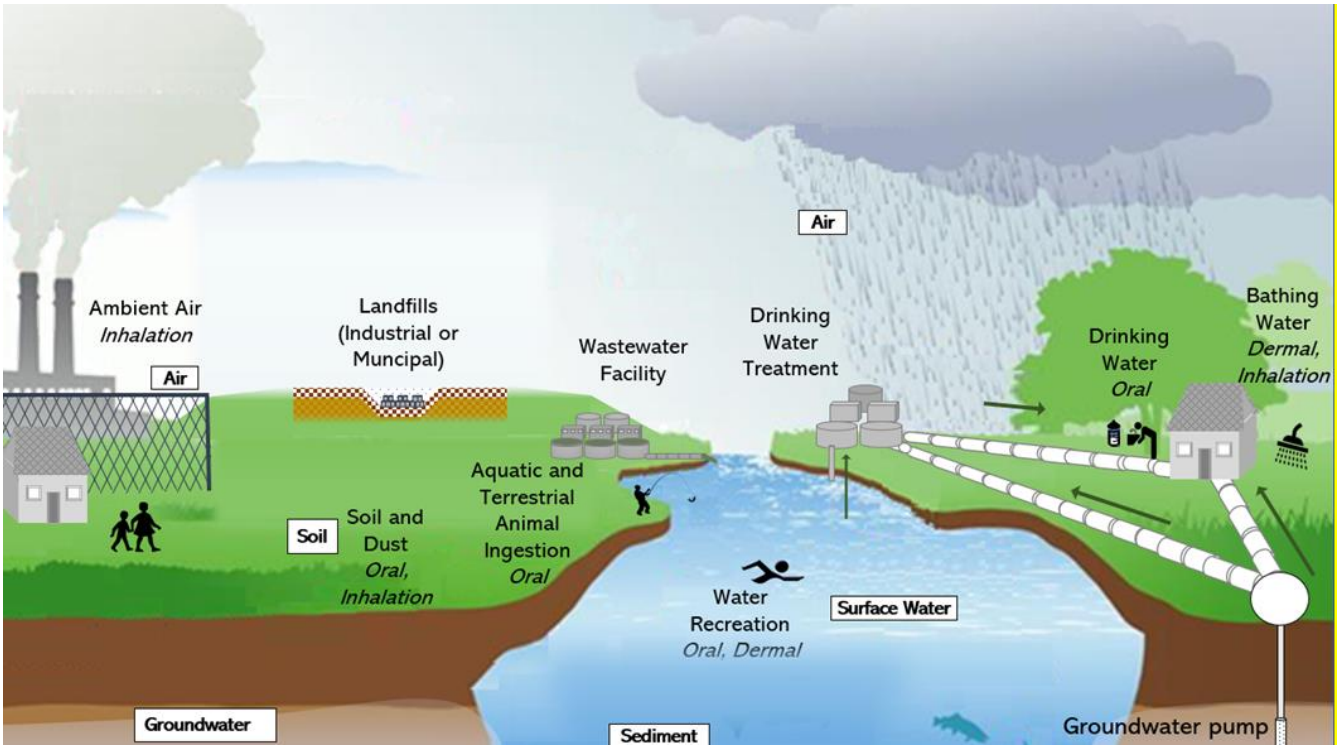

Figure 4-2. Potential Human Exposure Pathways to DCHP Environmental Releases for the General Population

Potential routes of exposure are shown in italics under each potential pathway of exposure.

High-end estimates of DCHP concentration in the various environmental media presented in Table 3-6 and in the *Draft Environmental Media, General Population, and Environmental Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024p) were used for screening-level purposes in the general population exposure assessment. EPA's *Guidelines for Human Exposure Assessment* (U.S. EPA, 2019b) defines high-end exposure estimates as a "plausible estimate of individual exposure for those individuals at the upper end of an exposure distribution, the intent of which is to convey an estimate of exposure in the upper range of the distribution while avoiding estimates that are beyond the true distribution." If risk is not found for these individuals with high-end exposure, no risk is anticipated for central tendency exposures, which is defined as "an estimate of individuals in the middle of the distribution." Plainly, if there is no risk for an individual identified as having the potential for the highest exposure associated with a COU for a given pathway of exposure, then that pathway was determined not to be a pathway of concern and not pursued further. If any pathways were identified as a pathway of concern for the general population, further exposure assessments for that pathway would be conducted to include higher tiers of modeling when available, refinement of exposure estimates, and exposure estimates for additional subpopulations and OES/COUs.

Identifying individuals at the upper end of an exposure distribution included consideration of high-end exposure scenarios defined as those associated with the industrial and commercial releases from a COU and OES that resulted in the highest environmental media concentrations. As described in Section 3.3, EPA focused on estimating high-end concentrations of DCHP from the largest estimated releases for the purpose of its screening level assessment for environmental and general population exposures. This means that the Agency considered the environmental concentration of DCHP in a given environmental medium resulting from the OES that had the highest release compared to any other OES for the same releasing media. Release estimates from OES resulting in lower environmental media concentrations were not considered for this screening-level assessment. Additionally, individuals with the greatest intake rate of DCHP per body weight were considered to be those at the upper end of the exposure.

Table 4-8 summarizes the high-end exposure scenarios that were considered in the screening level analysis, including the lifestage assessed as the most potentially exposed population based on intake rate and body weight. It also indicates which pathways were evaluated quantitatively or qualitatively. Exposure was assessed quantitatively only when environmental media concentrations were quantified for the appropriate exposure scenario. For example, exposure from groundwater resulting from DCHP release to the environment via biosolids or landfills was not quantitatively assessed because environmental releases from biosolids and landfills were not quantified. Due to the high confidence in the biodegradation rates and physical and chemical data, there is robust confidence that DCHP in soils will not be mobile and will have low persistence potential. There is robust confidence that DCHP is unlikely to be present in landfill leachates. However, exposure was still assessed qualitatively for exposures potentially resulting from biosolids and landfills. Further details on the screening level approach and exposure scenarios evaluated by EPA for the general population are provided in the *Draft Environmental Media, General Population, and Environmental Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024p). Selected OESs represent those resulting in the highest modeled environmental media concentrations for the purpose of a screening-level analysis. A crosswalk between OESs and COUs is presented in Section 3.1.1.1.

Table 4-8. Exposure Scenarios Assessed in General Population Screening Level Analysis

OES	Exposure Pathway	Exposure Route	Exposure Scenario	Lifestage	Analysis (Quantitative or Qualitative) [a]
All	Biosolids	No specific exposure scenarios were assessed for qualitative assessments			Qualitative Section 3.1
All	Landfills	No specific exposure scenarios were assessed for qualitative assessments			Qualitative Section 3.2
PVC plastics compounding	Surface Water	Dermal	Dermal exposure to DCHP in surface water during swimming	Adults, youths, and children	Quantitative Section 5.1.1
		Oral	Incidental ingestion of DCHP in surface water during swimming	Adults, youths, and children	Quantitative Section 5.1.2
PVC plastics compounding	Drinking Water	Oral	Ingestion of drinking water	Adults, youths, and children	Quantitative Section 6
All	Fish Ingestion	Oral	Ingestion of fish for General Population	Adults and children	Quantitative Section 7.1
PVC plastics compounding			Ingestion of fish for subsistence fishers	Adult	Quantitative Section 7.2
PVC plastics compounding			Ingestion of fish for Tribal populations	Adult	Quantitative Section 7.3
Application of paints, coatings, adhesives, and sealants	Ambient Air	Inhalation	Inhalation of DCHP in ambient air resulting from industrial releases	All	Quantitative Section 9

[a] Note the references are to sections in *Draft Environmental Media, General Population, and Environmental Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024p) and *not* this document.

EPA also considered urinary biomonitoring data, from CDC's National Health and Nutrition Examination Survey (NHANES) (see Section 11 of EPA's *Draft Environmental Media, General Population, and Environmental Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024p)). The Agency analyzed urinary data for MCHP (mono-cyclohexyl phthalate, a metabolite of DCHP) measured in the 1999 to 2010 NHANES cycle. Low detection rates and limited variability in data precluded any meaningful statistical analyses. CDC stopped collecting urinary data for MCHP after 2010. Furthermore, EPA's systematic review process did not identify any suitable alternative sources of DCHP biomonitoring data fit for use in this risk evaluation Those studies were not considered because they used NHANES data, had very low (<30%) detection levels, evaluated very specific study populations (*e.g.*, a cohort examining specific health concerns), or were not measured in the United States. Given the lack of recent urinary biomonitoring data, EPA did not conduct reverse dosimetry to calculate daily intake values for DCHP.

4.1.3.1 General Population Screening Level Exposure Assessment Results

Land Pathway

EPA evaluated general population exposures via the land pathway (*i.e.*, application of biosolids, landfills) qualitatively. Due to low water solubility (1.48 mg/L) and affinity for sorption to soil and organic constituents in soil (log Koc = 4.47), DCHP is unlikely to migrate to groundwater via runoff after land application of biosolids. Additionally, the half-life of 8.1 to 13.8 days in aerobic soils (U.S.

EPA, 2024z) indicates that DCHP will have low persistence potential in the aerobic environments associated with freshly applied biosolids. Because the physical and chemical properties of DCHP indicate that it is unlikely to migrate from land applied biosolids to groundwater via runoff, EPA did not model groundwater concentrations resulting from land application of biosolids.

Although there are no measured data on DCHP in landfill leachates, the potential to leach from landfills into nearby groundwater or surface water systems is limited. Interpretation of the high-quality physical and chemical property data indicates that DCHP is expected to have a high affinity to particulate (log Koc = 4.47) and organic media (log Kow = 4.82). This will cause significant retardation in groundwater and limit leaching to groundwater. Because of its high hydrophobicity and high affinity for soil sorption, it is unlikely that DCHP will migrate from landfills via groundwater infiltration or surface runoff. Therefore, EPA concludes that further assessment of DCHP in landfill leachate is not needed.

Surface Water Pathway – Incidental Ingestion and Dermal Contact from Swimming

EPA conducted modeling of releases to surface water at the point of release (*i.e.,* in the immediate water body receiving the effluent) to estimate the resulting environmental media concentrations from TSCA COUs. EPA conducted modeling with the U.S. EPA's Variable Volume Water Model with Point Source Calculator tool (PSC) to estimate concentrations of DCHP within surface water and to estimate settled sediment in the benthic region of streams. Releases associated with the PVC plastics compounding OES resulted in the highest total water column concentrations, with 30Q5 water concentrations of 126 µg/L without wastewater treatment and 39.6 µg/L when run under an assumption of 68.6 percent wastewater treatment removal efficiency (Table 4-9). Both treated and untreated scenarios were assessed due to uncertainty about the prevalence of wastewater treatment from discharging facilities and to demonstrate the hypothetical disparity in exposures between treated and untreated effluent in the generic release scenarios. COUs mapped to this OES are shown in Table 3-1. These water column concentrations were used to estimate the ADR from dermal exposure and incidental ingestion of DCHP while swimming for adults (2+ years), youths (11–15 years), and children (6–10 years). Exposure scenarios leading to the highest modeled ADR are shown in Table 4-9.

Surface Water Pathway – Drinking Water

For the drinking water pathway, modeled surface water concentrations were used to estimate drinking water exposures. For screening-level purposes, only the OES scenario resulting in the highest modeled surface water concentrations, PVC plastics compounding, was included in the drinking water exposure analysis. COUs mapped to this OES are shown in Table 3-1. EPA evaluated drinking water scenarios that assumed a wastewater treatment removal efficiency of 68.6 percent and no further drinking water treatment (Table 4-9). ADR and ADD values from drinking water exposure to DCHP were calculated for various age groups but the most exposed lifestage, infants (birth to <1 year), is shown below. Exposure scenarios leading to the highest ADR and ADD are shown in Table 4-9.

Table 4-9. Summary of the Highest Doses in the General Population through Surface and Drinking Water Exposure

OES[a]	Water Column Concentrations	Incidental Dermal Surface Water[b]	Incidental Ingestion[c]	Drinking Water[d]
	30Q5 Conc. (µg/L)	ADR_{POT} (mg/kg-day)	ADR_{POT} (mg/kg-day)	ADR_{POT} (mg/kg-day)
PVC plastics compounding *without wastewater treatment*	126	1.1E−03	6.7E−04	1.8E−02
PVC plastics compounding With Wastewater Treatment	39.6	3.50E−04	2.1E−04	5.6E−03

[a] Only this OES was used in the screening assessment because it resulted in the highest surface water concentrations. Table 3-1 provides a crosswalk of industrial and commercial COUs to OES.
[b] Most exposed age group: Adults (21+ years)
[c] Most exposed age group: Youth (11–15 years)
[d] Most exposed age group: Infant (birth to <1 year)

Fish Ingestion

The key parameters to estimate human exposure to DCHP via fish ingestion are the surface water concentration, bioaccumulation factor (BAF), and fish ingestion rate. Surface water concentrations for DCHP associated with a particular COU were modeled using VVWM-PSC as described in Section 3.3.1.1. EPA used the PVC plastics compounding OES that resulted in the highest modeled DCHP concentrations in surface water, as well as various flow rates, in its screening-level analysis. The details on the BAF, which considers the animal's uptake of a chemical from both diet and the water column, can be found in Section 8 of the *Draft Environmental Media, General Population, and Environmental Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024p).

EPA evaluated exposure to DCHP through fish ingestion for populations and age groups that had the highest fish ingestion rate per kg of body weight—including for adults and young toddlers in the general population, adult subsistence fishers, and adult Tribal populations. Only the fish ingestion rate changes for across the different populations; the surface water concentration and BAF remain the same. ADR and ADD values from fish ingestion exposure to DCHP were calculated for various populations and age groups and can be found in *Draft Environmental Media, General Population, and Environmental Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024p), but Table 4-10 shows only the scenarios leading to the highest exposure.

Table 4-10. Summary of the Highest Doses for Fish Ingestion for Adults in Tribal Populations

Calculation Method	Current Mean Ingestion Rate [b]	Heritage Ingestion Rate [b]
	ADR/ADD (mg/kg-day) [a]	ADR/ADD (mg/kg-day) [a]
Water solubility limit (1.48 mg/L)	2.68E−01	2.04
Modeled SWC for PVC plastics compounding, P50 flow (0.087 mg/L)	1.59E−02	1.21E−01
Modeled SWC for PVC plastics compounding, P75 flow (3.48E−03 mg/L)	6.30E−04	4.80E−03
Modeled SWC for PVC plastics compounding, P90 flow (2.4E−04 mg/L)	4.40E−05	3.35E−04
Highest monitored SWC (1.0E−05 mg/L)	2.53E−06	1.93E−05

SWC = surface water concentration
[a] Current ingestion rate refers to the present-day consumption levels that are suppressed by contamination, degradation, or loss of access. Heritage rates existed prior to non-indigenous settlement on Tribal fisheries resources and changes to culture and lifeway.
[b] The ADR and ADDs are identical because the inputs to estimating both exposure scenarios are identical.

Ambient Air Pathway

As part of the ambient air exposure assessment, EPA considered exposures to the general population in proximity to releasing facilities, including fenceline communities, by utilizing pre-screening methodology described in EPA's *Draft TSCA Screening Level Approach for Assessing Ambient Air and Water Exposures to Fenceline Communities (Version 1.0)* (U.S. EPA, 2022b). EPA used the IIOAC to estimate ambient air concentrations using pre-run results from a suite of dispersion scenarios in a variety of meteorological and land-use settings within EPA's American Meteorological Society/EPA Regulatory Model (AERMOD). The highest modeled 95th percentile annual ambient air concentration across all release scenarios was 67.57 µg/m^3 at 100 m from the releasing facility for the Application of paints and coatings OES (Table 3-6). COUs mapped to this OES are shown in Table 3-1. This OES was the only one assessed for the purpose of a screening-level assessment as it was associated with the highest ambient air concentration (see Section 13 of *Draft Environmental Media, General Population, and Environmental Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024p) for more details).

Table 4-11. General Population Ambient Air Exposure Summary

OES[a]	Acute (Daily Average) [b]		Chronic (Annual Average) [b]	
	Air Concentration [c] (µg/m^3)	AC (mg/kg-day)	Air Concentration [c] (µg/m^3)	ADC (mg/kg-day)
Application of paints and coatings	67.57	67.57	46.28	46.28

AC = acute concentration; ADC = average daily concentration
[a] Table 3-1 provides a crosswalk of industrial and commercial COUs to OES.
[b] EPA assumes the general population is continuously exposed (*i.e.*, 24 hours per day, 365 days per year) to outdoor ambient air concentrations. Therefore, daily average modeled ambient air concentrations are equivalent to acute exposure concentrations, and annual average modeled ambient air concentrations are equivalent to chronic exposure concentrations.
[c] Air concentrations are reported for the high-end (95th percentile) modeled value at 100 m from the emitting facility and stack plus fugitive releases combined.

4.1.3.1 Overall Confidence in General Population Screening Level Exposure Assessment

The weight of scientific evidence supporting the general population exposure to environmental releases estimate is decided based on the strengths, limitations, and uncertainties associated with the exposure estimates, which are discussed in detail for ambient air, surface water, drinking water, and fish ingestion in the *Draft Environmental Media, General Population, and Environmental Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024p). EPA summarized its weight of scientific evidence using confidence descriptors: robust, moderate, slight, or indeterminate. The Agency used general considerations (*i.e.*, relevance, data quality, representativeness, consistency, variability, uncertainties) as well as chemical-specific considerations for its weight of scientific evidence conclusions.

EPA determined robust confidence in its qualitative assessment of biosolids and landfills. For its quantitative assessment, the Agency modeled exposure due to various general population and environmental release exposure scenarios resulting from different pathways of exposure. Exposure estimates used high-end inputs for the purpose of risk screening. When available, monitoring data were compared to modeled estimates to evaluate overlap, magnitude, and trends. EPA has robust confidence that modeled releases used are appropriately conservative for a screening level-analysis. *Therefore, EPA has robust confidence that no exposure scenarios will lead to greater doses than presented in this draft risk evaluation. Despite slight and moderate confidence in the estimated values themselves, confidence in exposure estimates capturing high-end exposure scenarios was robust given that many of the modeled values exceeded those of monitored values*.

4.1.4 Human Milk Exposures

Infants are a potentially susceptible subpopulation because of their higher exposure per body weight, immature metabolic systems, and the potential for chemical toxicants to disrupt sensitive developmental processes—among other reasons. Reasonably available information from studies of experimental animal models also indicates that DCHP is a developmental toxicant (U.S. EPA, 2024v). EPA considered exposure and hazard information, as well as pharmacokinetic models, to determine the most scientifically supportable appropriate approach to evaluate infant exposure to DCHP from human milk ingestion (U.S. EPA, 2024p).

EPA identified two studies from Germany that measured DCHP concentrations in human milk. Neither of the studies characterized the possibility of occupational exposure to DCHP. No U.S. biomonitoring studies were identified. It is important to note that biomonitoring data do not distinguish between exposure routes or pathways and do not allow for source apportionment. In other words, biomonitoring data reflect total infant exposure through human milk ingestion and the contribution of specific TSCA COUs to overall exposure cannot be determined.

Furthermore, no human health studies have evaluated only lactational exposure from quantified levels of DCHP in milk. Uncertainties in the toxic moiety for DCHP and the limited half-life data of its metabolites in the human body that are both sensitive and specific also precluded modeling human milk concentrations by COUs. However, EPA has robust confidence that not modeling human milk concentrations is still protective of a nursing infant because multigenerational studies were evaluated to derive the hazard values. The multigenerational studies observed the effects on offspring across at least three generations resulting from maternal exposure during lactation, gestation, and other exposure periods. The hazard values are thus expected to protect a nursing infant's greater susceptibility during this unique lifestage whether due to sensitivity or greater exposure per body weight. Further discussion of the human milk pathway is provided in the *Draft Environmental Media, General Population, and Environmental Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024p).

4.1.5 Aggregate and Sentinel Exposure

TSCA section 6(b)(4)(F)(ii) (15 U.S.C. 2605(b)(4)(F)(ii)) requires EPA, in conducting a risk evaluation, to describe whether aggregate and sentinel exposures under the COUs were considered and the basis for their consideration.

EPA defines aggregate exposure as "the combined exposures to an individual from a chemical substance across multiple routes and across multiple pathways (40 CFR 702.33)." For the draft DCHP risk evaluation, the Agency considered aggregate risk across all routes of exposure for each individual consumer and occupational COU evaluated for acute, intermediate, and chronic exposure durations. EPA did not consider aggregate exposure for the general population exposed to environmental releases. As described in Section 4.1.3, the Agency employed a risk screen approach for the general population exposure assessment. Based on results from the risk screen, no pathways of concern (*i.e.*, ambient air, surface water, drinking water, fish ingestion) to DCHP exposure were identified for the generation population.

EPA did not consider aggregate exposure scenarios across COUs because the Agency did not find any evidence to support such an aggregate analysis, such as statistics of populations using certain products represented across COUs or workers performing tasks across COUs. However, EPA considered combined exposure across all routes of exposure for each individual occupational and consumer COU to calculate aggregate risks (Sections 4.3.2 and 4.3.3).

EPA defines sentinel exposure as "the exposure to a chemical substance that represents the plausible upper bound of exposure relative to all other exposures within a broad category of similar or related exposures (40 CFR 702.33)." In terms of this draft risk evaluation, EPA considered sentinel exposures by considering risks to populations who may have upper bound exposures; for example, workers and ONUs who perform activities with higher exposure potential, or consumers who have higher exposure potential or certain physical factors like body weight or skin surface area exposed. The Agency characterized high-end exposures in evaluating exposure using both monitoring data and modeling approaches. Where statistical data are available, EPA typically uses the 95th percentile value of the available data set to characterize high-end exposure for a given COU. For general population and consumer exposures, the Agency occasionally characterized sentinel exposure through a "high-intensity use" category based on elevated consumption rates, breathing rates, or user-specific factors.

4.2 Summary of Human Health Hazards

4.2.1 Background

This section briefly summarizes the non-cancer and cancer human health hazards of DCHP (Section 4.2.2 and 4.2.3). Additional information on the non-cancer and cancer human health hazards of DCHP are provided in the *Draft Non-Cancer Human Health Hazard Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024v) and *Draft Cancer Human Health Hazard Assessment for Di(2-ethylhexyl) Phthalate (DEHP), Dibutyl Phthalate (DBP), Butyl Benzyl Phthalate (BBP), Diisobutyl Phthalate (DIBP), and Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2025a).

4.2.2 Non-cancer Human Health Hazards of DCHP

EPA identified effects on the developing male reproductive system as the most sensitive and robust non-cancer hazard associated with oral exposure to DCHP in experimental animal models. Existing assessments of DCHP—including (U.S. CPSC, 2014, 2010), (ECCC/HC, 2020; EC/HC, 2015), (ECHA, 2014), and (NICNAS, 2016, 2008)—also consistently identified effects on the developing male reproductive system as a sensitive and robust non-cancer effect following oral exposure to DCHP. EPA

also considered epidemiologic evidence qualitatively as part of hazard identification and characterization. However, epidemiologic evidence from the one DCHP study was not considered further for dose-response analysis due to limitations and uncertainties in exposure characterization that are discussed further in the *Draft Non-cancer Human Health Hazard Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024v). Use of epidemiologic evidence qualitatively is consistent with phthalates assessments by Health Canada and U.S. CPSC.

EPA is proposing a point of departure (POD) of 10 mg/kg-day (human equivalent dose [HED] of 2.4 mg/kg-day) based on phthalate syndrome-related effects on the developing male reproductive system (decreased fetal testicular testosterone; decreased AGD; Leydig cell effects; decreased mRNA and/or protein expression of steroidogenic genes; decreased protein expression of INSL3) to estimate non-cancer risks from oral exposure to DCHP for acute, intermediate, and chronic durations of exposure in the draft risk evaluation of DCHP. The proposed POD is the most sensitive no-observed-adverse-effect level (NOAEL) and is further supported by one study reporting a NOAEL of 17 mg/kg-day (Hoshino et al., 2005) and four other studies reporting effects on the developing male reproductive system consistent with a disruption of androgen action and phthalate syndrome in rats at lowest-observed-adverse-effect (LOAELs) ranging from 20 to 33 mg/kg-day (Ahbab et al., 2017; Ahbab and Barlas, 2015; Furr et al., 2014; Ahbab and Barlas, 2013). The Agency has performed ¾ body weight scaling to yield the HED and is applying the animal to human uncertainty factor (*i.e.*, interspecies uncertainty factor; UF_A) of 3 and the within human variability uncertainty factor an (*i.e.*, intraspecies uncertainty factor; UF_H) of 10. Thus, a total UF of 30 is applied for use as the benchmark MOE.

Overall, based on the strengths, limitations, and uncertainties discussed in the *Draft Non-Cancer Human Health Hazard Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024v), *EPA has robust overall confidence in the proposed POD based on adverse effects on the developing male reproductive system* (*i.e.*, phthalate syndrome, which results from decreased fetal testicular testosterone). *This POD will be used to characterize risk from exposure to DCHP for acute, intermediate, and chronic exposure scenarios.*

The applicability and relevance of this POD for all exposure durations (acute, intermediate, and chronic) is described in the *Draft Non-Cancer Human Health Hazard Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024v). For purposes of assessing non-cancer risks, the selected POD is considered most applicable to women of reproductive age, pregnant women, male infants, and male children. Use of this POD to assess risk for other age groups (*e.g.*, adult males, and the elderly) is considered to be conservative and appropriate for a screening-level assessment for these other age groups.

No data are available for the dermal or inhalation routes that are suitable for deriving route-specific PODs. Therefore, EPA is using the acute/intermediate/chronic oral POD to evaluate risks from dermal exposure to DCHP. Differences between oral and dermal absorption are accounted for in dermal exposure estimates in the draft risk evaluation for DCHP. For the inhalation route, EPA is extrapolating the oral HED to an inhalation human equivalent concentration (HEC) per EPA's *Methods for Derivation Of Inhalation Reference Concentrations and Application of Inhalation Dosimetry* (U.S. EPA, 1994) using the updated human body weight and breathing rate relevant to continuous exposure of an individual at rest provided in EPA's *Exposure Factors Handbook: 2011 Edition* (U.S. EPA, 2011b). The oral HED and inhalation HEC values selected by EPA to estimate non-cancer risk from acute/intermediate/chronic exposure to DCHP in the draft risk evaluation of DCHP are summarized in Table 4-12.

Table 4-12. Non-cancer HECs and HEDs Used to Estimate Risks

Exposure Scenario	Target Organ System	Species	Duration	POD (mg/kg-day)	Effect at LOAEL	HED [a] (mg/kg-day)	HEC [a] (mg/m^3) [ppm]	Benchmark MOE [b]	Reference
Acute, intermed., chronic	Developing male reproductive system	Rat	10 days during gestation	NOAEL= 10 [c]	Phthalate syndrome-related effects (*e.g.*, ↓ fetal testicular testosterone; ↓ AGD; Leydig cell effects; ↓ mRNA and/or protein expression of steroidogenic genes; ↓INSL3)	2.4	13 [0.95]	UF_A= 3 UF_H=10 *Total UF=30*	(Li et al., 2016)

HEC = human equivalent concentration; HED = human equivalent dose; MOE = margin of exposure; NOAEL = no-observed-adverse-effect level; LOAEL = lowest-observed-adverse-effect level; POD = point of departure; UF = uncertainty factor

[a] HED and HEC values were calculated based on the most sensitive NOAEL of 10 mg/kg-day.

[b] EPA used allometric body weight scaling to the ¾ power to derive the HED. Consistent with EPA Guidance (U.S. EPA, 2011c), the interspecies uncertainty factor (UF_A), was reduced from 10 to 3 to account remaining uncertainty associated with interspecies differences in toxicodynamics. The Agency used a default intraspecies (UF_H) of 10 to account for variation in sensitivity within human populations.

[c] Statistically significant effects at 10 mg/kg-day are limited to fetal Leydig cell effects, decreased expression of genes and proteins involved in steroidogenesis, and decreased protein expression of INSL3 (all of which are not considered adverse in isolation). The remaining effects listed reached statistical significance at higher doses.

4.2.3 Cancer Human Health Hazards of DCHP

DCHP has not been evaluated for carcinogenicity in any 2-year cancer bioassays. EPA therefore evaluated the relevance of read-across approaches to assess potential cancer hazards of DCHP based on cancer bioassays and MOA information available for other phthalates being evaluated under TSCA (*i.e.*, DEHP, DBP, BBP, DINP, DIDP) as discussed in the *Draft Cancer Human Health Hazard Assessment for Di(2-ethylhexyl) Phthalate (DEHP), Dibutyl Phthalate (DBP), Butyl Benzyl Phthalate (BBP), Diisobutyl Phthalate (DIBP), and Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2025a). (Note: EPA plans to release the draft cancer assessment for peer review by the SACC and public comment in early 2025.)

EPA used elements of the Rethinking Chronic Toxicity and Carcinogenicity Assessment for Agrochemicals Project (ReCAAP) weight of evidence framework (Hilton et al., 2022) to determine the need for carcinogenicity studies for DCHP. The framework takes into consideration multiple lines of evidence to support decision-making for the chemical(s) of interest—including information pertaining to nomenclature, physical and chemical properties; exposure and use patterns; absorption, distribution, metabolism, and excretion (ADME) properties; and toxicological data (*e.g.*, genetic toxicity, acute toxicity, subchronic toxicity, hormone perturbation, immunotoxicity, and mode of action [MOA]). The framework was developed by a workgroup comprising scientists from academia, government, non-governmental organizations, and industry stakeholders. Recently, the Organisation for Economic Co-operation and Development (OECD) developed several Integrated Approach to Testing and Assessment (IATA) case studies demonstrating applicability of the weight of evidence framework (OECD, 2024).

As part of this weight of evidence approach, human health hazard profiles for DCHP were evaluated and compared to profiles for five read-across chemicals, including DEHP, DBP, BBP, DINP, and DIDP

(also referred to as "read-across phthalates" in this document). Overall, based on the weight of scientific evidence, EPA has preliminarily concluded that the non-cancer POD for DCHP based on effects on the developing male reproductive system consistent with a disruption of androgen action and phthalate syndrome that was selected for characterizing risk from acute, intermediate, and chronic exposure to DCHP is appropriate for use in human health risk assessment and is protective of human health, including for PESS. Furthermore, *EPA preliminarily concludes that potential carcinogenicity of DCHP is not a significant remaining source of uncertainty in the quantitative and qualitative risk characterization, despite the lack of carcinogenicity bioassays for DCHP*. Further, these preliminary conclusions are based on several key weight of scientific evidence considerations.

First, DCHP is toxicologically similar to DEHP, DBP, BBP, DINP, and DIBP and can induce antiandrogenic effects and disrupt fetal testicular testosterone biosynthesis in rats leading to a spectrum of effects on the developing male reproductive system consistent with phthalate syndrome. Second, for the five read-across phthalates, effects on the developing male reproductive system consistent with phthalate syndrome was the most sensitive and robust endpoint for deriving PODs for use in characterizing risk for acute, intermediate, and chronic exposure scenarios. The only exception to this was for DINP, in which chronic non-cancer liver effects were identified as a more sensitive outcome than developmental toxicity for deriving a chronic POD. Finally, although cancer classifications for the five read-across phthalates vary, in no case was cancer found to be a risk driver.

4.3 Human Health Risk Characterization

4.3.1 Risk Assessment Approach

The exposure scenarios, populations of interest, and toxicological endpoints used for evaluating risks from acute, short-term/intermediate, and chronic/lifetime exposures are summarized in Table 4-13.

Table 4-13. Exposure Scenarios, Populations of Interest, and Hazard Values

Population of Interest and Exposure Scenario	**Workers** Male and female adolescents and adults (16+ years) and women of reproductive age directly working with DCHP under light activity (breathing rate of 1.25 m^3/h) (for further details see (U.S. EPA, 2024q)) Exposure Durations • *Acute* – 8 hours for a single workday • *Intermediate* – 8 hours per workday for 22 days per 30-day period • *Chronic* – 8 hours per workday for 250 days per year for 31 or 40 working years Exposure Routes • Inhalation and dermal
	Occupational Non-users Male and female adolescents and adults (16+ years old) indirectly exposed to DCHP within the same work area as workers (breathing rate of 1.25 m^3/h) (for further details see (U.S. EPA, 2024q)) Exposure Durations • *Acute, Intermediate, and Chronic* – same as workers Exposure Routes • Inhalation, dermal (mist and dust deposited on surfaces)
	Consumers Male and female infants (<1 year), toddlers (1–2 years), children (3–5 years and 6–10 years), young teens (11–15 years), teenagers (16–20 years) and adults (21+ years) exposed to DCHP through product or article use (for further details see (U.S. EPA, 2024c)) Exposure Durations • *Acute* – 1 day exposure • *Intermediate* – 30 days per year

Population of Interest and Exposure Scenario	• *Chronic* – 365 days per year Exposure Routes • Inhalation, dermal, and oral
	Bystanders Male and female infants (<1 year), toddlers (1–2 years), and children (3–5 years and 6–10 years) incidentally exposed to DCHP through product use (for further details see (U.S. EPA, 2024c)) Exposure Durations • *Acute* – 1 day exposure • *Intermediate* – 30 days per year • *Chronic* – 365 days per year Exposure Routes • Inhalation
	General Population Male and female infants, children, youth, and adults exposed to DCHP through drinking water, surface water, ambient air, and fish ingestion (for further details see (U.S. EPA, 2024p)) Exposure Durations • *Acute* – Exposed to DCHP continuously for a 24-hour period • *Chronic* – Exposed to DCHP continuously for up to 78 years Exposure Routes • Inhalation, dermal, and oral (depending on exposure scenario)
	National Population Children aged 3–5, 6–11 years, and 11 to <16 years; male and female adults 16+ years; and women of reproductive age (16–49 years of age) exposed to DEHP, DBP, BBP, DIBP, and DINP through all exposure pathways and routes as measured through urinary biomonitoring (*i.e.*, NHANES) (for further details see (U.S. EPA, 2024ah)) Exposure Durations • Durations not easily characterized in urinary biomonitoring studies • Likely between acute and intermediate as phthalates have elimination half-lives on the order of several hours and are quickly excreted from the body in urine. Spot urine samples, as collected through NHANES, are representative of relatively recent exposures. Exposure Routes • NHANES urinary biomonitoring data provides an estimate of aggregate exposure (*i.e.*, exposure through oral, inhalation, and dermal routes)
Health Effects, Concentration and Time Duration	**Non-cancer Acute/Intermediate/Chronic Value** Sensitive health effect: Developmental toxicity (*i.e.*, effects on the developing male reproductive system including decreased fetal testicular testosterone; decreased AGD; Leydig cell effects; decreased mRNA and/or protein expression of steroidogenic genes; decreased protein expression of INSL3) (for further details see (U.S. EPA, 2024v)) HEC Daily, continuous = 13 mg/m^3 (0.95 ppm) HED Daily = 2.4 mg/kg-day; dermal and oral Total UF (benchmark MOE) = 30 (UF_A = 3; UF_H = 10) **Hazard Relative Potency** Relative potency factors for DEHP, DBP, BBP, DIBP, DCHP, and DINP were derived based on reduced fetal testicular testosterone. DBP was selected as the index chemical (for further details see (U.S. EPA, 2024ah)). RPF_{DEHP} = 0.84 RPF_{DBP} = 1 (index chemical) RPF_{BBP} = 0.52 RPF_{DIBP} = 053 RPF_{DCHP} = 1.66 RPF_{DINP} = 0.21 Index chemical (DBP) POD = HED Daily = 2.1 mg/kg-day Total UF (benchmark MOE) = 30 (UF_A = 3; UF_H = 10)

4.3.1.1 Estimation of Non-cancer Risks from Exposure to DCHP

EPA used a margin of exposure (MOE) approach to identify potential non-cancer risks for individual exposure routes (*i.e.*, oral, dermal, inhalation). The MOE is the ratio of the non-cancer POD divided by a human exposure dose. Acute, short-term, and chronic MOEs for non-cancer inhalation and dermal risks were calculated using Equation 4-1.

Equation 4-1. Margin of Exposure Calculation

$$MOE = \frac{Non-cancer\ Hazard\ Value\ (POD)}{Human\ Exposure}$$

Where:

MOE	=	Margin of exposure for acute, intermediate, or chronic risk comparison (unitless)
Non-cancer Hazard Value (POD)	=	HEC (mg/m^3) or HED (mg/kg-day)
Human Exposure	=	Exposure estimate (mg/m^3 or mg/kg-day)

MOE risk estimates may be interpreted in relation to benchmark MOEs. Benchmark MOEs are typically the total UF for each non-cancer POD. The MOE estimate is interpreted as a human health risk of concern if the MOE estimate is less than the benchmark MOE (*i.e.*, the total UF). On the other hand, if the MOE estimate is equal to or exceeds the benchmark MOE, the risk is not considered to be of concern and mitigation is not needed. Typically, the larger the MOE, the more unlikely it is that a non-cancer adverse effect occurs relative to the benchmark. When determining whether a chemical substance presents unreasonable risk to human health or the environment, calculated risk estimates are not "bright-line" indicators of unreasonable risk, and EPA has the discretion to consider other risk-related factors in addition to risks identified in the risk characterization.

4.3.1.2 Estimation of Non-cancer Aggregate Risks from Exposure to DCHP

As described in Section 4.1.5, EPA considered aggregate risk from exposure to DCHP across all routes of exposure for each individual consumer and occupational COU evaluated for acute, intermediate, and chronic exposure durations. To identify potential non-cancer risks for aggregate exposure scenarios for workers (Section 4.3.2) and consumers (Section 4.3.3), EPA used the total MOE approach (U.S. EPA, 2001). For the total MOE approach, MOEs for each exposure route of interest in the aggregate scenario must first be calculated. The total MOE for the aggregate scenario can then be calculated using Equation 4-2.

Equation 4-2. Total Margin of Exposure Calculation

$$Total\ MOE = \frac{1}{\frac{1}{MOE_{Oral}} + \frac{1}{MOE_{Dermal}} + \frac{1}{MOE_{Inhalation}} \ldots}$$

Where:

Total MOE	=	Margin of exposure for aggregate scenario (unitless)
MOE_{Oral}	=	Margin of exposure for oral route (unitless)
MOE_{Dermal}	=	Margin of exposure for dermal route (unitless)
$MOE_{Inhalation}$	=	Margin of exposure for inhalation route (unitless)

Total MOE risk estimates may be interpreted in relation to benchmark MOEs, as described in Section 4.3.1.1.

4.3.2 Risk Estimates for Workers

This section summarizes risk estimates for workers from inhalation and dermal exposures, as well as aggregated exposures to DCHP from individual DCHP COUs across routes. In this section, risks are calculated for all exposed workers based on the DCHP-derived PODs described in Section 4.2.2. Subsequently in Section 4.4.4, those same risks for female workers of reproductive age exposed to DCHP at the highest levels (acute durations) are calculated using the more robust RPFs described in Section 4.4.1 and added to estimates of national non-attributable exposure of five toxicologically similar phthalates for an estimate of cumulative risk.

Risk estimates for workers from inhalation and dermal exposures, as well as aggregated exposures, are shown in Table 4-14. This section provides discussion and characterization of risk estimates for workers, including women of reproductive age and ONUs, for the various OESs and COUs.

Manufacturing

For the manufacture of DCHP, inhalation exposure from dust generation is expected to be the dominant route of exposure. MOEs for high-end acute, intermediate, and chronic inhalation exposure ranged from 3.5 to 5.6 for average adult workers and women of reproductive age, while high-end dermal MOEs for the same populations and exposure scenarios ranged from 532 to 845 (Benchmark = 30). The central tendency MOEs for the same populations and exposure scenarios ranged from 36 to 58 for inhalation exposure and 1,064 to 1,689 for dermal exposure (Benchmark = 30). Aggregation of inhalation and dermal exposures led to negligible differences in risk when compared to risk estimates from inhalation exposure alone. The variations between the central tendency and high-end estimates of worker inhalation exposures are described below.

EPA estimated worker inhalation exposures using the *Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR)* for dust exposures (U.S. EPA, 2021b). For inhalation exposure to PNOR, EPA determined the 50th and 95th percentiles of the surrogate dust monitoring data taken from facilities with NAICS Codes starting with 325 (Chemical Manufacturing). EPA multiplied these dust concentrations by the industry provided maximum DCHP concentration manufactured (*i.e.*, 100%) to estimate DCHP particulate concentrations in the air. Therefore, the differences in the central tendency and high-end dust concentrations led to significant differences between the central tendency and high-end risk estimates.

Although the PNOR (*i.e.*, dust) concentration data provides a reliable range of dust concentrations that a worker may experience in the chemicals industry, the composition of workplace dust is uncertain. The exposure and risk estimates are based on the assumption that the concentration of DCHP in workplace dust is the same as the concentration of DCHP manufactured. However, it is likely that workplace dust contains a variety of constituents that do not contain any DCHP in addition to particles from manufactured DCHP. The constituents that do not contain DCHP would dilute the overall concentration of DCHP in the dust, and the concentration of DCHP in workplace dust is likely less than the concentration of DCHP in the final product. Due to this uncertainty in DCHP concentration in workplace dust, central tendency values of exposure are expected to be most reflective of worker exposures within the COUs covered under the "Manufacturing" OES (*i.e.*, Manufacturing COU: Domestic manufacturing).

Import and Repackaging

For the import of DCHP, inhalation exposure from dust generation is expected to be the dominant route of exposure. MOEs for high-end acute, intermediate, and chronic inhalation exposure ranged from 5.8 to 9.3 for average adult workers and women of reproductive age, while high-end dermal MOEs for the same populations and exposure scenarios ranged from 532 to 845 (Benchmark = 30). The central tendency MOEs for the same populations and exposure scenarios ranged from 134 to 259 for inhalation exposure and 1,064 to 2,031 for dermal exposure (Benchmark = 30). Aggregation of inhalation and dermal exposures led to negligible differences in risk when compared to risk estimates from inhalation exposure alone. The large variations between the central tendency and high-end estimates of worker inhalation exposures are described below.

EPA estimated worker inhalation exposures using the *Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR)* for dust exposures (U.S. EPA, 2021b). For inhalation exposure to PNOR, EPA determined the 50th and 95th percentiles of the surrogate dust monitoring data taken from facilities with NAICS Codes starting with 45 (Wholesale and Retail Trade). EPA multiplied these dust concentrations by the industry provided maximum DCHP concentration imported (*i.e.*, 100%) to estimate DCHP particulate concentrations in the air. Therefore, the differences in the central tendency and high-end dust concentrations led to significant differences between the central tendency and high-end risk estimates.

Although the PNOR (*i.e.*, dust) concentration data provides a reliable range of dust concentrations that a worker may experience in the wholesale and retail trade industry, the composition of workplace dust is uncertain. The exposure and risk estimates are based on the assumption that the concentration of DCHP in workplace dust is the same as the concentration of imported DCHP. However, it is likely that workplace dust contains a variety of constituents that do not contain any DCHP in addition to particles from imported DCHP. The constituents that do not contain DCHP would dilute the overall concentration of DCHP in the dust, and the concentration of DCHP in workplace dust is likely less than the concentration of DCHP in the imported product. Due to this uncertainty in DCHP concentration in workplace dust, central tendency values of exposure are expected to be most reflective of worker exposures within the COUs covered under the "Import and repackaging" OES (*i.e.*, Manufacture COU: Importing; Processing COU: Repackaging [*e.g.*, laboratory chemicals]).

Incorporation into Adhesives and Sealants

For the incorporation of DCHP into adhesives and sealants, inhalation exposure from dust generation is expected to be the dominant route of exposure. MOEs for high-end acute, intermediate, and chronic inhalation exposure ranged from 3.5 to 5.6 for average adult workers and women of reproductive age, while high-end dermal MOEs for the same populations and exposure scenarios ranged from 532 to 845 (Benchmark = 30). The central tendency MOEs for the same populations and exposure scenarios ranged from 36 to 58 for inhalation exposure and 1,064 to 1,689 for dermal exposure (Benchmark = 30). Aggregation of inhalation and dermal exposures led to negligible differences in risk when compared to risk estimates from inhalation exposure alone. The variations between the central tendency and high-end estimates of worker inhalation exposures are described below.

EPA estimated worker inhalation exposures using the *Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR)* for dust exposures (U.S. EPA, 2021b). For inhalation exposure to PNOR, EPA determined the 50th and 95th percentiles of the surrogate dust monitoring data taken from facilities with NAICS Ccodes starting with 325 (Chemical Manufacturing). EPA multiplied these dust concentrations by the industry provided maximum potential DCHP concentration in the raw material (*i.e.*, 100%) to estimate DCHP particulate

concentrations in the air. Therefore, the differences in the central tendency and high-end dust concentrations led to significant differences between the central tendency and high-end risk estimates.

Although the PNOR (*i.e.*, dust) concentration data provides a reliable range of dust concentrations that a worker may experience in the chemical manufacturing industry, the composition of workplace dust is uncertain. The exposure and risk estimates are based on the assumption that the concentration of DCHP in workplace dust is the same as the concentration of DCHP in the raw material. However, it is likely that workplace dust contains a variety of constituents that do not contain any DCHP in addition to particles from DCHP-containing raw materials. The constituents that do not contain DCHP would dilute the overall concentration of DCHP in the dust, and the concentration of DCHP in workplace dust is likely less than the concentration of DCHP in the raw material. Due to this uncertainty in DCHP concentration in workplace dust, central tendency values of exposure are expected to be most reflective of worker exposures within the COUs covered under the "Incorporation into adhesives and sealants" OES (*i.e.*, Processing COUs: Plasticizer in adhesive manufacturing; Adhesive and sealant chemicals in adhesive manufacturing; Stabilizing agent in adhesive manufacturing).

Incorporation into Paints and Coatings

For the incorporation of DCHP into paints and coatings, inhalation exposure from dust generation is expected to be the dominant route of exposure. MOEs for high-end acute, intermediate, and chronic inhalation exposure ranged from 3.5 to 5.6 for average adult workers and women of reproductive age, while high-end dermal MOEs for the same populations and exposure scenarios ranged from 532 to 845 (Benchmark = 30). The central tendency MOEs for the same populations and exposure scenarios ranged from 36 to 58 for inhalation exposure and 1,064 to 1,689 for dermal exposure (Benchmark = 30). Aggregation of inhalation and dermal exposures led to negligible differences in risk when compared to risk estimates from inhalation exposure alone. The variations between the central tendency and high-end estimates of worker inhalation exposures are described below.

EPA estimated worker inhalation exposures using the *Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR)* for dust exposures (U.S. EPA, 2021b). For inhalation exposure to PNOR, EPA determined the 50th and 95th percentiles of the surrogate dust monitoring data taken from facilities with NAICS Codes starting with 325 (Chemical Manufacturing). EPA multiplied these dust concentrations by the industry provided maximum potential DCHP concentration in the raw material (*i.e.*, 100%) to estimate DCHP particulate concentrations in the air. Therefore, the differences in the central tendency and high-end dust concentrations led to significant differences between the central tendency and high-end risk estimates.

Although the PNOR (*i.e.*, dust) concentration data provides a reliable range of dust concentrations that a worker may experience in the chemical manufacturing industry, the composition of workplace dust is uncertain. The exposure and risk estimates are based on the assumption that the concentration of DCHP in workplace dust is the same as the concentration of DCHP in the raw material. However, it is likely that workplace dust contains a variety of constituents that do not contain any DCHP in addition to particles from DCHP-containing raw materials. The constituents that do not contain DCHP would dilute the overall concentration of DCHP in the dust, and the concentration of DCHP in workplace dust is likely less than the concentration of DCHP in the raw material. Due to this uncertainty in DCHP concentration in workplace dust, central tendency values of exposure are expected to be most reflective of worker exposures within the COUs covered under the "Incorporation into paints and coatings" OES (*i.e.*, Processing COUs: Plasticizer in paint and coating manufacturing; Stabilizing agent in paint and coating manufacturing).

Incorporation into Other Formulations, Mixtures, or Reaction Products Not Otherwise Specified
For the incorporation of DCHP into other formulations, mixtures, or reaction products not otherwise specified, inhalation exposure from dust generation is expected to be the dominant route of exposure. MOEs for high-end acute, intermediate, and chronic inhalation exposure ranged from 3.5 to 5.6 for average adult workers and women of reproductive age, while high-end dermal MOEs for the same populations and exposure scenarios ranged from 532 to 845 (Benchmark = 30). The central tendency MOEs for the same populations and exposure scenarios ranged from 36 to 58 for inhalation exposure and 1,064 to 1,689 for dermal exposure (Benchmark = 30). Aggregation of inhalation and dermal exposures led to negligible differences in risk when compared to risk estimates from inhalation exposure alone. The variations between the central tendency and high-end estimates of worker inhalation exposures are described below.

EPA estimated worker inhalation exposures using the *Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR)* for dust exposures (U.S. EPA, 2021b). For inhalation exposure to PNOR, EPA determined the 50th and 95th percentiles of the surrogate dust monitoring data taken from facilities with NAICS codes starting with 325 (Chemical Manufacturing). EPA multiplied these dust concentrations by the industry provided maximum potential DCHP concentration in the raw material (*i.e.,* 100%) to estimate DCHP particulate concentrations in the air. Therefore, the differences in the central tendency and high-end dust concentrations led to significant differences between the central tendency and high-end risk estimates.

Although the PNOR (*i.e.,* dust) concentration data provides a reliable range of dust concentrations that a worker may experience in the chemical manufacturing industry, the composition of workplace dust is uncertain. The exposure and risk estimates are based on the assumption that the concentration of DCHP in workplace dust is the same as the concentration of DCHP in the raw material. However, it is likely that workplace dust contains a variety of constituents that do not contain any DCHP in addition to particles from DCHP-containing raw materials. The constituents that do not contain DCHP would dilute the overall concentration of DCHP in the dust, and the concentration of DCHP in workplace dust is likely less than the concentration of DCHP in the raw material. Due to this uncertainty in DCHP concentration in workplace dust, central tendency values of exposure are expected to be most reflective of worker exposures within the COUs covered under the "Incorporation into other formulations, mixtures, or reaction products not Covered Elsewhere" OES (*i.e.,* Processing COU: Stabilizing agent in asphalt paving, roofing, and coating materials manufacturing).

PVC Plastics Compounding
For PVC plastics compounding, inhalation exposure from dust generation is expected to be the dominant route of exposure. MOEs for high-end acute, intermediate, and chronic inhalation exposure ranged from 3.7 to 6.0 for average adult workers and women of reproductive age, while high-end dermal MOEs ranged from 532 to 845 (Benchmark = 30). For central tendency, MOEs for the same population and exposure scenarios ranged from 76 to 137 for inhalation exposure and 1,064 to 1,894 for dermal exposures (Benchmark = 30). Aggregation of inhalation and dermal exposures led to negligible differences in risk when compared to risk estimates from inhalation exposure alone. The reason for the variation between high-end and central tendency estimates of worker inhalation exposures is described below.

EPA estimated worker inhalation exposures using the *Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR)* for dust exposures (U.S. EPA, 2021b). For inhalation exposure to PNOR, EPA determined the 50th and 95th percentiles of the surrogate dust monitoring data taken from facilities with NAICS Codes starting

with 326 (Plastics and Rubber Manufacturing). EPA multiplied these dust concentrations by the industry provided maximum potential DCHP concentration in the raw additive material (*i.e.,* 100%) to estimate DCHP particulate concentrations in the air. Therefore, the differences in the central tendency and high-end dust concentrations led to significant differences between the central tendency and high-end risk estimates.

Although the PNOR (*i.e.,* dust) concentration data provides a reliable range of dust concentrations that a worker may experience in the compounding industry, the composition of workplace dust is uncertain. The exposure and risk estimates assume that the concentration of DCHP in workplace dust is the same as the concentration of DCHP in the raw material. However, it is likely that workplace dust contains a variety of constituents that do not contain any DCHP in addition to particles from DCHP-containing raw materials. The constituents that do not contain DCHP would dilute the overall concentration of DCHP in the dust, and the concentration of DCHP in workplace dust is likely less than the concentration of DCHP in the raw material. Due to the uncertainty of DCHP concentrations in workplace dust, central tendency values of exposure are expected to be most reflective of worker exposures within the COUs covered under the "PVC plastics compounding" OES (*i.e.,* Processing COUs: Plasticizer in plastic material and resin manufacturing; Plastics product manufacturing; Stabilizing agent in plastics product manufacturing).

Non-PVC Material Compounding

For non-PVC material compounding, inhalation exposure from dust generation is expected to be the dominant route of exposure. MOEs for high-end acute, intermediate, and chronic inhalation exposure ranged from 6.2 to 9.9 for average adult workers and women of reproductive age, while high-end dermal MOEs ranged from 532 to 845 (Benchmark = 30). For central tendency, MOEs for the same population and exposure scenarios ranged from 126 to 217 for inhalation exposure and 1,064 to 1,805 for dermal exposures (Benchmark = 30). Aggregation of inhalation and dermal exposures led to negligible differences in risk when compared to risk estimates from inhalation exposure alone. The reason for the variation between high-end and central tendency estimates of worker inhalation exposures is described below.

EPA estimated worker inhalation exposures using the *Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR)* for dust exposures (U.S. EPA, 2021b). For inhalation exposure to PNOR, EPA determined the 50th and 95th percentiles of the surrogate dust monitoring data taken from facilities with NAICS Codes starting with 326 (Plastics and Rubber Manufacturing). EPA multiplied these dust concentrations by the industry provided maximum potential DCHP concentration in the raw additive material (*i.e.,* 60%) to estimate DCHP particulate concentrations in the air. Therefore, the differences in the central tendency and high-end dust concentrations led to significant differences between the central tendency and high-end risk estimates.

Although the PNOR (*i.e.,* dust) concentration data provides a reliable range of dust concentrations that a worker may experience in the compounding industry, the composition of workplace dust is uncertain. The exposure and risk estimates assume that the concentration of DCHP in workplace dust is the same as the concentration of DCHP in the raw material. However, it is likely that workplace dust contains a variety of constituents that do not contain any DCHP in addition to particles from DCHP-containing raw materials. The constituents that do not contain DCHP would dilute the overall concentration of DCHP in the dust, and the concentration of DCHP in workplace dust is likely less than the concentration of DCHP in the raw material. Due to the uncertainty of DCHP concentrations in workplace dust, central tendency values of exposure are expected to be most reflective of worker exposures within the COUs covered

under the "Non-PVC Material Compounding" OES (*i.e.*, Processing COUs: Plasticizer in in plastic material and resin manufacturing; Plastics product manufacturing; Rubber product manufacturing; Stabilizing agent in plastics product manufacturing).

PVC Plastics Converting

For PVC plastics converting, inhalation exposure from dust generation is expected to be the dominant route of exposure. MOEs for high-end acute, intermediate, and chronic inhalation exposure ranged from 8.2 to 13 for average adult workers and women of reproductive age, while high-end dermal MOEs ranged from 532 to 845 (Benchmark = 30). For central tendency, MOEs for the same population and exposure scenarios ranged from 168 to 309 for inhalation exposure and 1,064 to 1,929 for dermal exposures (Benchmark = 30). Aggregation of inhalation and dermal exposures led to negligible differences in risk when compared to risk estimates from inhalation exposure alone. The reason for the variation between high-end and central tendency estimates of worker inhalation exposures is described below.

EPA estimated worker inhalation exposures using the *Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR)* for dust exposures (U.S. EPA, 2021b). For inhalation exposure to PNOR, EPA determined the 50th and 95th percentiles of the surrogate dust monitoring data taken from facilities with NAICS Codesstarting with 326 (Plastics and Rubber Manufacturing). EPA multiplied these dust concentrations by the industry provided maximum potential DCHP concentration in PVC plastic (*i.e.*, 45%) to estimate DCHP particulate concentrations in the air. Therefore, the differences in the central tendency and high-end dust concentrations led to differences between the central tendency and high-end risk estimates.

Although the PNOR (*i.e.*, dust) concentration data provides a reliable range of dust concentrations that a worker may experience in the converting industry, the composition of workplace dust is uncertain. The exposure and risk estimates assume that the concentration of DCHP in workplace dust is the same as the concentration of DCHP in the PVC plastic. However, it is likely that workplace dust contains a variety of constituents that do not contain any DCHP in addition to particles from DCHP-containing PVC plastics. The constituents that do not contain DCHP would dilute the overall concentration of DCHP in the dust, and the concentration of DCHP in workplace dust is likely less than the concentration of DCHP in the PVC plastic. Due to the uncertainty of DCHP concentrations in workplace dust, central tendency values of exposure are expected to be most reflective of worker exposures within the COUs covered under the "PVC plastics converting" OES (*i.e.*, Processing COU: Plasticizer in plastics product manufacturing).

Non-PVC Material Converting

For non-PVC material converting, inhalation exposure from dust generation is expected to be the dominant route of exposure. MOEs for high-end acute, intermediate, and chronic inhalation exposure ranged from 18 to 30 for average adult workers and women of reproductive age, while high-end dermal MOEs ranged from 532 to 845 (Benchmark = 30). For central tendency, MOEs for the same population and exposure scenarios ranged from 378 to 696 for inhalation exposure and 1,064 to 1,929 for dermal exposures (Benchmark = 30). Aggregation of inhalation and dermal exposures led to negligible differences in risk when compared to risk estimates from inhalation exposure alone. The reason for the variation between high-end and central tendency estimates of worker inhalation exposures is described below.

EPA estimated worker inhalation exposures using the *Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR)* for

dust exposures (U.S. EPA, 2021b). For inhalation exposure to PNOR, EPA determined the 50th and 95th percentiles of the surrogate dust monitoring data taken from facilities with NAICS Codes starting with 326 (Plastics and Rubber Manufacturing). EPA multiplied these dust concentrations by the industry provided maximum potential DCHP concentration in non-PVC material (*i.e.*, 20%) to estimate DCHP particulate concentrations in the air. Therefore, the differences in the central tendency and high-end dust concentrations led to differences between the central tendency and high-end risk estimates.

Although the PNOR (*i.e.*, dust) concentration data provides a reliable range of dust concentrations that a worker may experience in the converting industry, the composition of workplace dust is uncertain. The exposure and risk estimates assume that the concentration of DCHP in workplace dust is the same as the concentration of DCHP in the non-PVC material. However, it is likely that workplace dust contains a variety of constituents that do not contain any DCHP in addition to particles from DCHP-containing non-PVC materials. The constituents that do not contain DCHP would dilute the overall concentration of DCHP in the dust, and the concentration of DCHP in workplace dust is likely less than the concentration of DCHP in the non-PVC material. Due to the uncertainty of DCHP concentrations in workplace dust, central tendency values of exposure are expected to be most reflective of worker exposures within the COUs covered under the "Non-PVC Material Converting" OES (*i.e.*, Processing COUs: Plasticizer in plastics product manufacturing; Rubber product manufacturing).

Application of Adhesives and Sealants

The applications of adhesives and sealants were assessed for solid and liquid products containing DCHP. The majority of DCHP-containing adhesive and sealant products identified exist in solid form and inhalation exposure from dust generation is expected to be the dominant route of exposure for solid adhesive and sealant products, though dermal exposures to solid adhesive and sealant products containing DCHP were also considered. There were a few liquid adhesive and sealant products containing DCHP identified; however, liquid adhesive and sealant products containing DCHP are extremely viscous and are better classified as "paste-like" materials. The literature and product data do not indicate the potential for spray coating of DCHP-containing adhesive and sealant products; therefore, inhalation exposures from the use of liquid adhesive and sealant chemicals containing DCHP are expected to be *de minimis* since there are no mists generated during use, and the vapor pressure of DCHP is very low. Consequently, EPA assumed negligible inhalation exposure from the use of liquid adhesive and sealant products containing DCHP and only assessed dermal exposures for liquid adhesive and sealant use. Risk values associated with the use of liquid adhesive and sealant products containing DCHP are covered under the "Application of adhesives and sealants – liquids" OES (*i.e.*, Industrial COUs: Adhesives and sealants (transportation equipment manufacturing; computer and electronic product manufacturing) and Commercial COUs: Adhesives and sealants). See Appendix F of the *Draft Environmental Release and Occupational Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024q) for product details.

MOEs for high-end acute, intermediate, and chronic inhalation exposure ranged from 6.4 to 10 for average adult workers and women of reproductive age, while high-end dermal MOEs ranged from 532 to 845 (Benchmark = 30). For central tendency, MOEs for the same population and exposure scenarios ranged from 116 to 201 for inhalation exposure and 1,064 to 1,821 for dermal exposures (Benchmark = 30). For dust exposure from solid products, the aggregation of inhalation and dermal exposures led to negligible differences in risk when compared to risk estimates from inhalation exposure alone. The use of liquid adhesive and sealant products is not expected to produce an inhalation exposure and therefore dermal exposure to the liquid is expected to be the dominant route of exposure. For liquid adhesive and sealant products, the high-end and central tendency dermal MOEs ranged from 532 to 845 and 1,064 to 1,821, respectively (Benchmark = 30). The reason for the variation between high-end and central

tendency estimates of inhalation exposure to dust and the rationale for not assessing inhalation data for liquids is described below.

EPA estimated worker inhalation exposures to dust from solid products using the *Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR)* for dust exposures (U.S. EPA, 2021b). The application of adhesives and sealants does not fall under a specific NAICS Code; therefore, EPA used the entire PNOR model data set to estimate DCHP particulate concentrations in the air during the use of solid DCHP-containing adhesive and sealant products. EPA determined the 50th and 95th percentiles of the surrogate dust monitoring data and multiplied these dust concentrations by the maximum potential DCHP concentration in solid adhesive and sealant products (*i.e.*, 55%) to estimate DCHP particulate concentrations in the air. Therefore, the differences in the central tendency and high-end dust concentrations led to differences between the central tendency and high-end risk estimates.

Although the PNOR (*i.e.*, dust) concentration data provides a reliable range of dust concentrations that a worker may experience in a variety of industries, the composition of workplace dust is uncertain. The exposure and risk estimates assume that the concentration of DCHP in workplace dust is the same as the concentration of DCHP in the adhesive or sealant material. However, it is likely that workplace dust contains a variety of constituents that do not contain any DCHP in addition to particles from solid DCHP-containing adhesive and sealant products. The constituents that do not contain DCHP would dilute the overall concentration of DCHP in the dust, and the concentration of DCHP in workplace dust is likely less than the concentration of DCHP in solid adhesive and sealant products. Due to the uncertainty of DCHP concentrations in workplace dust, central tendency values of exposure are expected to be most reflective of worker exposures within the COUs covered under the "Application of adhesives and sealants – solids" OES (*i.e.*, Industrial COUs: Adhesives and sealants (Transportation equipment manufacturing; Computer and electronic product manufacturing) and Commercial COUs: Adhesives and sealants).

Application of Paints and Coatings

The applications of paints and coatings were assessed for solid and liquid products containing DCHP. For the liquid and solid paint and coating products containing DCHP, inhalation exposure is expected to be the dominant route of exposure. For liquids, inhalation exposure is expected to occur primarily from mist during spray application of the product, and for solids, inhalation exposure is expected to primarily occur from dust release of the solid product prior to mixing with other components. Therefore, EPA distinguished exposure estimates between *liquid spray* and *solid dust* exposure from the application of paint and coating products containing DCHP. MOEs for high-end acute, intermediate, and chronic inhalation exposure from the *liquid spray application scenario* ranged from 2.0 to 3.2 for average adult workers and women of reproductive age, while high-end dermal MOEs ranged from 532 to 845 (Benchmark = 30). For central tendency of the *liquid spray application scenario*, MOEs for the same populations and exposure scenarios ranged from 41 to 66 for inhalation exposures and 1,064 to 1,689 for dermal exposures (Benchmark = 30). MOEs for high-end acute, intermediate, and chronic inhalation exposure from the *solid dust scenario* ranged from 3.5 to 5.7 for average adult workers and women of reproductive age, while high-end dermal MOEs ranged from 532 to 845 (Benchmark = 30). For central tendency of the *solid dust scenario*, MOEs for the same populations and exposure scenarios ranged from 62 to 100 for inhalation exposure and 1,064 to 1,689 for dermal exposure (Benchmark = 30). Aggregation of inhalation and dermal exposures led to small differences in MOEs when compared to MOE estimates from dominant exposure route alone.

For the "Application of paint and coatings – liquids" exposure scenario, EPA relied on mist monitoring data from the ESD on Coating Application via Spray-Painting in the Automotive Refinishing Industry (OECD, 2011a), which showed that the central tendency (*i.e.*, 50th percentile) of mist concentrations from automotive refinishing was 3.38 mg/m^3 and the high-end (*i.e.*, 95th percentile) was 22.1 mg/m^3. These mist concentration data were derived from a variety of industrial and commercial automotive refinishing scenarios (*e.g.*, different gun types and booth configurations), but all scenarios considered in the ESD commonly used the spray application of auto refinishing coatings. While the tasks evaluated for mist concentrations varied in time, with the 95th percentile of spray times among tasks being 141 minutes, EPA assumed that these mist concentrations may be persistent in an environment where spraying occurs throughout all or most of the workday. The more highly pressurized spray guns generally lead to higher inhalation exposure levels, and less pressurized spray guns generally lead to lower inhalation exposure levels. The same trend is expected for dermal exposure. Specifically, high-pressure spray applications are more likely to lead to higher levels of dermal exposure, and low-pressure spray guns are more likely to lead to lower levels of dermal exposure. However, there are a variety of factors other than spray equipment type that affect exposure levels, such as spray booth ventilation configuration, product concentration, and spray duration. High-end levels of exposure represent scenarios where one or more factors are contributing to unusually elevated exposure levels, whereas central tendency levels of exposure represent more typical levels of exposure for scenarios where there are few factors contributing to increased exposure. There is uncertainty regarding the particular combination of factors that would lead to high-end levels of exposure.

The range of exposure estimates shown in Table 4-14 for "Application of paints and coatings – liquids" are potentially reflective of industrial or commercial operations where paints and coatings are applied using spray methods (*i.e.*, Industrial COU: Paints and coatings; and Commercial COU: Paints and coatings). As described in the section above, EPA assumed that task-based mist concentrations may be persistent throughout the entirety of a workday, which is realistic but on the conservative end of expected exposure duration for spray coating scenarios. The central tendency estimates of the spray application scenario represent the midpoint of available product concentrations and the mist concentration from the 50th percentile of the data presented in the ESD on Coating Application via Spray-Painting in the Automotive Refinishing Industry (OECD, 2011a), and these levels of exposure are expected to be typical for standard working conditions where workers are spray applying paint and coating products containing DCHP for up to 8 hours per day. However, it is noted that there are several factors that affect exposure levels related to the spray application of paint and coating chemicals including spray equipment type, spray booth ventilation configuration, product concentration, and spray duration.

High-end levels of exposure may occur if one or more of these factors contribute to elevated levels of exposure; however, there is uncertainty regarding the conditions associated with high-end exposures. Because the high-end risk estimates are based on high-end mist concentration levels, high-end product concentration, and high-end exposure duration, the high-end risk values presented in Table 4-14 for "Application of paints and coatings – liquids" may overestimate exposures for typical working conditions. However, EPA does expect high-pressure spray application of paint and coating products containing DCHP based on the available product information. Specifically, EPA identified one product (Carboline, 2019b) that is intended for high-pressure spray application and the concentration of DCHP in the product is listed as up to 2.5 percent. For an 8-hour workday spent spraying with a paint/coating product containing 2.5 percent DCHP, mist levels exceeding 12.8 mg/m^3 (*i.e.*, 91st percentile of the distribution of mist monitoring data) would result in risk values below the benchmark MOE. Although most worker exposures to DCHP through spray application of paints and coatings are expected to be closer to the central tendency exposure values for this COU, a confluence of a subset of variables (*e.g.*,

low ventilation, high-pressure spray, *etc.*) would result in risk below the benchmark. While most workers are not expected to experience elevated exposures (*i.e.,* greater than 90th percentile of mist concentration data for an 8-hour period) on a daily basis, it is considered plausible and expected for such exposures to occur in an acute one-day scenario.

For any liquid paint and coating products that are applied using non-spray methods (*i.e.,* Industrial COUs: Inks, toner, and colorant products [*e.g.,* screen printing ink]; Cellulose film production; Paints and coatings; and Commercial COUs: Inks, toner, and colorant products [*e.g.,* screen printing ink]; Paints and coatings), inhalation exposures are expected to be *de minimis* because mists or dusts are not generated during application and the vapor pressure of DCHP is extremely low at room temperature. However, workers may be exposed through the dermal route under non-spray application scenarios. Therefore, exposures associated with the non-spray application of liquid paint and coating products containing DCHP are characterized by the range of dermal risk values only, which are shown in Table 4-16 for "Application of paints and coatings – liquids."

For the "Application of paints and coatings – solids" exposure scenario, EPA estimated worker inhalation exposures to dust from solid products using the *Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR)* for dust exposures (U.S. EPA, 2021b). The application of paints and coatings does not fall under a specific NAICS Code; therefore, EPA used the entire PNOR model data set to estimate DCHP particulate concentrations in the air during the use of solid DCHP-containing paint and coating products. EPA determined the 50th and 95th percentiles of the surrogate dust monitoring data and multiplied these dust concentrations by the maximum potential DCHP concentration in the solid paint and coating component (*i.e.,* 100%) to estimate DCHP particulate concentrations in the air. Therefore, the differences in the central tendency and high-end dust concentrations led to differences between the central tendency and high-end risk estimates.

Although the PNOR (*i.e.,* dust) concentration data provides a reliable range of dust concentrations that a worker may experience in a variety of industries, the composition of workplace dust is uncertain. The exposure and risk estimates assume that the concentration of DCHP in workplace dust is the same as the concentration of DCHP in the solid paint and coating component. However, it is likely that workplace dust contains a variety of constituents that do not contain any DCHP in addition to particles from solid DCHP-containing paint and coating products. The constituents that do not contain DCHP would dilute the overall concentration of DCHP in the dust, and the concentration of DCHP in workplace dust is likely less than the concentration of DCHP in solid paint and coating products. Due to the uncertainty of DCHP concentrations in workplace dust, central tendency values of exposure are expected to be most reflective of worker exposures within the COUs covered under the "Application of paints and coatings – solids" OES (*i.e.,* Industrial COUs: Inks, toner, and colorant products [*e.g.,* screen printing ink]; Cellulose film production; Paints and coatings; and Commercial COUs: Inks, toner, and colorant products [*e.g.,* screen printing ink]; Paints and coatings).

Use of Laboratory Chemicals

The use of laboratory chemicals was assessed for solid and liquid products containing DCHP. Inhalation exposure from dust generation is expected to be the dominant route of exposure for solid laboratory chemicals. MOEs for high-end acute, intermediate, and chronic inhalation exposure ranged from 6.4 to 10 for average adult workers and women of reproductive age, while high-end dermal MOEs ranged from 532 to 845 (Benchmark = 30). For central tendency, MOEs for the same population and exposure scenarios ranged from 91 to 157 for inhalation exposure and 1,064 to 1,797 for dermal exposures (Benchmark = 30). For dust exposure, the aggregation of inhalation and dermal exposures led to

negligible differences in risk when compared to risk estimates from inhalation exposure alone. The use of liquid laboratory chemicals is not expected to produce an inhalation exposure and therefore dermal exposure to the liquid is expected to be the dominant route of exposure. For liquid laboratory chemicals, the high-end and central tendency dermal MOEs ranged from 532 to 845 and 1,064 to 1,797, respectively (Benchmark = 30). The reason for the variation between high-end and central tendency estimates of worker inhalation exposure to dust and the rational for not assessing inhalation data for liquids is described below.

EPA assessed worker inhalation exposures to dust from solid laboratory chemicals. The literature and product data do not indicate the potential for the generation of mists during the use of liquid lab chemicals. Therefore, inhalation exposures from the use of liquid DCHP-containing lab chemicals containing DCHP are expected to be *de minimis* because there are no mists generated during use and the vapor pressure of DCHP is very low. Consequently, EPA assumed negligible inhalation exposure from the use of liquid lab chemicals and only assessed dermal exposures for liquid laboratory chemical use.

EPA estimated worker inhalation exposures to dust from solid laboratory chemicals using the *Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR)* for dust exposures (U.S. EPA, 2021b). For inhalation exposure to PNOR, EPA determined the 50th and 95th percentiles of the surrogate dust monitoring data taken from facilities with NAICS Codes starting with 54 (Professional, Scientific, and Technical Services). EPA determined the 50th and 95th percentiles of the surrogate dust monitoring data and multiplied these dust concentrations by the industry provided maximum potential DCHP concentration in lab chemicals (*i.e.*, 100%) to estimate DCHP particulate concentrations in the air. Therefore, the differences in the central tendency and high-end dust concentrations led to differences between the central tendency and high-end risk estimates.

Although the PNOR (*i.e.*, dust) concentration data provides a reliable range of dust concentrations that a worker may experience in the laboratory services industry, the composition of workplace dust is uncertain. The exposure and risk estimates assume that the concentration of DCHP in workplace dust is the same as the concentration of DCHP in the laboratory chemicals. However, it is likely that workplace dust contains a variety of constituents that do not contain any DCHP in addition to particles from solid DCHP-containing laboratory chemicals. The constituents that do not contain DCHP would dilute the overall concentration of DCHP in the dust, and the concentration of DCHP in workplace dust is likely less than the concentration of DCHP in the solid laboratory chemicals. Due to the uncertainty of DCHP concentrations in workplace dust, central tendency values of exposure are expected to be most reflective of worker exposures within the COUs covered under the "Use of lab chemicals" OES (*i.e.*, Commercial COU: Laboratory chemical).

Fabrication or Use of Final Products or Articles

For fabrication or use of final products or articles, inhalation exposure from dust generation is expected to be the dominant route of exposure. MOEs for high-end acute, intermediate, and chronic inhalation exposure ranged from 21 to 35 for average adult workers and women of reproductive age, whereas high-end dermal MOEs for the same populations and exposure scenarios ranged from 532 to 845 (Benchmark = 30). For central tendency, MOEs for the same population and exposure scenarios ranged from 193 to 311 for inhalation exposure and 1,064 to 1,689 for dermal exposures (Benchmark = 30). Aggregation of inhalation and dermal exposures led to negligible differences in risk when compared to risk estimates from inhalation exposure alone. The variations between the central tendency and high-end estimates of worker inhalation exposures are described below.

EPA estimated worker inhalation exposures using the *Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR)* for dust exposures (U.S. EPA, 2021b). For inhalation exposure to PNOR, EPA determined the 50th and 95th percentiles of the surrogate dust monitoring data taken from facilities with NAICS Codes starting with 337 (Furniture and Related Product Manufacturing). EPA multiplied these dust concentrations by the maximum DCHP concentration in PVC (*i.e.,* 45%) to estimate DCHP particulate concentrations in the air. Therefore, the differences in the central tendency and high-end dust concentrations led to significant differences between the central tendency and high-end risk estimates.

Although the PNOR (*i.e.,* dust) concentration data provides a reliable range of dust concentrations that a worker may experience in the end use and fabrication industries, the composition of workplace dust is uncertain. The exposure and risk estimates assume that the concentration of DCHP in workplace dust is the same as the concentration of DCHP in the PVC material. However, it is likely that workplace dust contains a variety of constituents that do not contain any DCHP in addition to particles from DCHP-containing products or articles. The constituents that do not contain DCHP would dilute the overall concentration of DCHP in the dust, and the concentration of DCHP in workplace dust is likely less than the concentration of DCHP in final products and articles. Due to the uncertainty of DCHP concentrations in workplace dust, central tendency values of exposure are expected to be most reflective of worker exposures within the COUs covered under the "Fabrication or use of final products or articles" OES (*i.e.,* Industrial COU: Plastic and rubber products not covered elsewhere in transportation equipment manufacturing; and Commercial COUs: Building/construction materials not covered elsewhere; Other articles with routine direct contact during normal use including rubber articles; Plastic articles [hard]).

Recycling and Waste Handling, Treatment, and Disposal

The approaches for the Recycling OES and the Waste handling, treatment and disposal OES are identical and therefore consolidated here. For both OESs, the inhalation exposure from dust generation is expected to be the dominant route of exposure. MOEs for high-end acute, intermediate, and chronic inhalation exposure ranged from 11 to 18 for average adult workers and women of reproductive age, while high-end dermal MOEs for the same populations and exposure scenarios ranged from 532 to 845 (Benchmark = 30) for both OESs. The central tendency MOEs for the same populations and exposure scenarios ranged from 161 to 291 for inhalation exposure and 1,064 to 1,894 for dermal exposure for both OES (Benchmark = 30). Aggregation of inhalation and dermal exposures led to negligible differences in risk when compared to risk estimates from inhalation exposure alone. The variations between the central tendency and high-end estimates of worker inhalation exposures are described below.

EPA estimated worker inhalation exposures using the *Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR)* for dust exposures (U.S. EPA, 2021b). For inhalation exposure to PNOR, EPA determined the 50th and 95th percentiles of the surrogate dust monitoring data taken from facilities with NAICS Codes starting with 56 (Administrative and Support and Waste Management and Remediation Services). EPA multiplied these dust concentrations by the industry provided maximum DCHP concentration in PVC (*i.e.,* 45%) to estimate DCHP particulate concentrations in the air. PVC concentration was used for this estimate because it is expected to be the predominant type of waste containing DCHP that is recycled or disposed of. Therefore, the differences in the central tendency and high-end dust concentrations led to significant differences between the central tendency and high-end risk estimates.

Although the PNOR (*i.e.,* dust) concentration data provides a reliable range of dust concentrations that a

worker may experience in the recycling and disposal industry, the composition of workplace dust is uncertain. The exposure and risk estimates are based on the assumption that the concentration of DCHP in workplace dust is the same as the concentration of DCHP in PVC plastics. However, it is likely that workplace dust contains a variety of constituents that do not contain any DCHP in addition to particles from DCHP-containing products or articles. The constituents that do not contain DCHP would dilute the overall concentration of DCHP in the dust, and the concentration of DCHP in workplace dust is likely less than the concentration of DCHP in recycled or disposed products or articles. Therefore, central tendency values of exposure are expected to be more reflective of worker exposures within the COUs covered under the "Recycling" and the "Disposal" OESs (*i.e.*, Processing COU: Recycling; and Disposal COU: Disposal).

Distribution in Commerce

Distribution in commerce includes transporting DCHP or DCHP-containing products between work sites or to final use sites as well as loading and unloading from transport vehicles. Individuals in occupations that transport DCHP-containing products (*e.g.*, truck drivers) or workers who load and unload transport trucks may encounter DCHP or DCHP-containing products.

Although some worker activities (*e.g.*, loading or unloading) associated with distribution in commerce are similar to COUs such as manufacturing or import, it is expected that workers involved in distribution in commerce spend less time exposed to DCHP than workers in manufacturing or import facilities since only part of the workday is spent in an area with potential exposure. Therefore, occupational exposures associated with the distribution in commerce COU are expected to be less than other COUs with similar worker activities (*i.e.*, manufacturing and import).

4.3.2.1 Overall Confidence in Worker Risk Estimates for Individual DCHP COUs

As described in Section 4.1.1.5, EPA has moderate confidence in the assessed occupational inhalation and dermal exposures (Table 4-5) and robust confidence in the non-cancer POD selected to characterize risk from acute, intermediate, and chronic duration exposures to DCHP (Section 4.2). Overall, the Agency has moderate confidence in the risk estimates calculated for worker and ONU inhalation and dermal exposure scenarios. Sources of uncertainty associated with the occupational COUs are discussed above in Section 4.3.2.

Table 4-14. Occupational Aggregate Risk Summary Table for DCHP

Life Cycle Stage/ Category	Subcategory	OES	Worker Population	Exposure Level	Inhalation Risk Estimates (Benchmark MOE = 30)			Dermal Risk Estimates (Benchmark MOE = 30)			Aggregate Risk Estimates (Benchmark MOE = 30)		
					Acute	Intermed.	Chronic	Acute	Intermed.	Chronic	Acute	Intermed.	Chronic
Manufacturing – Domestic Manufacturing	Domestic manufacturing	Manufacturing	Average Adult Worker	High-End	3.8	5.2	5.6	532	725	776	3.8	5.2	5.6
				Central Tendency	40	55	58	1,064	1,451	1,553	39	53	56
			Women of Reproductive Age	High-End	*3.5* [a]	4.7	5.1	*579* [a]	789	845	*3.5* [a]	4.7	5.0
				Central Tendency	*36* [a]	49	53	*1,157* [a]	1,578	1,689	*35* [a]	48	51
			ONU	High-End	40	55	58	1,064	1,451	1,553	39	53	56
				Central Tendency	40	55	58	1,064	1,451	1,553	39	53	56
Manufacturing – Importing	Importing	Import and repackaging	Average Adult Worker	High-End	6.4	8.7	9.3	532	725	776	6.3	8.6	9.2
				Central Tendency	148	201	259	1,064	1,451	1,867	130	177	228
			Women of Reproductive Age	High-End	*5.8* [a]	7.9	8.5	*579* [a]	789	845	*5.7* [a]	7.8	8.4
Processing – Repackaging	Repackaging (*e.g.*, laboratory chemicals)			Central Tendency	*134* [a]	182	235	*1,157* [a]	1,578	2,031	*120* [a]	163	210
			ONU	High-End	148	201	216	1,064	1,451	1,553	130	177	189
				Central Tendency	148	201	259	1,064	1,451	1,867	130	177	228

Life Cycle Stage/ Category	Subcategory	OES	Worker Population	Exposure Level	Inhalation Risk Estimates (Benchmark MOE = 30)			Dermal Risk Estimates (Benchmark MOE = 30)			Aggregate Risk Estimates (Benchmark MOE = 30)		
					Acute	Intermed.	Chronic	Acute	Intermed.	Chronic	Acute	Intermed.	Chronic
Processing – Processing – incorporation into formulation, mixture, or reaction product	Plasticizer in: – adhesive manufacturing	Incorporation into adhesives and sealants	Average Adult Worker	High-End	3.8	5.2	5.6	532	725	776	3.8	5.2	5.6
	Adhesive and sealant chemicals in: – adhesive manufacturing			Central Tendency	40	55	58	1,064	1,451	1,553	39	53	56
	Stabilizing agent in: – adhesive manufacturing		Women of Reproductive Age	High-End	*3.5* [a]	4.7	5.1	*579* [a]	789	845	*3.5* [a]	4.7	5.0
				Central Tendency	*36* [a]	49	53	*1,157* [a]	1,578	1,689	*35* [a]	48	51
			ONU	High-End	40	55	58	1,064	1,451	1,553	39	53	56
				Central Tendency	40	55	58	1,064	1,451	1,553	39	53	56
Processing – Processing – incorporation into formulation, mixture, or reaction product	Plasticizer in: – paint and coating manufacturing – printing ink manufacturing	Incorporation into paints and coatings	Average Adult Worker	High-End	3.8	5.2	5.6	532	725	776	3.8	5.2	5.6
	Stabilizing agent in: – Paint and coating manufacturing			Central Tendency	40	55	58	1,064	1,451	1,553	39	53	56
			Women of Reproductive Age	High-End	*3.5* [a]	4.7	5.1	*579* [a]	789	845	*3.5* [a]	4.7	5.0
				Central Tendency	*36* [a]	49	53	*1,157* [a]	1,578	1,689	*35* [a]	48	51
			ONU	High-End	40	55	58	1,064	1,451	1,553	39	53	56
				Central Tendency	40	55	58	1,064	1,451	1,553	39	53	56

Life Cycle Stage/ Category	Subcategory	OES	Worker Population	Exposure Level	Inhalation Risk Estimates (Benchmark MOE = 30)			Dermal Risk Estimates (Benchmark MOE = 30)			Aggregate Risk Estimates (Benchmark MOE = 30)		
					Acute	Intermed.	Chronic	Acute	Intermed.	Chronic	Acute	Intermed.	Chronic
Processing – Processing – incorporation into formulation, mixture, or reaction product	Stabilizing agent in: – asphalt paving, roofing, and coating materials manufacturing	Incorporation into other formulations, mixtures, and reaction products not covered elsewhere	Average Adult Worker	High-End	3.8	5.2	5.6	532	725	776	3.8	5.2	5.6
				Central Tendency	40	55	58	1,064	1,451	1,553	39	53	56
			Women of Reproductive Age	High-End	*3.5* [a]	4.7	5.1	*579* [a]	789	845	*3.5* [a]	4.7	5.0
				Central Tendency	*36* [a]	49	53	*1,157* [a]	1,578	1,689	*35* [a]	48	51
			ONU	High-End	40	55	58	1,064	1,451	1,553	39	53	56
				Central Tendency	40	55	58	1,064	1,451	1,553	39	53	56
Processing – Processing – incorporation into formulation, mixture, or reaction product	Plasticizer in: – plastic material and resin manufacturing – plastics product manufacturing	PVC plastics compounding	Average Adult Worker	High-End	4.1	5.6	6.0	532	725	776	4.1	5.5	5.9
				Central Tendency	83	114	137	1,064	1,451	1,741	77	106	127
	Stabilizing agent in: – plastics product manufacturing		Women of Reproductive Age	High-End	*3.7* [a]	5.0	5.4	*579* [a]	789	845	*3.7* [a]	5.0	5.4
				Central Tendency	*76* [a]	103	124	*1,157* [a]	1,578	1,894	*71* [a]	97	116
			ONU	High-End	83	114	122	1,064	1,451	1,553	77	106	113
				Central Tendency	83	114	137	1,064	1,451	1,741	77	106	127

Life Cycle Stage/ Category	Subcategory	OES	Worker Population	Exposure Level	Inhalation Risk Estimates (Benchmark MOE = 30)			Dermal Risk Estimates (Benchmark MOE = 30)			Aggregate Risk Estimates (Benchmark MOE = 30)		
					Acute	Intermed.	Chronic	Acute	Intermed.	Chronic	Acute	Intermed.	Chronic
Processing – Processing – incorporation into article	Plasticizer in: – Plastics product manufacturing	PVC plastics converting	Average Adult Worker	High-End	9.1	12	13	532	725	776	8.9	12	13
				Central Tendency	186	253	309	1,064	1,451	1,773	158	215	263
			Women of Reproductive Age	High-End	*8.2* [a]	11	12	*579* [a]	789	845	*8.1* [a]	11	12
				Central Tendency	*168* [a]	229	280	*1,157* [a]	1,578	1,929	*147* [a]	200	244
			ONU	High-End	186	253	271	1,064	1,451	1,553	158	215	231
				Central Tendency	186	253	309	1,064	1,451	1,773	158	215	263
Processing – Processing – incorporation into formulation, mixture, or reaction product	Plasticizer in: – plastics product manufacturing – rubber product manufacturing – plastic material and resin manufacturing	Non-PVC material compounding	Average Adult Worker	High-End	6.8	9.3	9.9	532	725	776	6.7	9.2	9.8
				Central Tendency	139	190	217	1,064	1,451	1,659	123	168	192
			Women of Reproductive Age	High-End	*6.2* [a]	8.4	9.0	*579* [a]	789	845	*6.1* [a]	8.3	8.9
	Stabilizing agent in: – Plastics product manufacturing			Central Tendency	*126* [a]	172	196	*1,157* [a]	1,578	1,805	*114* [a]	155	177
			ONU	High-End	139	190	203	1,064	1,451	1,553	123	168	180
				Central Tendency	139	190	217	1,064	1,451	1,659	123	168	198

Life Cycle Stage/ Category	Subcategory	OES	Worker Population	Exposure Level	Inhalation Risk Estimates (Benchmark MOE = 30)			Dermal Risk Estimates (Benchmark MOE = 30)			Aggregate Risk Estimates (Benchmark MOE = 30)		
					Acute	Intermed.	Chronic	Acute	Intermed.	Chronic	Acute	Intermed.	Chronic
Processing – Processing – incorporation into article	Plasticizer in: – plastics product manufacturing – rubber product manufacturing	Non-PVC material converting	Average Adult Worker	High-End	20	28	30	532	725	776	20	27	29
				Central Tendency	417	569	696	1,064	1,451	1,773	300	409	500
			Women of Reproductive Age	High-End	*18* [a]	25	27	*579* [a]	789	845	*18* [a]	24	26
				Central Tendency	*378* [a]	515	630	*1,157* [a]	1,578	1,929	*285* [a]	388	475
			ONU	High-End	417	569	609	1,064	1,451	1,553	300	409	438
				Central Tendency	417	569	696	1,064	1,451	1,773	300	409	500
Industrial Use – Finishing agent	Cellulose film production	Application of paints and coatings – liquids	Average Adult Worker	High-End	2.2	3.0	3.2	532	725	776	2.2	2.9	3.2
Industrial Use – Inks, toner, and colorant products	Inks, toner, and colorant products (*e.g.*, screen printing ink)			Central Tendency	45	62	66	1,064	1,451	1,553	44	59	64
			Women of Reproductive Age	High-End	*2.0* [a]	2.7	2.9	*579* [a]	789	845	*2.0* [a]	2.7	2.9
Commercial Use – Inks, toner, and colorant products	Inks, toner, and colorant products (*e.g.*, screen printing ink)			Central Tendency	*41* [a]	56	60	*1,157* [a]	1,578	1,689	*40* [a]	54	58
			ONU	High-End	45	62	66	1,064	1,451	1,553	44	59	64
Industrial Use – Paints and coatings	Paints and coatings			Central Tendency	45	62	66	1,064	1,451	1,553	44	59	64
Commercial Use – Paints and coatings	Paints and coatings												

Life Cycle Stage/ Category	Subcategory	OES	Worker Population	Exposure Level	Inhalation Risk Estimates (Benchmark MOE = 30)			Dermal Risk Estimates (Benchmark MOE = 30)			Aggregate Risk Estimates (Benchmark MOE = 30)		
					Acute	Intermed.	Chronic	Acute	Intermed.	Chronic	Acute	Intermed.	Chronic
Industrial Use – Finishing agent	Cellulose film production	Application of paints and coatings – solids	Average Adult Worker	High-End	3.9	5.3	5.7	532	725	776	3.9	5.3	5.7
Industrial Use – Inks, toner, and colorant products	Inks, toner, and colorant products (*e.g.*, screen printing ink)			Central Tendency	69	94	100	1,064	1,451	1,553	64	88	94
Commercial Use – Inks, toner, and colorant products	Inks, toner, and colorant products (*e.g.*, screen printing ink)		Women of Reproductive Age	High-End	*3.5* [a]	4.8	5.2	*579* [a]	789	845	*3.5* [a]	4.8	5.1
				Central Tendency	*62* [a]	85	91	*1,157* [a]	1,578	1,689	*59* [a]	80	86
Industrial Use – Paints and coatings	Paints and coatings		ONU	High-End	69	94	100	1,064	1,451	1,553	64	88	94
Commercial Use – Paints and coatings	Paints and coatings			Central Tendency	69	94	100	1,064	1,451	1,553	64	88	94
Industrial Uses – Adhesives and sealants	Adhesives and sealants (*e.g.*, computer and electronic product manufact.; transportation equipment manufact.)	Application of adhesives and sealants – liquids	Average Adult Worker	High-End	N/A	N/A	N/A	532	725	776	532	725	776
				Central Tendency	N/A	N/A	N/A	1,064	1,451	1,674	1,064	1,451	1,674
			Women of Reproductive Age	High-End	N/A	N/A	N/A	579 [a]	789	845	*579* [a]	789	845
Commercial uses – Adhesives and sealants	Adhesives and sealants			Central Tendency	N/A	N/A	N/A	1,157[a]	1,578	1,821	*1,157* [a]	1,578	1,821
			ONU	High-End	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
				Central Tendency	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Life Cycle Stage/ Category	Subcategory	OES	Worker Population	Exposure Level	Inhalation Risk Estimates (Benchmark MOE = 30)			Dermal Risk Estimates (Benchmark MOE = 30)			Aggregate Risk Estimates (Benchmark MOE = 30)		
					Acute	Intermed.	Chronic	Acute	Intermed.	Chronic	Acute	Intermed.	Chronic
Industrial Uses – Adhesives and sealants	Adhesives and sealants in – computer and electronic product manufact.; transportation equipment manufact.	Application of adhesives and sealants – solids	Average Adult Worker	High-End	7.1	9.7	10	532	725	776	7.0	9.6	10
				Central Tendency	128	175	201	1,064	1,451	1,674	114	156	180
			Women of Reproductive Age	High-End	*6.4* [a]	8.8	9.4	*579* [a]	789	845	*6.4* [a]	8.7	9.3
Commercial Uses – Adhesives and sealants	Adhesives and sealants			Central Tendency	*116* [a]	158	182	*1,157* [a]	1,578	1,821	*105* [a]	144	166
			ONU	High-End	128	175	187	1,064	1,451	1,553	114	156	167
				Central Tendency	128	175	201	1,064	1,451	1,674	114	156	180
Commercial Use – Laboratory chemicals	Laboratory chemicals	Use of laboratory chemicals – liquid	Average Adult Worker	High-End	N/A	N/A	N/A	532	725	776	532	725	776
				Central Tendency	N/A	N/A	N/A	1,064	1,451	1,652	1,064	1,451	1,652
			Women of Reproductive Age	High-End	N/A	N/A	N/A	*579* [a]	789	845	*579* [a]	789	845
				Central Tendency	N/A	N/A	N/A	*1,157* [a]	1,578	1,797	*1,157* [a]	1,578	1,797
			ONU	High-End	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
				Central Tendency	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Life Cycle Stage/ Category	Subcategory	OES	Worker Population	Exposure Level	Inhalation Risk Estimates (Benchmark MOE = 30)			Dermal Risk Estimates (Benchmark MOE = 30)			Aggregate Risk Estimates (Benchmark MOE = 30)		
					Acute	Intermed.	Chronic	Acute	Intermed.	Chronic	Acute	Intermed.	Chronic
Commercial Use – Laboratory chemicals	Laboratory chemicals	Use of laboratory chemicals – solid	Average Adult Worker	High-End	7.1	9.7	10	532	725	776	7.0	9.6	10
				Central Tendency	101	138	157	1,064	1,451	1,652	92	126	143
			Women of Reproductive Age	High-End	*6.4* [a]	8.8	9.4	*579* [a]	789	845	*6.4* [a]	8.7	9.3
				Central Tendency	*91* [a]	125	142	*1,157* [a]	1,578	1,797	*85* [a]	116	132
			ONU	High-End	101	138	148	1,064	1,451	1,553	92	126	135
				Central Tendency	101	138	157	1,064	1,451	1,652	92	126	143
Industrial Use – Other articles with routine direct contact during normal use including rubber articles; plastic articles (hard)	Other articles with routine direct contact during normal use including rubber articles; plastic articles (hard) (*e.g.*, transportation equipment manufact.)	Fabrication or use of final products or articles	Average Adult Worker	High-End	24	32	35	532	725	776	23	31	33
				Central Tendency	213	291	311	1,064	1,451	1,553	178	242	259
			Women of Reproductive Age	High-End	*21* [a]	29	31	*579* [a]	789	845	*21* [a]	28	30
Commercial Use – Building/ construction materials not covered elsewhere	Building/ construction materials not covered elsewhere			Central Tendency	*193* [a]	263	282	*1,157* [a]	1,578	1,689	*166* [a]	226	242
Commercial Use – Other articles with routine direct contact during normal use including rubber articles	Other articles with routine direct contact during normal use including rubber articles; plastic articles (hard)		ONU	High-End	213	291	311	1,064	1,451	1,553	178	242	259
				Central Tendency	213	291	311	1,064	1,451	1,553	178	242	259

Life Cycle Stage/ Category	Subcategory	OES	Worker Population	Exposure Level	Inhalation Risk Estimates (Benchmark MOE = 30)			Dermal Risk Estimates (Benchmark MOE = 30)			Aggregate Risk Estimates (Benchmark MOE = 30)		
					Acute	Intermed.	Chronic	Acute	Intermed.	Chronic	Acute	Intermed.	Chronic
Processing – Recycling	Recycling	Recycling	Average Adult Worker	High-End	12	17	18	532	725	776	12	16	17
				Central Tendency	178	242	291	1,064	1,451	1,741	152	208	249
			Women of Reproductive Age	High-End	*11* [a]	15	16	*579* [a]	789	845	*11* [a]	15	16
				Central Tendency	*161* [a]	219	263	*1,157* [a]	1,578	1,894	*141* [a]	193	231
			ONU	High-End	178	242	260	1,064	1,451	1,553	152	208	222
				Central Tendency	178	242	291	1,064	1,451	1,741	152	208	249
Disposal – Disposal	Disposal	Waste handling, treatment and disposal	Average Adult Worker	High-End	12	17	18	532	725	776	12	16	17
				Central Tendency	178	242	291	1,064	1,451	1,741	152	208	249
			Women of Reproductive Age	High-End	*11* [a]	15	16	*579* [a]	789	845	*11* [a]	15	16
				Central Tendency	*161* [a]	219	263	*1,157* [a]	1,578	1,894	*141* [a]	193	231
			ONU	High-End	178	242	260	1,064	1,451	1,553	152	208	222
				Central Tendency	178	242	291	1,064	1,451	1,741	152	208	249

[a] Scaling by the RPF and application of the index chemical POD provides a more sensitive and robust hazard assessment than the DCHP-specific POD, given its more limited toxicological data set. Please see Table 4-22 for the RPF analysis values.

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4.3.3 Risk Estimates for Consumers

This section summarizes risk estimates for consumers from inhalation, ingestion, and dermal exposures, as well as aggregated exposures, to DCHP from individual DCHP COUs across routes. In this section, risks are calculated for all exposed populations based on the DCHP-derived PODs described in Section 4.2.2. Subsequently in Section 4.4.5, those same risks for consumers that are adults of reproductive age, infants, children, and teenagers exposed to DCHP at the highest levels (acute durations) are calculated using the more robust RPFs described in Section 4.4.1 and added to estimates of national non-attributable exposure of five toxicologically similar phthalates for an estimate of cumulative risk. Table 4-15 summarizes the dermal, inhalation, ingestion, and aggregate MOEs used to characterize non-cancer risk for acute, intermediate, and chronic exposure to DCHP and presents these values for all lifestages for each COU. A screening-level assessment for consumers considers high-intensity exposure scenarios which rely on conservative assumptions to assess exposures that would be expected to be on the high end of the expected exposure distribution. The corresponding high-intensity exposure scenario risk estimates are used as a conservative and health protective screening approach. MOEs for high-intensity exposure scenarios are shown for all consumer COUs, while MOEs for medium-intensity exposure scenarios are shown only for COUs with high-intensity MOEs close to the benchmark of 30 (no scenarios were in exceedance or within 20% of the benchmark). Exposure risk estimates were calculated considering product and article user and bystander. Bystanders are people that are not in direct use or application of a product but can be exposed to DCHP by proximity to the use of the product via inhalation of gas-phase emissions or suspended dust. Some product scenarios were assessed for children under 10 years as bystanders and children older than 11 years as users, because the products were not targeted for direct use by young children (<10 years). In instances where a lifestage could reasonably be either a product user or bystander, the inputs for a user were selected because that scenario would result in larger exposure doses.

Of note, the risk summary below is based on the most sensitive non-cancer endpoint for all relevant duration scenarios (*i.e.*, developmental toxicity for acute, intermediate, and chronic durations). MOEs for all high-, medium- and low-intensity exposure scenarios for all COUs are provided in the *Draft Consumer Risk Calculator for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024e).

COUs with MOEs for High-Intensity Exposure Scenarios Ranging from 740 to 950,000

All consumer COUs product and article examples resulted in MOEs for high-intensity exposure scenarios ranging from 740 for acute duration dermal exposure to DCHP from outdoor seating for infants (less than one year old) to 950,000 for intermediate duration inhalation of suspended dust from automotive adhesives for adults (21+ years) (Table 4-15). Variability in MOEs for these high-intensity exposure scenarios results from use of different exposure factors for each COU and product or article example that led to different estimates of exposure to DCHP. As described in the *Draft Consumer and Indoor Dust Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024c) and *Draft Non-Cancer Human Health Hazard Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024v), EPA has moderate to robust confidence in the exposure estimates and robust confidence in the non-cancer hazard value used to estimate non-cancer risk for these COUs.

Adhesives and Sealants

Two different scenarios were assessed under this COU for products with differing use patterns for example, adhesives for small repairs (2 products) and automotive adhesives (2 products). The two scenarios capture the variability in product formulation and use patterns in the high, medium, and low intensity use estimates. The small repairs products are used in small amounts and have very short working times (<5 minutes), which limits the potential for inhalation exposure. However, if dermal

exposure occurs during use it is possible that the product may not be washed off immediately, resulting in exposure. As such, both products were modeled for dermal exposure only. The automotive adhesives products may be used for large repairs to vehicle bodies and were assessed for both inhalation and dermal exposure. The overall confidence in the inhalation exposure estimates for this COU is robust because the CEM default parameters are representative and plausible use patterns and location of use. For dermal exposure, EPA used a dermal flux approach. The Agency has moderate confidence in dermal estimates because of the moderate uncertainty in the partitioning from product to skin. In addition, subsequent dermal absorption is not well characterized or confirmed with experimental results. However, other parameters such as frequency and duration of use, and surface area in contact, are well understood and representative, resulting in an overall confidence of moderate in a health protective estimate. Additionally, EPA has robust overall confidence in the underlying chronic POD based on developmental toxicity (Section 4.2).

Aggregate risk from dermal, ingestion, and inhalation exposures to DCHP for the two scenarios was also considered. All three exposure routes are essentially negligible in their overall contribution to the aggregate since the individual MOE values were significantly higher than the benchmark of 30.

Other Articles with Routine Direct Contact During Normal Use Including Rubber Articles; Plastic Articles (Hard)

One scenario was assessed under this COU. It considered multiple articles and routine dermal contact with similar use patterns. The scenario for small articles of routine dermal contact was assessed for dermal exposures only because inhalation and ingestion would have low exposure potential due to the small surface area of the articles and limited time spent in an indoor environment before disposal and mouthing was not an expected behavior based on the generic article examples identified.

The small articles with the potential for semi-routine contact scenario considers some generic example descriptions but not specific products, for example labels, nitrocellulose; ethylcellulose; chlorinated rubber; PVAc; PVC. These examples are expected to be used in smaller items and the primary exposure route is through dermal contact when handling the goods. Although DCHP content was not reported or measured in specific products, this scenario was included for dermal exposure calculations, which does not use weight fractions. Dermal contact events are likely short and/or infrequent, but an individual could have appreciable daily contact with multiple items. All acute and chronic MOE values were well above the benchmark of 30. The MOE values increase with increasing age due to changes in inhalation rate to body weight ratios, thus leading to decreasing exposure with increasing age.

Dermal absorption estimates are based on the assumption that dermal absorption of DCHP from solid objects would be limited by aqueous solubility of DCHP. EPA has slight confidence for solid objects because the high uncertainty in the assumption of partitioning from solid to liquid and subsequent dermal absorption is not well characterized. However, other parameters such as frequency and duration of use, and surface area in contact, are well understood and representative, resulting in an overall confidence of moderate in a health protective estimate. Additionally, EPA has robust overall confidence in the underlying chronic POD based on developmental toxicity (Section 4.2).

Other; Consumer Articles that Contain Dicyclohexyl Phthalate from: Inks, Toner, and Colorant, Paints and Coatings, Adhesives, and Sealants (e.g., Paper Products, Textiles, Products Using Cellulose Film, etc.)

Three different scenarios were assessed under this COU for articles with differing use patterns: Outdoor seating, small articles with potential for routine contact (multiple non-specific articles), and electronics containing dye adhesive (qualitative discussion). The outdoor seating and small articles scenarios were

assessed for dermal exposures only. For the outside seating scenario, based on DCHP's waterproofing and weather resistant properties and the expected use case for outdoor seating, EPA anticipated use of this article occurs outdoors where air exchange rates are large; thus, inhalation exposure is expected to be negligible. Dermal exposures were modeled for a scenario where consumers sit on coated surfaces (*e.g.,* on seats at a sporting event or directly on a terrace). The small articles with the potential for semi-routine contact scenario considers generic examples but no specific items were identified (like labels for cleaning products or arts and crafts materials); instead, EPA used article descriptors like labels and packaging adhesives, foil and cellophane lacquers, and printing inks. These articles are expected to be used in small quantities and the primary exposure route is through dermal contact when handling the goods. Although DCHP content was not reported or measured in specific articles, this scenario was included for dermal exposure calculations that do not use weight fractions. Dermal contact events are likely short and/or infrequent, but an individual could have appreciable daily contact with multiple items. The items are not expected to be mouthed and the likelihood of inhalation exposure is minimal due to their small surface area and limited time spent in an indoor environment before disposal. The electronics containing dye adhesive was qualitatively assessed because it is used in small quantities and contained within the electronic articles; thus, no exposures are expected during potential use of these items. An aggregate analysis for this COU was not performed because all scenarios were assessed for dermal exposures only.

EPA has slight confidence in some aspects of the exposure estimate for solid articles because of the high uncertainty in the assumption of partitioning from solid to liquid and because subsequent dermal absorption is not well characterized. However, other parameters such as frequency and duration of use and surface area in contact are well understood and representative, resulting in an overall confidence of moderate in a health protective estimate. Additionally, EPA has robust overall confidence in the underlying chronic POD based on developmental toxicity (Section 4.2).

4.3.3.1 Overall Confidence in Consumer Risks

As described in Section 4.1.2.3 and in more detail in the *Draft Consumer and Indoor Dust Exposure Assessment Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024c), EPA has moderate and robust confidence in the assessed inhalation, ingestion, and dermal consumer exposure scenarios, and robust confidence in the acute, intermediate and chronic non-cancer PODs selected to characterize risk from acute, intermediate, and chronic duration exposures to DCHP (see Section 4.2 and (U.S. EPA, 2024c)). The exposure doses used to estimate risk relied on conservative, health protective inputs and parameters that are considered representative of a wide selection of use patterns. Sources of uncertainty associated with all consumer COUs are discussed above in Section 4.3.3.

Table 4-15. Consumer Risk Summary Table

Life Cycle Stage: COU: Subcategory	Product or Article	Duration	Exposure Route	Exposure Scenario (H, M, L) [a]	Lifestage (years) (Benchmark MOE = 30)						
					Infant (<1 year)	Toddler (1–2 years)	Preschooler (3–5 years)	Middle Childhood (6–10 years)	Young Teen (11–15 years)	Teenagers (16–20 years)	Adult (21+ years)
Consumer Uses: Adhesives and sealants: Adhesives and sealants	Adhesives for small repairs	Acute [c]	Dermal	H	–	–	–	–	16,000	17,000	16,000
			Ingestion	H	–	–	–	–	–	–	–
			Inhalation	H	–	–	–	–	–	–	–
			Aggregate	H	–	–	–	–	16,000	17,000	16,000
		Intermed.	–	–	–	–	–	–	–	–	–
		Chronic	Dermal	H	–	–	–	–	110,000	120,000	110,000
			Ingestion	H	–	–	–	–	–	–	–
			Inhalation	H	–	–	–	–	–	–	–
			Aggregate	H	–	–	–	–	110,000	120,000	110,000
Consumer Uses: Adhesives and sealants: Adhesives and sealants	Automotive adhesives ([b] = MOE for bystander scenario)	Acute [c]	Dermal	H	–	–	–	–	11,000	12,000	11,000
			Ingestion	H	–	–	–	–	–	–	–
			Inhalation	H	20,000 [b]	21,000 [b]	26,000 [b]	37,000 [b]	43,000	52,000	63,000
			Aggregate	H	20,000 [b]	21,000 [b]	26,000 [b]	37,000 [b]	8,800	9,800	9,600
		Intermed.	Dermal	H	–	–	–	–	170,000	180,000	170,000
			Ingestion	H	–	–	–	–	–	–	–
			Inhalation	H	300,000 [b]	310,000 [b]	390,000 [b]	560,000 [b]	650,000	780,000	950,000
			Aggregate	H	300,000 [b]	310,000 [b]	390,000 [b]	560,000 [b]	130,000	150,000	140,000
		Chronic	–	–	–	–	–	–	–	–	–
Consumer Uses: Other articles with routine direct contact during normal use including rubber articles; plastic articles (hard)	Small articles with potential for semi-routine contact: labels, nitrocellulose; ethylcellulose; chlorinated rubber; PVAc; PVC	Acute [c]	Dermal	H	2,100	2,400	2,800	3,500	4,400	4,900	4,500
			Ingestion	H	–	–	–	–	–	–	–
			Inhalation	H	–	–	–	–	–	–	–
			Aggregate	H	2,100	2,400	2,800	3,500	4,400	4,900	4,500
		Intermed.	–	–	–	–	–	–	–	–	–
		Chronic	Dermal	H	2,100	2,400	2,800	3,500	4,400	4,900	4,500
			Ingestion	H	–	–	–	–	–	–	–
			Inhalation	H	–	–	–	–	–	–	–
			Aggregate	H	2,100	2,400	2,800	3,500	4,400	4,900	4,500

Life Cycle Stage: COU: Subcategory	Product or Article	Duration	Exposure Route	Exposure Scenario (H, M, L) [a]	Lifestage (years) (Benchmark MOE = 30)						
					Infant (<1 year)	Toddler (1–2 years)	Preschooler (3–5 years)	Middle Childhood (6–10 years)	Young Teen (11–15 years)	Teenagers (16–20 years)	Adult (21+ years)
Consumer Uses: Consumer articles that contain dicyclohexyl phthalate from: Inks, toner, and colorants; Paints and coatings; Adhesives and sealants (*e.g.*, paper products, textiles, products using cellulose film, etc.)	Outdoor seating	Acute [c]	Dermal	H	740	870	1,000	1,200	1,600	1,700	1,600
			Ingestion	H	–	–	–	–	–	–	–
			Inhalation	H	–	–	–	–	–	–	–
			Aggregate	H	740	870	1,000	1,200	1,600	1,700	1,600
		Intermed.	–	–	–	–	–	–	–	–	–
		Chronic	Dermal	H	5,200	6,100	7,000	8,700	11,000	12,000	11,000
			Ingestion	H	–	–	–	–	–	–	–
			Inhalation	H	–	–	–	–	–	–	–
			Aggregate	H	5,200	6,100	7,000	8,700	11,000	12,000	11,000
Consumer Uses: Consumer articles that contain dicyclohexyl phthalate from: Inks, toner, and colorants; Paints and coatings; Adhesives and sealants (*e.g.*, paper products, textiles, products using cellulose film, etc.)	Small articles with the potential for semi-routine contact: labels, and packaging adhesives, foil and cellophane lacquers, and printing inks	Acute[c]	Dermal	H	2,100	2,400	2,800	3,500	4,400	4,900	4,500
			Ingestion	H	–	–	–	–	–	–	–
			Inhalation	H	–	–	–	–	–	–	–
			Aggregate	H	2,100	2,400	2,800	3,500	4,400	4,900	4,500
		Intermed.	–	–	–	–	–	–	–	–	–
		Chronic	Dermal	H	2,100	2,400	2,800	3,500	4,400	4,900	4,500
			Ingestion	H	–	–	–	–	–	–	–
			Inhalation	H	–	–	–	–	–	–	–
			Aggregate	H	2,100	2,400	2,800	3,500	4,400	4,900	4,500
Consumer Uses: Consumer articles that contain dicyclohexyl phthalate from: Inks, toner, and colorants; Paints and coatings; Adhesives and sealants (*e.g.*, paper products, textiles, products using cellulose film, etc.)	Electronics containing dye adhesive	Exposures not expected. Identified in dye attach adhesive used in wirebond packaging for semiconductor devices or in automotive cameras. As the adhesive is used in small quantities and contained within the electronic articles, no exposures are expected during potential use of these items									

[a] Exposure scenario intensities include high (H), medium (M), and low (L).
[b] Bystander scenarios
[c] Scaling by the RPF and application of the index chemical POD provides a more sensitive and robust hazard assessment than the DCHP-specific POD, given its more limited toxicological data set. Please see Table 4-23 for the RPF analysis values.

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4.3.4 Risk Estimates for General Population Exposed to DCHP through Environmental Releases

As described in the *Draft Environmental Media, General Population, and Environmental Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024p) and Section 4.1.3, EPA used a screening-level approach for general population exposures for DCHP releases associated with TSCA COUs. Fenceline communities were considered as part of the general population in proximity to releasing facilities as part of the ambient air exposure assessment by utilizing pre-screening methodology described in EPA's *Draft TSCA Screening Level Approach for Assessing Ambient Air and Water Exposures to Fenceline Communities (Version 1.0)* (U.S. EPA, 2022b). For other exposure pathways, the Agency's screening method assessing high-end exposure scenarios used release data that reflect exposures expected to occur in proximity to releasing facilities, which would include fenceline communities.

EPA evaluated surface water, drinking water, fish ingestion, and ambient air pathways quantitatively, in addition to the land pathway (*i.e.*, landfills and application of biosolids) qualitatively. For pathways assessed quantitatively, high-end estimates of DCHP concentration in the various environmental media were used for screening-level purposes. EPA used an MOE approach using high-end exposure estimates to determine whether an exposure pathway had potential non-cancer risks. High-end exposure estimates were defined as those associated with the industrial and commercial releases from a COU and OES that resulted in the highest environmental media concentrations. If there is no risk for an individual identified as having the potential for the highest exposure associated with a COU for a given pathway of exposure, then that pathway was determined to not be a pathway of concern and not pursued further. If any pathways were identified as a pathway of concern for the general population, further exposure assessments for that pathway would be conducted to include higher tiers of modeling when available and exposure estimates developed for additional subpopulations and COUs. Using a screening-level approach described in Section 4.1.3, no *pathways of exposure were identified to be of concern for the general population exposed to environmental releases*.

Land Pathway

DCHP has a low water solubility and high affinity for sorption to particulate and organic media. This indicates that it is unlikely to migrate from land-applied biosolids to groundwater via runoff. DCHP's potential to leach from landfills into nearby groundwater or surface water systems is also limited. Therefore, EPA evaluated general population exposures via the land pathway (*i.e.*, application of biosolids, landfills) qualitatively (Section 4.1.3.1).

Surface Water Pathway

MOEs for general population exposure through incidental ingestion and dermal contact during swimming ranged from 2,171 to 6,310 for scenarios assuming no wastewater treatment and from 5,521 to 20,000 for scenarios assuming 68.6 percent wastewater treatment removal efficiency (Table 4-16). Therefore, *based on a screening-level assessment, risk for non-cancer health effects is not expected for the surface water pathway, and the pathway is not considered to be a pathway of concern for the general population.*

Acute MOEs through drinking water ingestion were 135 and 430 without and with wastewater treatment, respectively, for the lifestage (*i.e.*, infants) with the highest exposure (Table 4-16). *Based on the screening-level analysis, risk for non-cancer health effects is not expected for the drinking water pathway, and the drinking water pathway is not considered to be a pathway of concern for the general population.*

Table 4-16. Summary of the Highest Doses for General Population through Surface and Drinking Water Exposure

OES [a]	Water Column Concen.	Incidental Dermal Surface Water [b]		Incidental Ingestion Surface Water [c]		Drinking Water [d]	
	30Q5 Conc. (µg/L)	ADR_{POT} (mg/kg-day)	Acute MOE (Benchmark MOE = 30)	ADR_{POT} (mg/kg-day)	Acute MOE (Benchmark MOE = 30)	ADR_{POT} (mg/kg-day)	Acute MOE (Benchmark MOE = 30)
PVC plastics compounding *without wastewater treatment*	126	1.1E–03	2,171	6.7E–04	3,559	1.8E–02	135
PVC plastics compounding *with wastewater treatment*	39.6	3.50E–04	6,913	2.1E–04	11,000	5.6E–03	430

N/A = not applicable
[a] Table 3-1 provides a crosswalk of industrial and commercial COUs to OES.
[b] Most exposed age group: Adults (21+ years)
[c] Most exposed age group: Youth (11–15 years)
[d] Most exposed age group: Infant (birth to <1 year)

Fish Ingestion

EPA evaluated potential exposure and subsequent risks to DCHP through fish ingestion for populations and age groups that had the highest fish ingestion rate per kg of body weight—including adults and young toddlers in the general population, adult subsistence fishers, and adult Tribal populations. Risks were estimated for various populations and age groups; however, Table 4-17 show only results for the Tribal populations because it led to the highest exposure.

For the screening-level analysis, EPA started with the water solubility limit as an upper limit of DCHP concentration in surface water for the general population, subsistence fisher, and Tribal populations. Screening-level risk estimates were above the benchmark for the general population based on conservative exposure estimates. Refinements were needed for the subsistence fisher and Tribal populations because screening-level risk estimates using the water solubility limit were below the benchmark (see Section 8 of (U.S. EPA, 2024p)). Refinements included use of estimated water releases by OES, as well as incorporation of various hydrologic flow data for each OES, to model the surface water concentrations. Briefly, hydrologic flow data were categorized into median flow (P50), 75th percentile flow (P75), and 90th percentile flow (P90). EPA expects high-end releases to discharge to surface waters with higher flow conditions (*e.g.*, P75 and P90).

The PVC plastics compounding OES resulted in the highest surface water concentrations. Surface water concentrations calculated based on the median flow rate led to risk estimates below benchmark for only Tribal populations ingesting fish at the heritage rate. Heritage rates are not suppressed by contamination, degradation, or loss of access and existed prior to non-indigenous settlement on Tribal fisheries resources (U.S. EPA, 2016a). As high-end releases are not expected to discharge to water bodies with low flow conditions like P50, EPA incorporated higher flow rates and treatment efficiency into its analysis for Tribal populations. When treatment is considered, risk estimates were above benchmark even at the P50 condition for all scenarios. Lastly, DCHP is expected to have low potential for bioaccumulation, biomagnification, and uptake by aquatic organisms because of its low water solubility and high hydrophobicity as described in Section 4.4. *Therefore, fish ingestion is not a pathway of concern for DCHP for Tribal members, subsistence fishers, or the general population.*

Table 4-17. Fish Ingestion for Adults in Tribal Populations Summary

Calculation Method	Current Mean Ingestion Rate[b] (Benchmark MOE = 30)		Heritage Ingestion Rate[b] (Benchmark MOE = 30)	
	ADR/ADD (mg/kg-day)	Chronic and Acute MOE[a]	ADR/ADD (mg/kg-day)	Chronic and Acute MOE[a]
Water solubility limit (1.48 mg/L)	2.68E–01	9	2.04	1
Modeled SWC for PVC plastics compounding, P50 flow (0.087 mg/L)	1.59E–02	151	1.21E–01	20
Modeled SWC for PVC plastics compounding, P75 flow (3.48E−03 mg/L)	6.30E–04	3,812	4.80E–03	500
Modeled SWC for PVC plastics compounding, P90 flow (2.4E−04 mg/L)	4.40E–05	54,597	3.35E–04	7,163
Modeled SWC for PVC plastics compounding, P50 flow, Treated (2.7E−02 mg/L)	4.97E–03	482	3.79E–02	63
Highest monitored SWC (1.0E−05 mg/L)	2.53E–06	947,643	1.93E–05	124,326

SWC = surface water concentration
[a] The acute and chronic MOEs are identical because the exposure estimates and the POD do not change between acute and chronic.
[b] Current ingestion rate refers to the present-day consumption levels that are suppressed by contamination, degradation, or loss of access. Heritage rates existed prior to non-indigenous settlement on Tribal fishers resources and changes to culture and lifeway.

Ambient Air Pathway

As part of the ambient air exposure assessment, EPA considered exposures to the general population in proximity to releasing facilities, including fenceline communities, by utilizing pre-screening methodology described in EPA's *Draft TSCA Screening Level Approach for Assessing Ambient Air and Water Exposures to Fenceline Communities (Version 1.0)* (U.S. EPA, 2022b). Using the highest modeled 95th percentile air concentration, MOEs for general population exposure through inhalation are 192 for acute and 281 for chronic (Table 4-18) (compared to a benchmark of 30).

Based on risk screening results, risk for non-cancer health effects is not expected for the ambient air pathway; therefore, the ambient air pathway is not considered to be a pathway of concern to DCHP for the general population, including fenceline communities.

Table 4-18. General Population Ambient Air Exposure Summary

OES[a]	Acute (Daily Average)			Chronic (Annual Average)		
	Air Concentration[b] (µg/m^3)	AC (mg/kg-day)	MOE	Air Concentration[b] (µg/m^3)	ADC (mg/kg-day)	MOE
Application of paints and coatings	67.57	67.57	192	46.28	46.28	281

AC = acute concentration; ADC = average daily concentration; MOE = margin of exposure; OES = occupation exposure scenario
[a] Table 1-1 provides a crosswalk of industrial and commercial COUs to OES.
[b] Air concentrations are reported for the high-end (95th percentile) modeled value at 100 m from the emitting facility and stack plus fugitive releases combined.

Urinary Biomonitoring Data – NHANES

CDC stopped collected urinary data for MCHP after 2010. EPA analyzed biomonitoring data from the 1999–2010 NHANES cycle but the low detection rates and limited data variability precluded any meaningful statistical analyses. Furthermore, EPA's systematic review process did not identify any suitable alternative sources of DCHP biomonitoring data. Therefore, EPA did not conduct reverse dosimetry to calculate daily intake values for DCHP (Section 4.1.3.1).

4.3.4.1 Overall Confidence in General Population Screening Level Exposure Assessment

The weight of scientific evidence supporting the general population exposure estimate is decided based on the strengths, limitations, and uncertainties associated with the exposure estimates, which are discussed in detail for ambient air, surface water, drinking water, and fish ingestion in the *Draft Environmental Media, General Population, and Environmental Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024p). EPA summarized its weight of scientific evidence using confidence descriptors: robust, moderate, slight, or indeterminate. EPA used general considerations (*i.e.,* relevance, data quality, representativeness, consistency, variability, uncertainties) as well as chemical-specific considerations for its weight of scientific evidence conclusions.

EPA determined robust confidence in its qualitative assessment of biosolids and landfills. For its quantitative assessment, EPA modeled exposure due to various general population exposure scenarios resulting from different pathways of exposure. Exposure estimates used high-end inputs for the purpose of risk screening. When available, monitoring data was compared to modeled estimates to evaluate overlap, magnitude, and trends. EPA has robust confidence that modeled releases used are appropriately conservative for a screening level analysis. Therefore, EPA has robust confidence that no exposure scenarios will lead to greater doses than presented in this evaluation. Despite slight and moderate confidence in the estimated values themselves, confidence in exposure estimates capturing high-end exposure scenarios was robust given that many of the modeled values exceeded those of monitored values.

4.3.5 Risk Estimates for Potentially Exposed or Susceptible Subpopulations

EPA considered PESS throughout the exposure assessment and throughout the hazard identification and dose-response analysis supporting the draft DCHP risk evaluation.

Some population group lifestages may be more susceptible to the health effects of DCHP exposure. As discussed in Section 4.2 and in EPA's *Draft Non-cancer Human Health Hazard Assessment for Dicyclohexyl Phthalate* (U.S. EPA, 2024v) and *Draft Technical Support Document for the Cumulative Risk Analysis of DEHP, DBP, BBP, DIBP, DCHP, and DINP Under TSCA* (U.S. EPA, 2024ah), exposure to DCHP causes adverse effects on the developing male reproductive system consistent with a disruption of androgen action and phthalate syndrome in experimental animal models. Therefore, women of reproductive age, pregnant women, male infants, male children, and male adolescents are considered to be susceptible subpopulations. These susceptible lifestages were considered throughout the draft risk evaluation. For example, women of reproductive age were evaluated for occupational exposures to DCHP for each COU (Section 4.3.2). Additionally, infants (<1 year), toddlers (1–2 years), preschoolers (3–5 years), middle school children (6–10 years), young teens (11–15 years), and teenagers (16–20 years) were evaluated for exposure to DCHP through consumer products and articles (Section 4.3.3). EPA also considered cumulative phthalate exposure and risk for female workers of reproductive age, as well as male children and female consumers of reproductive age. Additionally, the Agency used a value of 10 for the UF_H to account for human variability. The Risk Assessment Forum, in *A Review of the Reference Dose and Reference Concentration Processes*, discusses some of the evidence for

choosing the default factor of 10 when data are lacking—including toxicokinetic and toxicodynamic factors as well as greater susceptibility of children and elderly populations (U.S. EPA, 2002b).

The available data suggest that some groups or lifestages have greater exposure to DCHP. This includes people exposed to DCHP at work, those who frequently use consumer products and/or articles containing high concentrations of DCHP, those who may have greater intake of DCHP per body weight (*e.g.*, infants, children, adolescents) leading to greater exposure. EPA accounted for these populations with greater exposure in the draft DCHP risk evaluation as follows:

- EPA evaluated a range of OESs for workers and ONUs, including high-end exposure scenarios for women of reproductive age (a susceptible subpopulation) and average adult workers.
- EPA evaluated a range of consumer exposure scenarios, including high-intensity exposure scenarios for infants and children (susceptible subpopulations). These populations had greater intake per body weight.
- EPA evaluated a range of general population exposure scenarios, including high-end exposure scenarios for infants and children (susceptible subpopulations). These populations had greater intake per body weight.
- EPA evaluated exposure to DCHP through fish ingestion for subsistence fishers and Tribal populations.
- EPA aggregated occupational inhalation and dermal exposures for each COU for women of reproductive age (a susceptible subpopulation) and average adult workers.
- EPA aggregated consumer inhalation, dermal, and oral exposures for each COU for infants and children (susceptible subpopulations).
- EPA evaluated cumulative exposure to DEHP, DBP, BBP, DIBP, and DINP for the U.S. civilian population using NHANES urinary biomonitoring data and reverse dosimetry for women of reproductive age (16–49 years) and male children (3–5, 6–11, and 12–15 years of age).
- For women of reproductive age, black non-Hispanic women had higher, albeit not statistically significantly higher, 95th percentile cumulative exposures to DEHP, DBP, BBP, DIBP, and DINP compared to women of other races (*e.g.*, white non-Hispanic, Mexican America). The 95th percentile cumulative exposure estimate for black non-Hispanic women served as the non-attributable national cumulative exposure estimate used by EPA to evaluate cumulative risk to workers and consumers.

4.4 Human Health Cumulative Risk Assessment and Characterization

EPA developed a *Draft Technical Support Document for the Cumulative Risk Analysis of DEHP, DBP, BBP, DIBP, DCHP, and DINP Under TSCA* (U.S. EPA, 2024ah) (draft CRA TSD) for the CRA of six toxicologically similar phthalates being evaluated under Section 6 of the Toxic Substances Control Act (TSCA): di(2-ethylhexyl) phthalate (DEHP), butyl benzyl phthalate (BBP), dibutyl phthalate (DBP), dicyclohexyl phthalate (DCHP), diisobutyl phthalate (DIBP), and diisononyl phthalate (DINP). EPA previously issued a *Draft Proposed Approach for Cumulative Risk Assessment of High-Priority Phthalates and a Manufacturer-Requested Phthalate under the Toxic Substances Control Act* (draft 2023 approach), which outlined an approach for this assessment (U.S. EPA, 2023c). EPA's proposal was subsequently peer-reviewed by the Science Advisory Committee on Chemicals (SACC) in May 2023 (U.S. EPA, 2023f). In the 2023 draft approach, EPA identified a cumulative chemical group and PESS [15 U.S.C. section 2605(b)(4)]. Based on toxicological similarity and induced effects on the developing male reproductive system consistent with a disruption of androgen action and phthalate syndrome, EPA proposed a cumulative chemical group of DEHP, BBP, DBP, DCHP, DIBP, and DINP, but not diisodecyl phthalate (DIDP). This approach emphasizes a uniform measure of hazard for sensitive subpopulations, namely women of reproductive age and/or male infants and children, however

additional health endpoints are known for broader populations and described in the individual non-cancer human health hazard assessments for DEHP (U.S. EPA, 2024w), DBP (U.S. EPA, 2024u), DIBP (U.S. EPA, 2024x), BBP (U.S. EPA, 2024t), DCHP (U.S. EPA, 2024v), and DINP (U.S. EPA, 2025b), including hepatic, kidney, and other developmental and reproductive toxicity.

EPA's approach for assessing cumulative risk is described in detail in the draft CRA TSD (U.S. EPA, 2024ah) and incorporates feedback from the SACC (U.S. EPA, 2023f) on EPA's 2023 draft proposal (U.S. EPA, 2023c). EPA is focusing its CRA on acute duration exposures of women of reproductive age, male infants, and male children to six toxicologically similar phthalates (*i.e.*, DEHP, DBP, BBP, DIBP, DCHP, DINP) that induce effects on the developing male reproductive system consistent with a disruption of androgen action and phthalate syndrome. The Agency is further focusing its CRA on acute duration exposures because there is evidence that effects on the developing male reproductive system consistent with a disruption of androgen action can result from a single exposure during the critical window of development (see Section 1.5 of (U.S. EPA, 2024ah) for further details). To evaluate cumulative risk, EPA is using a relative potency factor (RPF) approach. RPFs for DEHP, DBP, BBP, DIBP, DCHP, and DINP were developed using a meta-analysis and benchmark dose (BMD) modeling approach based on a uniform measure (*i.e.*, reduced fetal testicular testosterone). EPA is also using NHANES data to supplement, not substitute, evaluations for exposure scenarios for TSCA COUs to provide non-attributable, total exposure for addition to the relevant scenarios presented in the individual risk evaluations.

The analogy of a "risk cup" is used throughout this document to describe cumulative exposure estimates. The risk cup term is used to help conceptualize the contribution of various phthalate exposure routes and pathways to overall cumulative risk estimates and serves primarily as a communication tool. The term/ concept describes exposure estimates where the full cup represents the total exposure that leads to risk (cumulative MOE) and each chemical contributes a specific amount of exposure that adds a finite amount of risk to the cup. A full risk cup indicates that the cumulative MOE has dropped below the benchmark MOE (*i.e.*, total UF), whereas cumulative MOEs above the benchmark indicate that only a percentage of the risk cup is full.

The remainder of the human health CRA is organized as follows:

- Section 4.4.1 – Describes the approach used by EPA to derive draft relative potency factors for DEHP, DBP, BBP, DIBP, DCHP, and DINP based on reduced fetal testicular testosterone, which are used by EPA as part of the current CRA and to assess exposures to individual phthalates by scaling to an index chemical (RPF analysis). Section 2 of EPA's draft CRA TSD (U.S. EPA, 2024ah) provides more details.
- Section 4.4.2 – Briefly describes the approach used by EPA to calculate cumulative non-attributable phthalate exposure for the U.S. population using NHANES urinary biomonitoring and reverse dosimetry. Section 4 of EPA's draft CRA TSD (U.S. EPA, 2024ah) provides additional details.
- Section 4.4.3 – Describes how EPA combined exposures to DCHP from individual consumer and occupational COUs/OES with cumulative non-attributable phthalate exposures from NHANES to estimate cumulative risk. An empirical example is also provided. Section 5 of EPA's draft CRA TSD (U.S. EPA, 2024ah) provides additional details.

For additional details regarding EPA's draft CRA, readers are directed to the following TSDs:

- *Draft Technical Support Document for the Cumulative Risk Analysis of Di(2-ethylhexyl) Phthalate (DEHP), Dibutyl Phthalate (DBP), Butyl Benzyl Phthalate (BBP), Diisobutyl*

Phthalate (DIBP), Dicyclohexyl Phthalate (DCHP), and Diisononyl Phthalate (DINP) Under the Toxic Substances Control Act (TSCA) (U.S. EPA, 2024ah);

- *Draft Meta-Analysis and Benchmark Dose Modeling of Fetal Testicular Testosterone for Di(2-ethylhexyl) Phthalate (DEHP), Dibutyl Phthalate (DBP), Butyl Benzyl Phthalate (BBP), Diisobutyl Phthalate (DIBP), and Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024s);
- *Draft Proposed Approach for Cumulative Risk Assessment of High-Priority Phthalates and a Manufacturer-Requested Phthalate under the Toxic Substances Control Act* (U.S. EPA, 2023c);
- *Draft Proposed Principles of Cumulative Risk Assessment under the Toxic Substances Control Act* (U.S. EPA, 2023d); and
- *Science Advisory Committee on Chemicals meeting minutes and final report, No. 2023-01 - A set of scientific issues being considered by the Environmental Protection Agency regarding: Draft Proposed Principles of Cumulative Risk Assessment (CRA) under the Toxic Substances Control Act and a Draft Proposed Approach for CRA of High-Priority Phthalates and a Manufacturer-Requested Phthalate* (U.S. EPA, 2023f).

4.4.1 Hazard Relative Potency

This section briefly summarizes the RPF approach used by EPA to evaluate phthalates for cumulative risk. Section 4.4.1.1 provides a brief overview and background for the RPF approach methodology, while Section 4.4.1.2 provides a brief overview of the draft RPFs derived by EPA for DEHP, DBP, BBP, DIBP, DCHP, and DINP based on decreased fetal testicular testosterone. Further details regarding the draft relative potency analysis conducted by EPA are provided in the following two TSDs:

- *Draft Technical Support Document for the Cumulative Risk Analysis of Di(2-ethylhexyl) Phthalate (DEHP), Dibutyl Phthalate (DBP), Butyl Benzyl Phthalate (BBP), Diisobutyl Phthalate (DIBP), Dicyclohexyl Phthalate (DCHP), and Diisononyl Phthalate (DINP) Under the Toxic Substances Control Act (TSCA)* (U.S. EPA, 2024ah); and
- *Draft Meta-Analysis and Benchmark Dose Modeling of Fetal Testicular Testosterone for Di(2-ethylhexyl) Phthalate (DEHP), Dibutyl Phthalate (DBP), Butyl Benzyl Phthalate (BBP), Diisobutyl Phthalate (DIBP), and Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024s).

4.4.1.1 Relative Potency Factor Approach Overview

For the RPF approach, chemicals being evaluated require data that support toxicologic similarity (*e.g.*, components of a mixture share a known or suspected common MOA or share a common apical endpoint/effect) and have dose-response data for the effect of concern over similar exposure ranges (U.S. EPA, 2023a, 2000, 1986). RPF values account for potency differences among chemicals in a mixture and scale the dose of one chemical to an equitoxic dose of another chemical (*i.e.*, the index chemical). The chemical selected as the index chemical is often among the best characterized toxicologically and considered to be representative of the type of toxicity elicited by other components of the mixture. Implementing an RPF approach requires a quantitative dose-response assessment for the index chemical and pertinent data that allow the potency of the mixture components to be meaningfully compared to that of the index chemical. In the RPF approach, RPFs are calculated as the ratio of the potency of the individual component to that of the index chemical using either (1) the response at a fixed dose, or (2) the dose at a fixed response (Equation 4-3).

Equation 4-3. Calculating RPFs

$$RPF_i = \frac{BMD_{R-IC}}{BMD_{R-i}}$$

Where:

BMD	=	Benchmark dose (mg/kg/day)
R	=	Magnitude of response (*i.e.*, benchmark response)
I	=	i^{th} chemical
IC	=	Index chemical

After scaling the chemical component doses to the potency of the index chemical, the scaled doses are summed and expressed as index chemical equivalents for the mixture (Equation 4-4).

Equation 4-4. Calculating Index Chemical Equivalents

$$Index\ Chemical\ Equivalents_{MIX} = \sum_{i=1}^{n} d_i \times RPF_i$$

Where:

Index chemical equivalents	=	Dose of the mixture in index chemical equivalents (mg/kg/day)
d_i	=	Dose of the i^{th} chemical in the mixture (mg/kg/day)
RPF_i	=	Relative potency factor of the i^{th} chemical in the mixture (unitless)

Non-cancer risk associated with exposure to an individual chemical or the mixture can then be assessed by calculating an MOE, which in this case is the ratio of the index chemical's non-cancer hazard value (*e.g.*, the BMDL) to an estimate of exposure expressed in terms of index chemical equivalents. The MOE is then compared to the benchmark MOE (*i.e.*, the total uncertainty factor associated with the assessment) to characterize risk.

4.4.1.2 Relative Potency Factors

Derivation of Draft RPFs

To derive RPFs for DEHP, DBP, BBP, DIBP, DCHP, and DINP, EPA utilized a meta-analysis and BMD modeling approach similar to that used by NASEM (2017) to model decreased fetal testicular testosterone. As described further in EPA's *Draft Meta-Analysis and Benchmark Dose Modeling of Fetal Testicular Testosterone for DEHP, DBP, BBP, DIBP, and DCHP* (U.S. EPA, 2024s), the Agency evaluated benchmark responses (BMRs) of 5, 10, and 40 percent. For input into the CRA of phthalates, EPA has derived draft RPFs using BMD_{40} estimates (Table 4-19). For further details regarding RPFs derivation, see Section 2 of EPA's *Draft Technical Support Document for the Cumulative Risk Analysis of DEHP, DBP, BBP, DIBP, DCHP, and DINP Under TSCA* (U.S. EPA, 2024ah).

Selection of the Index Chemical

Of the six phthalates being evaluated for cumulative risk under TSCA (*i.e.*, DEHP, DBP, BBP, DIBP, DCHP, and DINP), *EPA has preliminarily selected DBP as the index chemical.*

As described further in Section 2 of EPA's *Draft Technical Support Document for the Cumulative Risk Analysis of DEHP, DBP, BBP, DIBP, DCHP, and DINP under TSCA* (U.S. EPA, 2024ah), EPA selected DBP as the index chemical DBP has a high-quality toxicological database of studies demonstrating effects on the developing male reproductive system consistent with a disruption of androgen action and phthalate syndrome. Furthermore, studies of DBP demonstrate toxicity representative of all phthalates in the cumulative chemical group and DBP is well characterized for the MOA associated with phthalate syndrome. Finally, compared to other phthalates, including well-studied phthalates such as DEHP, DBP

has the most dose-response data available in the low-end range of the dose-response curve where the BMD_5 and $BMDL_5$ are derived, which provides a robust and scientifically sound foundation of BMD and BMDL estimates on which the RPF approach is based.

Table 4-19. Draft Relative Potency Factors Based on Decreased Fetal Testicular Testosterone

Phthalate	BMD_{40} (mg/kg-day)	RPF Based on BMD_{40}
DBP (Index chemical)	149	**1**
DEHP	178	**0.84**
DIBP	279	**0.53**
BBP	284	**0.52**
DCHP	90	**1.66**
DINP	699	**0.21**

Index Chemical POD

As with any risk assessment that relies on BMD analysis, the POD is the lower confidence limit used to mark the beginning of extrapolation to determine risk associated with human exposures. As described further in the non-cancer human health hazards of DEHP (U.S. EPA, 2024w), DBP (U.S. EPA, 2024u), BBP (U.S. EPA, 2024t), DIBP (U.S. EPA, 2024x), DCHP (U.S. EPA, 2024v), and DINP (U.S. EPA, 2025b) (see Appendices titled "Considerations for Benchmark Response (BMR) Selection for Reduced Fetal Testicular Testosterone" in each hazard assessment), EPA has reached the conclusion that a BMR of 5 percent is the most appropriate and health protective response level for evaluating decreased fetal testicular testosterone. For the index chemical, DBP, the $BMDL_5$ for the best fitting linear-quadratic model is 9 mg/kg-day for reduced fetal testicular. Using allometric body weight scaling to the three-quarters power (U.S. EPA, 2011c), *EPA extrapolated an HED of 2.1 mg/kg-day to use as the POD for the index chemical in the CRA.*

Selection of the Benchmark MOE

Consistent with Agency guidance (U.S. EPA, 2022c, 2002b), EPA selected an intraspecies uncertainty factor (UF_H) of 10, which accounts for variation in susceptibility across the human population and the possibility that the available data might not be representative of individuals who are most susceptible to the effect. EPA used allometric body weight scaling to the three-quarters power to derive an HED of 2.1 mg/kg-day DBP, which accounts for species differences in toxicokinetics. Consistent with EPA Guidance (U.S. EPA, 2011c), the interspecies uncertainty factor (UF_A), was reduced from 10 to 3 to account remaining uncertainty associated with interspecies differences in toxicodynamics. *Overall, a total uncertainty factor of 30 was selected for use as the benchmark margin of exposure for the CRA* (based on a interspecies uncertainty factor [UF_A] of 3 and a intraspecies uncertainty factor [UF_H] of 10).

Weight of Scientific Evidence

EPA has preliminary selected an HED of 2.1 mg/kg-day ($BMDL_5$ of 9 mg/kg-day) as the index chemical (DBP) POD. This POD is based on a meta-analysis and BMD modeling of decreased fetal testicular testosterone from eight studies of rats gestationally exposed to DBP. The Agency EPA has also derived draft RPFs of 1, 0.84, 0.53, 0.52, 1.66, and 0.21 for DBP (index chemical), DEHP, DIBP, BBP, DCHP, and DINP, respectively, based on a common toxicological outcome (*i.e.*, reduced fetal testicular testosterone). EPA has *robust overall confidence in the proposed POD for the index chemical (i.e., DBP) and the derived draft RPFs.*

Application of RPF provides a more robust basis for assessing the dose-response to the common hazard endpoint across all assessed phthalates. For DCHP and a subset of the phthalates with a more limited toxicological data set, scaling by the RPF and application of the index chemical POD provides a more sensitive and robust hazard assessment than the chemical-specific POD. Readers are directed to the *Draft Technical Support Document for the Cumulative Risk Analysis of DEHP, DBP, BBP, DIBP, DCHP, and DINP Under TSCA* (U.S. EPA, 2024ah) for a discussion of the weight of evidence supporting EPA's preliminary conclusions.

4.4.2 Cumulative Phthalate Exposure: Non-attributable Cumulative Exposure to DEHP, DBP, BBP, DIBP, and DINP Using NHANES Urinary Biomonitoring and Reverse Dosimetry

This section briefly summarizes EPA's approach and results for estimating non-attributable cumulative exposure to phthalates using NHANES urinary biomonitoring data and reverse dosimetry. Readers are directed to Section 4 of EPA's *Draft Technical Support Document for the Cumulative Risk Analysis of DEHP, DBP, BBP, DIBP, DCHP, and DINP Under TSCA* (U.S. EPA, 2024ah) for additional details.

NHANES is an ongoing exposure assessment of the U.S. population's exposure to environmental chemicals using biomonitoring. The NHANES biomonitoring data set is a national, statistical representation of the general, non-institutionalized, civilian U.S. population. CDC's NHANES data set provides an estimate of average aggregate exposure to individual phthalates for the U.S. population. However, exposures measured via NHANES cannot be attributed to specific sources, such as TSCA COUs or other sources. Given the short half-lives of phthalates, neither can NHANES capture acute, low frequency exposures. Instead, as concluded by the SACC review of the draft 2023 approach, NHANES provides a "snapshot" or estimate of total, non-attributable phthalate exposure for the U.S. population and relevant subpopulations (U.S. EPA, 2023f). These estimates of total non-attributable exposure can supplement assessments of scenario-specific acute risk in individual risk evaluations.
Monoester metabolites of BBP, DBP, DEHP, DIBP, and DINP in human urine are regularly measured as part of the NHANES biomonitoring program and are generally detectable in human urine at a high frequency, including during the most recent NHANES survey period (*i.e.*, 2017–2018). One urinary metabolite (*i.e.*, monocyclohexyl phthalate [MCHP]) of DCHP was included in NHANES from 1999 through 2010, but was excluded from NHANES after 2010 due to low detection levels and a low frequency of detection in human urine (detected in <10% of samples in 2009–2010 NHANES survey) (CDC, 2013).Therefore, EPA did not use NHANES urinary biomonitoring data to estimate a daily aggregate intake value for DCHP through reverse dosimetry.

EPA used urinary phthalate metabolite concentrations for DEHP, DBP, BBP, DIBP, and DINP measured in the most recently available NHANES survey (2017–2018) to estimate the average daily aggregate intake of each phthalate through reverse dosimetry for

- Women of reproductive age (16–49 years);
- Male children (4 to <6 years, used as a proxy for male infants and toddlers);
- Male children (6–11 years); and
- Male children (12 to <16 years).

Since NHANES does not include urinary biomonitoring for infants or toddlers, and other national data sets are not available, EPA used biomonitoring data from male children 3 to less than 6 years of age as a proxy for male infants (<1 year) and male toddlers (1–2 years). See Section 4 of (U.S. EPA, 2024ah) for further details regarding the reverse dosimetry approach. Aggregate daily intake estimates for these

populations are presented in Table 4-20.[4] Aggregate daily intake values were also calculated for women of reproductive age stratified by race and socioeconomic status (Table 4-21). A similar analysis by race was not done for male children because the NHANES sample size is smaller for this population.

Aggregate daily intake values for each phthalate were then scaled by relative potency using the RPFs in Table 4-19, expressed in terms of index chemical (DBP) equivalents, and summed to estimate cumulative daily intake in terms of index chemical (DBP) equivalents using the approach outlined in Sections 4.4.1 and 4.4.3.

Since EPA is focusing its CRA on acute exposure durations, EPA selected 95th percentile exposure estimates from NHANES to serve as the non-attributable nationally representative exposure estimate for use in its CRA. For women of reproductive age, EPA's analysis indicates that black, non-Hispanic women have slightly higher 95th percentile cumulative phthalate exposure compared to other racial groups; thus, 95th percentile cumulative exposure estimates for black non-Hispanic women of reproductive age was selected for use in the CRA of DCHP (Table 4-20).

The 95th percentile of national cumulative exposure serves as the estimate of non-attributable phthalate exposure for its CRA of DCHP as follows:

- Women of reproductive age (16–49 years, black Non-Hispanic): 5.16 µg/kg-day index chemical (DBP) equivalents. This serves as the non-attributable contribution to worker and consumer women of reproductive age in Section 4.4.4 and Section 4.4.5.
- Males (3–5 years): 10.8 µg/kg-day index chemical (DBP) equivalents. This serves as the non-attributable contribution to consumer male infants (<1 year), toddlers (1–2 years), and preschoolers (3–5 years) in Section 4.4.5. Since NHANES does not include urinary biomonitoring for infants (<1 year) or toddlers (1–2 years), and other national data sets are not available, EPA used biomonitoring data from male children (3 to <6 years) as a proxy for male infants and toddlers.
- Males (6–11 years): 7.35 µg/kg-day index chemical (DBP) equivalents This serves as the non-attributable contribution to consumer male children (6–10 years) in Section 4.4.5.
- Males (12–15 years): 4.36 µg/kg-day index chemical (DBP) equivalents. This serves as the non-attributable contribution to consumer male teenagers (11–15 years) in Section 4.4.5.

4.4.2.1.1 Weight of Scientific Evidence: Non-attributable Cumulative Exposure to Phthalates

Overall, EPA has robust confidence in the derived estimates of non-attributable cumulative exposure from NHANES urinary biomonitoring using reverse dosimetry. The Agency EPA used urinary biomonitoring data from the CDC's national NHANES dataset, which provides a statistical representation of the general, non-institutionalized, civilian U.S. population. To estimate daily intake values from urinary biomonitoring for each phthalate, EPA used reverse dosimetry. The reverse dosimetry approach used by EPA has been used extensively in the literature and has been used by CPSC (2014) and Health Canada (ECCC/HC, 2020) to estimate phthalate daily intake values from urinary biomonitoring data. However, given the short half-lives of phthalates, NHANES biomonitoring data is not expected to capture low frequency exposures and may be an underestimate of acute phthalate exposure.

[4] EPA defines *aggregate exposure* as the "combined exposures to an individual from a single chemical substance across multiple routes and across multiple pathways" (40 CFR section 702.33).

Table 4-20. Cumulative Phthalate Daily Intake (µg/kg-day) Estimates for Women of Reproductive Age, Male Children, and Male Teenagers from the 2017–2018 NHANES Cycle

Population	Percentile	Phthalate	Aggregate Daily Intake (µg/kg-day)	RPF	Aggregate Daily Intake in DBP Equivalents (µg/kg-day)	% Contribution to Cumulative Exposure	Cumulative Daily Intake (DBP Equivalents, µg/kg-day)	Cumulative MOE (POD = 2,100 µg/kg-day)	% Contribution to Risk Cup (Benchmark = 30)[a]
Females (16–49 years; n = 1,620)	50	DBP	0.21	1	0.210	22.1	0.950	2,211	1.4%
		DEHP	0.53	0.84	0.445	46.9			
		BBP	0.08	0.52	0.042	4.38			
		DIBP	0.2	0.53	0.106	11.2			
		DINP	0.7	0.21	0.147	15.5			
	95	DBP	0.61	1	0.610	17.2	3.55	592	5.1%
		DEHP	1.48	0.84	1.24	35.0			
		BBP	0.42	0.52	0.218	6.15			
		DIBP	0.57	0.53	0.302	8.51			
		DINP	5.6	0.21	1.18	33.1			
Males (3–5 years; n = 267)	50	DBP	0.56	1	0.560	18.4	3.04	690	4.3%
		DEHP	2.11	0.84	1.77	58.2			
		BBP	0.22	0.52	0.114	3.76			
		DIBP	0.57	0.53	0.302	9.93			
		DINP	1.4	0.21	0.294	9.66			
	95	DBP	2.02	1	2.02	18.6	10.8	194	15.5%
		DEHP	6.44	0.84	5.41	49.9			
		BBP	2.46	0.52	1.28	11.8			
		DIBP	2.12	0.53	1.12	10.4			
		DINP	4.8	0.21	1.01	9.30			

Population	Percentile	Phthalate	Aggregate Daily Intake (µg/kg-day)	RPF	Aggregate Daily Intake in DBP Equivalents (µg/kg-day)	% Contribution to Cumulative Exposure	Cumulative Daily Intake (DBP Equivalents, µg/kg-day)	Cumulative MOE (POD = 2,100 µg/kg-day)	% Contribution to Risk Cup (Benchmark = 30)[a]
Males (6–11 years; n = 553)	50	DBP	0.38	1	0.380	20.1	1.89	1,111	2.7%
		DEHP	1.24	0.84	1.04	55.1			
		BBP	0.16	0.52	0.083	4.40			
		DIBP	0.33	0.53	0.175	9.26			
		DINP	1	0.21	0.210	11.1			
	95	DBP	1.41	1	1.41	19.2	7.35	286	10.5%
		DEHP	4.68	0.84	3.93	53.5			
		BBP	0.84	0.52	0.437	5.94			
		DIBP	1.62	0.53	0.859	11.7			
		DINP	3.4	0.21	0.714	9.71			
Males (12–15 years; n = 308)	50	DBP	0.33	1	0.330	27.6	1.19	1,758	1.7%
		DEHP	0.66	0.84	0.554	46.4			
		BBP	0.14	0.52	0.073	6.09			
		DIBP	0.21	0.53	0.111	9.32			
		DINP	0.6	0.21	0.126	10.5			
	95	DBP	0.62	1	0.620	14.2	4.36	482	6.2%
		DEHP	2.51	0.84	2.11	48.3			
		BBP	0.64	0.52	0.333	7.63			
		DIBP	0.59	0.53	0.313	7.17			
		DINP	4.7	0.21	0.987	22.6			

[a] A cumulative exposure of 70 µg DBP equivalents/kg-day would result in a cumulative MOE of 30 (*i.e.*, 2,100 µg DBP-equivalents/kg-day ÷ 70 µg DBP equivalents/kg-day = 30), which is equivalent to the benchmark of 30, indicating that the exposure is at the threshold for risk. Therefore, to estimate the percent contribution to the risk cup, the cumulative exposure expressed in DBP equivalents is divided by 70 µg DBP equivalents/kg-day to estimate percent contribution to the risk cup.

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Table 4-21. Cumulative Phthalate Daily Intake (µg/kg-day) Estimates for Women of Reproductive Age (16–49 years old) by Race and Socioeconomic Status from the 2017–2018 NHANES Cycle

Race/ Socioeconomic Status (SES)	Percentile	Phthalate	Aggregate Daily Intake (µg/kg-day)	RPF	Aggregate Daily Intake in DBP Equivalents (µg/kg-day)	% Contribution to Cumulative Exposure	Cumulative Daily Intake (DBP Equivalents, µg/kg-day)	Cumulative MOE (POD = 2,100 µg/kg-day)	% Contribution to Risk Cup (Benchmark = 30) [a]
Race: white non-Hispanic (n = 494)	50	DBP	0.22	1	0.22	21.6	1.02	2,058	1.5%
		DEHP	0.59	0.84	0.50	48.6			
		BBP	0.10	0.52	0.05	5.1			
		DIBP	0.20	0.53	0.11	10.4			
		DINP	0.70	0.21	0.15	14.4			
	95	DBP	0.58	1	0.58	17.6	3.30	636	4.7%
		DEHP	1.44	0.84	1.21	36.6			
		BBP	0.29	0.52	0.15	4.6			
		DIBP	0.55	0.53	0.29	8.8			
		DINP	5.10	0.21	1.07	32.4			
Race: black non-Hispanic (n = 371)	50	DBP	0.10	1	0.10	15.0	0.667	3,151	1.0%
		DEHP	0.38	0.84	0.32	47.9			
		BBP	0.04	0.52	0.02	3.1			
		DIBP	0.15	0.53	0.08	11.9			
		DINP	0.70	0.21	0.15	22.1			
	95	DBP	0.48	1	0.48	9.3	5.16	407	7.4%
		DEHP	4.28	0.84	3.60	69.7			
		BBP	0.30	0.52	0.16	3.0			
		DIBP	0.40	0.53	0.21	4.1			
		DINP	3.40	0.21	0.71	13.8			

Race/ Socioeconomic Status (SES)	Percentile	Phthalate	Aggregate Daily Intake (µg/kg-day)	RPF	Aggregate Daily Intake in DBP Equivalents (µg/kg-day)	% Contribution to Cumulative Exposure	Cumulative Daily Intake (DBP Equivalents, µg/kg-day)	Cumulative MOE (POD = 2,100 µg/kg-day)	% Contribution to Risk Cup (Benchmark = 30) [a]
Race: Mexican American (n = 259)	50	DBP	0.19	1	0.19	22.4	0.849	2,474	1.2%
		DEHP	0.49	0.84	0.41	48.5			
		BBP	0.06	0.52	0.03	3.7			
		DIBP	0.17	0.53	0.09	10.6			
		DINP	0.60	0.21	0.13	14.8			
	95	DBP	0.42	1	0.42	11.6	3.61	582	5.2%
		DEHP	1.24	0.84	1.04	28.9			
		BBP	0.39	0.52	0.20	5.6			
		DIBP	0.46	0.53	0.24	6.8			
		DINP	8.10	0.21	1.70	47.1			
Race: Other (n = 496)	50	DBP	0.26	1	0.26	25.3	1.03	2041	1.5%
		DEHP	0.64	0.84	0.54	52.2			
		BBP	0.07	0.52	0.04	3.5			
		DIBP	0.15	0.46	0.07	6.7			
		DINP	0.60	0.21	0.13	12.2			
	95	DBP	0.84	1	0.84	20.7	4.06	517	5.8%
		DEHP	1.37	0.84	1.15	28.3			
		BBP	0.41	0.52	0.21	5.2			
		DIBP	0.46	0.53	0.24	6.0			
		DINP	7.70	0.21	1.62	39.8			

Race/ Socioeconomic Status (SES)	Percentile	Phthalate	Aggregate Daily Intake (µg/kg-day)	RPF	Aggregate Daily Intake in DBP Equivalents (µg/kg-day)	% Contribution to Cumulative Exposure	Cumulative Daily Intake (DBP Equivalents, µg/kg-day)	Cumulative MOE (POD = 2,100 µg/kg-day)	% Contribution to Risk Cup (Benchmark = 30) [a]
SES: Below poverty level (n = 1,056)	50	DBP	0.21	1	0.21	22.0	0.955	2,199	1.4%
		DEHP	0.53	0.84	0.45	46.6			
		BBP	0.09	0.52	0.05	4.9			
		DIBP	0.20	0.53	0.11	11.1			
		DINP	0.70	0.21	0.15	15.4			
	95	DBP	0.82	1	0.82	18.2	4.50	467	6.4%
		DEHP	1.75	0.84	1.47	32.7			
		BBP	0.34	0.52	0.18	3.9			
		DIBP	0.51	0.53	0.27	6.0			
		DINP	8.40	0.21	1.76	39.2			
SES: At or above poverty level (n = 354)	50	DBP	0.20	1.00	0.20	27.9	0.718	2,924	1.0%
		DEHP	0.31	0.84	0.26	36.3			
		BBP	0.06	0.52	0.03	4.3			
		DIBP	0.15	0.53	0.08	11.1			
		DINP	0.70	0.21	0.15	20.5			
	95	DBP	0.48	1.00	0.48	16.3	2.94	713	4.2%
		DEHP	1.07	0.84	0.90	30.5			
		BBP	0.45	0.52	0.23	7.9			
		DIBP	0.65	0.53	0.34	11.7			
		DINP	4.70	0.21	0.99	33.5			

Race/ Socioeconomic Status (SES)	Percentile	Phthalate	Aggregate Daily Intake (µg/kg-day)	RPF	Aggregate Daily Intake in DBP Equivalents (µg/kg-day)	% Contribution to Cumulative Exposure	Cumulative Daily Intake (DBP Equivalents, µg/kg-day)	Cumulative MOE (POD = 2,100 µg/kg-day)	% Contribution to Risk Cup (Benchmark = 30) [a]
SES: Unknown (n = 210)	50	DBP	0.26	1.00	0.26	23.2	1.12	1,870	1.6%
		DEHP	0.67	0.84	0.56	50.1			
		BBP	0.06	0.52	0.03	2.8			
		DIBP	0.23	0.53	0.12	10.9			
		DINP	0.70	0.21	0.15	13.1			
	95	DBP	0.60	1.00	0.60	25.5	2.35	893	3.4%
		DEHP	0.86	0.84	0.72	30.7			
		BBP	0.21	0.52	0.11	4.6			
		DIBP	0.35	0.53	0.19	7.9			
		DINP	3.50	0.21	0.74	31.2			

[a] A cumulative exposure of 70 µg DBP equivalents/kg-day would result in a cumulative MOE of 30 (*i.e.*, 2,100 µg DBP-equivalents/kg-day ÷ 70 µg DBP equivalents/kg-day = 30), which is equivalent to the benchmark of 30, indicating that the exposure is at the threshold for risk. Therefore, to estimate the percent contribution to the risk cup, the cumulative exposure expressed in DBP equivalents is divided by 70 µg DBP equivalents/kg-day to estimate percent contribution to the risk cup.

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4.4.3 Estimation of Risk Based on Relative Potency

As described in the *Draft Technical Support Document for the Cumulative Risk Analysis of DEHP, DBP, BBP, DIBP, DCHP, and DINP under TSCA* (U.S. EPA, 2024ah), EPA is focusing its exposure assessment for the CRA for DCHP on evaluation of exposures through individual TSCA consumer and occupational DCHP COUs as well as non-attributable cumulative exposure to DEHP, DBP, BBP, DIBP, and DINP using NHANES urinary biomonitoring data and reverse dosimetry. To estimate cumulative risk, EPA first scaled all phthalate exposures by relative potency using the RPFs presented in Table 4-19 to express phthalate exposure in terms of index chemical (DBP) equivalents. Exposures from individual DCHP consumer or worker COUs/OES were then combined to estimate cumulative risk. Cumulative risk was estimated using the four-step process outlined below, along with one empirical example of how EPA calculated cumulative risk for one occupational OES for DCHP (*i.e.,* Application of paints and coatings [solids]).

Step 1: Convert DCHP Exposure Estimates from Each Individual Consumer and Occupational COU to Index Chemical Equivalents (i.e., Occupational and Consumer Exposure from Sections 4.1.1 and 4.1.2, Respectively)

In this step, DCHP acute duration exposure estimates from each consumer and occupational COU/OES are scaled by relative potency and expressed in terms of index chemical (DBP) equivalents using Equation 4-5. This step is repeated for all individual exposure estimates for each route of exposure being assessed for each COU (*i.e.,* inhalation and dermal exposures for occupational COUs; inhalation, ingestion, and dermal exposure for consumer COUs).

Equation 4-5. Scaling DCHP Exposures by Relative Potency

$$DCHP\ Exposure\ (in\ DBP\ equivalents) = AD_{Route\ 1} x\ RPF_{DCHP}$$

Where:

DCHP exposure	=	Acute exposure for a given route of exposure from a single occupational or consumer COU expressed in terms of µg/kg index chemical (DBP) equivalents
$AD_{Route\ 1}$	=	Acute dose in µg/kg from a given route of exposure from a single occupational or consumer COU/OES
RPF_{DCHP}	=	The relative potency factor (unitless) for DCHP, which is 1.66 (Table 4-19).

Example: 50th percentile inhalation and dermal DCHP exposures for female workers of reproductive age are 38.7 and 2.07 µg/kg for the Application of paints and coatings (solids) OES (U.S. EPA, 2024ab). Using Equation 4-5, inhalation, dermal, and aggregate DCHP exposures for this OES can be scaled by relative potency to 64.2, 3.44, and 67.68 µg/kg DBP equivalents, respectively.

$$DCHP_{Inhalation-COU} = 64.2\ \mu g/kg\ DBP\ equivalents = 38.7\ \mu g/kg\ DCHP\ x\ 1.66$$

$$DCHP_{Dermal-COU} = 3.44\ \mu g/kg\ DBP\ equivalents = 2.07\ \mu g/kg\ DCHP\ x\ 1.66$$

$$DCHP_{Aggregate-COU} = 67.68\ \mu g/kg\ DBP\ equivalents$$
$$= (2.07\ \mu g/kg\ DCHP\ +\ 38.7\ \mu g/kg\ DCHP)\ x\ 1.66$$

Step 2: Estimate Non-attributable Cumulative Exposure to DEHP, DBP, BBP, DIBP, and DINP Using NHANES Urinary Biomonitoring Data and Reverse Dosimetry (see Section 4.4.2 for Further Details)

Non-attributable exposure for a national population to DEHP, DBP, BBP, DIBP, and DINP was estimated using Equation 4-6, where individual phthalate daily intake values estimated from NHANES biomonitoring data and reverse dosimetry were scaled by relative potency, expressed in terms of index chemical (DBP) equivalents, and summed to estimate non-attributable cumulative exposure in terms of DBP equivalents. Equation 4-6 was used to calculate the cumulative exposure estimates provided in Table 4-20 and Table 4-21.

Equation 4-6. Estimating Non-attributable Cumulative Exposure to DEHP, DBP, BBP, DIBP, and DINP

$$Cumulative\ Exposure\ (Non-attributable) = (DI_{DEHP}\ x\ RPF_{DEHP}) + (DI_{DBP}\ x\ RPF_{DBP}) + (DI_{BBP}\ x\ RPF_{BBP}) + (DI_{DIBP}\ x\ RPF_{DIBP}) + (DI_{DINP}\ x\ RPF_{DINP})$$

Where:

Cumulative exposure (non-attributable) is expressed in index chemical (DBP) equivalents (µg/kg-day).
DI is The daily intake value (µg/kg-day) for each phthalate that was calculated using NHANES urinary biomonitoring data and reverse dosimetry (DI) values for each phthalate for each assessed population are provided in Table 4-20 and Table 4-21).
RPF is the relative potency factor (unitless) for each phthalate from Table 4-19.

Example: The 95th percentile cumulative exposure estimate of 5.16 µg/kg-day DBP equivalents for black, non-Hispanic women of reproductive age (Table 4-21) is calculated using Equation 4-6 as follows:

$$5.16\ \mu g/kg\ DBP\ equivalents = (4.28\ \mu g/kg\ DEHP\ x\ 0.84) + (0.48\ \mu g/kg\ DBP\ x\ 1) + (0.30\ \mu g/kg\ BBP\ x\ 0.52) + (0.40\ \mu g/kg\ DIBP\ x\ 0.53) + (3.40\ \mu g/kg\ DINP\ x\ 0.21)$$

Step 3: Calculate MOEs for DCHP Exposures and for Each Phthalate Exposure Included in the Cumulative Scenario

Next, MOEs are calculated for each exposure of interest that is included in the cumulative scenario using Equation 4-7. For example, this step involves calculating MOEs for inhalation and dermal DCHP exposures expressed in index chemical equivalents for each individual COU/OES in Step 1, and an MOE for non-attributable cumulative phthalate exposure from Step 2 above.

Equation 4-7. Calculating MOEs for Exposures of Interest for Use in the RPF and Cumulative Approaches

$$MOE_1 = \frac{Index\ Chemical\ (DBP)\ POD}{Exposure_1\ in\ DBP\ Equivalents}$$

Where:

MOE_1 (unitless) = The MOE calculated for each exposure of interest included in the cumulative scenario.
Index chemical (DBP) POD = The POD selected for the index chemical, DBP. The index chemical POD is 2,100 µg/kg (Section 4.4.1).
$Exposure_1$ = The exposure estimate in DBP equivalents for the pathway

of interest (*i.e.*, from Step 1 or 2 above).

Example: Using Equation 4-7, the MOEs for inhalation and dermal DCHP exposure estimates for the Application of paints and coatings (solids) OES in DBP equivalents from Step 1 and the MOE for the non-attributable cumulative exposure estimate in DBP equivalents from sSep 2 are 33, 610, and 407, respectively.

$$MOE_{Cumulative\ Non-attributable} = 407 = \frac{2{,}100\ \mu g/kg}{5.16\ \mu g/kg}$$

$$MOE_{COU-Inhalation} = 32.7 = \frac{2{,}100\ \mu g/kg}{64.2\ \mu g/kg}$$

$$MOE_{COU-Dermal} = 610 = \frac{2{,}100\ \mu g/kg}{3.44\ \mu g/kg}$$

Step 4: Calculate the Cumulative MOE

For the cumulative MOE approach, MOEs for each exposure of interest in the cumulative scenario are first calculated (Step 3). The cumulative MOE for the cumulative scenario can then be calculated using Equation 4-8, which shows the addition of MOEs for the inhalation and dermal exposures routes from an individual DCHP COU as well as the MOE for non-attributable cumulative exposure to phthalates from NHANES urinary biomonitoring and reverse dosimetry. Additional MOEs can be added to the equation as necessary (*e.g.*, for the ingestion route for consumer scenarios).

Equation 4-8. Cumulative Margin of Exposure Calculation

$$Cumulative\ MOE = \frac{1}{\frac{1}{MOE_{COU-Inhalation}} + \frac{1}{MOE_{COU-Dermal}} + \frac{1}{MOE_{Cumulative-Non-attributable}} \ldots}$$

Example: The cumulative MOE for the Application of paints and coatings (solids) OES is 28.9 and is calculated by summing the MOEs for each exposure of interest from Step 3 as follows:

$$Cumulative\ MOE = 28.9 = \frac{1}{\frac{1}{32.7} + \frac{1}{610} + \frac{1}{407}}$$

4.4.4 Risk Estimates for Workers Based on Relative Potency

This section summarizes RPF analysis risk estimates for female workers of reproductive age from acute duration exposures to DCHP. In the RPF analysis, EPA focused its occupational risk assessment on this population and exposure duration because as described in Section 4.4 and (U.S. EPA, 2024ah), this population and exposure duration is considered most directly applicable to the common hazard outcome that serves as the basis for the RPF analysis (*i.e.*, reduced fetal testicular testosterone).

To evaluate cumulative risk to female workers of reproductive age, EPA combined inhalation and dermal exposures to DCHP from each individual occupational COU/OES with non-attributable cumulative exposure to DEHP, DBP, BBP, DIBP, and DINP (estimated from NHANES urinary biomonitoring using reverse dosimetry). As described in Section 4.4.3, for each individual phthalate exposures were scaled by relative potency per chemical, expressed in terms of index chemical (DBP) equivalents, and summed to estimate cumulative exposure and cumulative risk for each COU. MOEs in

Table 4-22 are shown both with (cumulative MOE) and without (MOEs for individual DCHP COU derived using the RPF analysis) the addition of non-attributable cumulative exposure (estimated from NHANES using reverse dosimetry) so that MOEs scaled by relative potency can be compared.

Table 4-22 summarizes the acute duration central tendency and high-end MOEs for female workers of reproductive age used to characterize cumulative risk from exposure to DCHP, DEHP, DBP, BBP, DIBP, and DINP, as well as DCHP MOEs scaled by relative potency without non-attributable cumulative exposure (*i.e.*, NHANES) included. MOE calculations are also provided in the *Draft Occupational and Consumer Cumulative Risk Calculator for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024y). As discussed in Section 4.3.2, high-end acute MOEs for female workers of reproductive age were below the benchmark of 30 for all DCHP COUs/OES evaluated as part of the individual chemical assessment. Addition of non-attributable cumulative national exposure (from NHANES) would have no influence on high-end risk conclusions. Therefore, EPA focused its cumulative risk characterization on central tendency MOEs (none of which were <30 in the individual DCHP assessment in Section 4.3.2). For all COUs, the Agency presents MOEs for each individual exposure route. That is, MOEs resulting from inhalation and dermal DCHP exposures for each COU/OES scaled to index chemical (DBP) equivalents (*i.e.,* the RPF analysis) as well as cumulative occupational exposure (*i.e.*, aggregate exposure to DCHP from a single COU [in index chemical equivalents] combined with cumulative national exposure [in index chemical equivalents]), so that the contribution of each exposure to the cumulative MOE can be discerned.

COUs/OES with Cumulative MOEs Ranging from 34 to 244

As can be seen from Table 4-22, cumulative acute central tendency MOEs ranged from 34 to 244 for COUs covered under 12 of the OESs evaluated for DCHP, including the following:

- Import and repackaging (cumulative MOE = 55);
- PVC plastics compounding (cumulative MOE = 34);
- PVC plastics converting (cumulative MOE = 65);
- Non-PVC materials compounding (cumulative MOE = 52);
- Non-PVC materials converting (cumulative MOE = 110);
- Application of adhesives and sealants (liquids) (cumulative MOE = 244);
- Application of adhesives and sealants (solids) (cumulative MOE = 49);
- Use of laboratory chemicals (liquids) (cumulative MOE = 244);
- Use of laboratory chemicals (solids) (cumulative MOE = 40);
- Recycling (cumulative MOE = 63);
- Fabrication or use of final products and articles (cumulative MOE = 72); and
- Waste handling, treatment, and disposal (cumulative MOE = 63).

COUs/OES with Cumulative MOEs Ranging from 18 to 29

As can be seen from Table 4-22, cumulative acute central tendency MOEs ranged from 18 to 29 for COUs covered under six OES, including:

- Manufacturing (cumulative MOE = 18);
- Incorporation into other formulations, mixtures, or reaction products (cumulative MOE = 18);
- Incorporation into adhesives and sealants (cumulative MOE = 18);
- Incorporation into paints and coatings *(*cumulative MOE = 18);
- Application of paints and coatings – liquids (cumulative MOE = 20); and
- Application of paints and coatings – solids (cumulative MOE = 29).

EPA characterizes these preceding six OESs as part of the individual chemical assessment in Section 4.3.2. The central tendency acute aggregate MOE from exposure to DCHP alone for female workers of reproductive age is 35 for four of the six OESs showing cumulative risk (*i.e.*, Manufacturing; Incorporation into other formulations, mixtures, or reaction products; Incorporation into adhesives and sealants; and Incorporation into paints and coatings) (Table 4-14), while the cumulative MOE for these four OES is 18 (Table 4-22). For one OES (Application of paints and coatings – liquids), the central tendency acute aggregate MOE from exposure to DCHP alone for female workers of reproductive age is 40 (Table 4-14), while the cumulative MOE for this OES is 20 (Table 4-22). For the sixth OES (Application of paints and coatings – solids), the central tendency acute aggregate MOE from exposure to DCHP alone for female workers of reproductive age is 60 (Table 4-14), while the cumulative MOE for this OES is 29 (Table 4-22).

For all of the evaluated OESs, including these six OESs, three factors contribute to the lower cumulative MOEs compared to the acute aggregate central tendency MOE for female workers of reproductive age:

Scaling by Relative Potency: DCHP inhalation and dermal exposures for the six OESs were scaled by relative potency to the index chemical. The RPF for DCHP is 1.66, which means DCHP exposures when multiplied by the RPF and expressed in terms of index chemical (DBP) equivalents, increased by 66 percent. *This 66 percent increase in exposure expressed in terms of index chemical equivalents is the primary factor leading to lower cumulative MOEs*. RPFs used to scale for relative potency were calculated based on a common hazard endpoint (*i.e.*, reduced fetal testicular testosterone) from data from multiple studies evaluating effects of phthalates on fetal testicular testosterone using a meta-analysis and BMD modeling approach for each of the six phthalates included in the cumulative chemical group (see (U.S. EPA, 2024ah) for further details). This analysis provides a robust basis for assessing the dose-response for the common hazard endpoint (*i.e.*, reduced fetal testicular testosterone) across the six toxicologically similar phthalates included in the cumulative assessment. For example, use of meta-analysis and BMD modeling allowed EPA to utilize more fetal testicular testosterone data in the low-end range of the dose-response curve to gain a better understanding of the hazards of DCHP at the low-end range of the dose-response curve compared to the index chemical, DBP. Overall, EPA has robust confidence in the draft RPFs used in this CRA (Section 4.4.4.1).

Index Chemical POD: As described previously in Sections 4.4.1 and 4.4.3, cumulative MOEs are calculated by dividing the cumulative exposure estimate expressed in terms of index chemical (DBP) equivalents by the index chemical POD. The POD for the index chemical (DBP) used to calculate cumulative risk is 2.1 mg/kg (based on a $BMDL_5$ for reduced fetal testicular testosterone). Comparatively, the DCHP POD used to calculate MOEs for individual DCHP COUs in Section 4.3.2 is 2.4 mg/kg (based on a NOAEL for phthalate syndrome-related effects). *The index chemical (DBP) POD is 12.5 percent lower (i.e., more sensitive) than the individual DCHP POD, which contributes to the lower cumulative MOEs.* Overall, EPA has robust confidence in the index chemical (DBP) POD used in this CRA. This is because the POD is based on fetal testicular testosterone data from eight publications that was integrated via meta-analysis and BMD modeling. Notably, several of the available studies evaluated effects on fetal testicular testosterone at dose levels in the low-end range of the dose response curve (*i.e.*, 1, 10, 33, and 50 mg/kg-day) where the BMD_5 (14 mg/kg-day) and $BMDL_5$ (9 mg/kg-day) were derived (see (U.S. EPA, 2024ah) for further details).

Addition of Non-attributable Cumulative Exposure: As part of its CRA, EPA calculated non-attributable cumulative exposure to DEHP, DBP, BBP, DIBP, and DINP using NHANES urinary biomonitoring data from the 2017 to 2018 survey (most recent data set available) and reverse dosimetry (see Section 4.4.2 and (U.S. EPA, 2024ah) for further details), representing exposure to a national population. DCHP was not included as part of the cumulative non-attributable national exposure estimate because DCHP

has not been included in NHANES analyses since 2011 due to low frequencies of detection and low detection levels in urine (Section 4.4.2). Non-attributable cumulative exposure estimates were scaled by relative potency and expressed in index chemical (DBP) equivalents. Non-attributable cumulative exposure was then combined with acute inhalation and dermal DCHP exposures for each individual COU/OES scaled by relative potency. For female workers of reproductive age, EPA added a non-attributable cumulative exposure of 5.16 µg/kg index chemical (DBP) equivalents to calculate the cumulative MOE. This non-attributable cumulative exposure estimate is the 95th percentile estimate for black non-Hispanic women of reproductive age (16 to 49 years). *This non-attributable cumulative exposure contributes approximately 7.4 percent to the risk cup with a benchmark MOE of 30.*

Overall, EPA has robust confidence in the non-attributable cumulative exposure estimate since it was calculated from CDC's NHANES biomonitoring data set, which provides a statistically representative sampling of the U.S. civilian population. Furthermore, the Agency used a well-established reverse dosimetry approach to calculate phthalate daily intake values from urinary biomonitoring data. For five out of the six OESs showing cumulative risk (*i.e.*, Manufacturing; Incorporation into other formulations, mixtures, or reaction products; Incorporation into adhesives and sealants; Incorporation into paints and coatings; and Application of paints and coatings – liquids), scaling acute inhalation exposures by relative potency alone led to acute inhalation MOEs below 30, ranging from 19 to 22, whereas the acute cumulative MOE (DCHP OES + cumulative non-attributable) ranged from 18 to 20. For one OES showing cumulative risk (*i.e.,* Application of paints and coatings – solids), the acute aggregate MOE based on exposure to DCHP expressed in index chemical equivalents was 31 and adding non-attributable cumulative exposure resulted in a cumulative MOE of 29.

4.4.4.1 Overall Confidence in Cumulative Worker Risk Estimates

EPA has robust confidence in the RPFs and index chemical POD used to calculate the RPF analysis and cumulative MOEs. To derive RPFs and the index chemical POD, the Agency integrated data from multiple studies evaluating fetal testicular testosterone using a meta-analysis approach and conducted BMD modeling. This meta-analysis and BMD modeling approach represents a refinement of the NOAEL/LOAEL approach used in the individual DCHP assessment and therefore increases EPA's confidence in risk estimates. Finally, the Agency has robust confidence in the non-attributable cumulative exposure estimates for DEHP, DBP, BBP, DIBP, and DINP derived from NHANES urinary biomonitoring data using reverse dosimetry.

3371 **Table 4-22. Risk Summary Table for Female Workers of Reproductive Age Using the RPF Analysis**

Life Cycle Stage/ Category	Subcategory	OES	Exposure Level	Acute MOEs for Female Workers of Reproductive Age (Benchmark = 30)			
				Inhalation MOE (DCHP COU; Exposure in DBP Equivalents)	Dermal MOE (DCHP COU; Exposure in DBP Equivalents)	Aggregate MOE (DCHP COU; Exposure in DBP Equivalents)	Cumulative MOE (Aggregate DCHP MOE + Cumulative Non-attributable) [a]
Manufacturing – Domestic manufacturing	Domestic manufacturing	Manufacturing	CT	19.1	610	18.5	17.7
			HE	1.8	305	1.8	1.8
Manufacturing – Importing	Importing	Import and Repackaging	CT	70	610	63	55
Processing – Repackaging	Repackaging (*e.g.*, laboratory chemicals)		HE	3.1	305	3.0	3.0
Processing – Processing – incorporation into formulation, mixture, or reaction product	Plasticizer in: – Adhesive manufacturing Adhesive and sealant chemicals in: – Adhesive manufacturing Stabilizing Agent in: – Adhesive manufacturing	Incorporation into adhesives and sealants	CT	19.1	610	18.5	17.7
			HE	1.8	305	1.8	1.8
Processing – Processing – incorporation into formulation, mixture, or reaction product	Plasticizer in: – Paint and coating manufacturing – Printing ink manufacturing Stabilizing agent in: – Paint and coating manufacturing	Incorporation into paints and coatings	CT	19.1	610	18.5	17.7
			HE	1.8	305	1.8	1.8
Processing – Processing – incorporation into formulation, mixture, or reaction product	Stabilizing agent in: Asphalt paving, roofing, and coating materials manufacturing	Incorporation into other formulations, mixtures, and reaction products not covered elsewhere	CT	19.1	610	18.5	17.7
			HE	1.8	305	1.8	1.8

Life Cycle Stage/ Category	Subcategory	OES	Exposure Level	Acute MOEs for Female Workers of Reproductive Age (Benchmark = 30)			
				Inhalation MOE (DCHP COU; Exposure in DBP Equivalents)	Dermal MOE (DCHP COU; Exposure in DBP Equivalents)	Aggregate MOE (DCHP COU; Exposure in DBP Equivalents)	Cumulative MOE (Aggregate DCHP MOE + Cumulative Non-attributable) [a]
Processing – Processing – incorporation into formulation, mixture, or reaction product	Plasticizer in: – Plastic material and resin manufacturing – Plastics product manufacturing	PVC plastics compounding	CT	40	610	37	34
			HE	1.9	305	1.9	1.9
	Stabilizing agent in: –Plastics product manufacturing						
Processing – Processing – incorporation into article	Plasticizer in: – Plastics product manufacturing	PVC plastics converting	CT	89	610	77	65
			HE	4.3	305	4.3	4.2
Processing – Processing – incorporation into formulation, mixture, or reaction product	Plasticizer in: – Plastics product manufacturing – Rubber product manufacturing – Plastic material and resin manufacturing	Non-PVC material compounding	CT	66	610	60	52
			HE	3.2	305	3.2	3.2
	Stabilizing agent in: –Plastics product manufacturing						
Processing – Processing – incorporation into article	Plasticizer in: – Plastics product manufacturing – Rubber product manufacturing	Non-PVC material converting	CT	199	610	150	110
			HE	9.7	305	9.4	9.2

Life Cycle Stage/ Category	Subcategory	OES	Exposure Level	Acute MOEs for Female Workers of Reproductive Age (Benchmark = 30)			
				Inhalation MOE (DCHP COU; Exposure in DBP Equivalents)	Dermal MOE (DCHP COU; Exposure in DBP Equivalents)	Aggregate MOE (DCHP COU; Exposure in DBP Equivalents)	Cumulative MOE (Aggregate DCHP MOE + Cumulative Non-attributable) [a]
Industrial Use – Finishing agent	Cellulose film production	Application of paints and coatings – liquids	CT	21.7	610	21.0	19.9
Industrial Use – Inks, toner, and colorant products	Inks, toner, and colorant products (*e.g.*, screen printing ink)		HE	1.0	305	1.0	1.0
Commercial Use – Inks, toner, and colorant products	Inks, toner, and colorant products (*e.g.*, screen printing ink)						
Industrial Use – Paints and coatings	Paints and coatings						
Commercial Use – Paints and coatings	Paints and coatings						
Industrial Use – Finishing agent	Cellulose film production	Application of paints and coatings – solids	CT	32.7	610	31.1	28.9
Industrial Use – Inks, toner, and colorant products	Inks, toner, and colorant products (*e.g.*, screen printing ink)		HE	1.9	305	1.9	1.8
Commercial Use – Inks, toner, and colorant products	Inks, toner, and colorant products (*e.g.*, screen printing ink)						
Industrial Use – Paints and coatings	Paints and coatings						
Commercial Use – Paints and coatings	Paints and coatings						

Life Cycle Stage/ Category	Subcategory	OES	Exposure Level	Acute MOEs for Female Workers of Reproductive Age (Benchmark = 30)			
				Inhalation MOE (DCHP COU; Exposure in DBP Equivalents)	Dermal MOE (DCHP COU; Exposure in DBP Equivalents)	Aggregate MOE (DCHP COU; Exposure in DBP Equivalents)	Cumulative MOE (Aggregate DCHP MOE + Cumulative Non-attributable) [a]
Industrial Uses – Adhesives and sealants	Adhesives and sealants (*e.g.*, computer and electronic product manufacturing; transportation equipment manufacturing)	Application of adhesives and sealants – liquids	CT	–	610	–	244
			HE	–	305	–	174.3
Commercial Uses – Adhesives and sealants	Adhesives and sealants						
Industrial Uses – Adhesives and sealants	Adhesives and sealants in (*e.g.*, computer and electronic product manufacturing; transportation equipment manufacturing)	Application of adhesives and sealants – solids	CT	61	610	56	49
			HE	3.4	305	3.4	3.3
Commercial Use – Laboratory chemicals	Laboratory chemicals	Use of laboratory chemicals – liquid	CT	–	610	–	244
			HE	–	305	–	174.3
Commercial Use – Laboratory chemicals	Laboratory chemicals	Use of laboratory chemicals – solid	CT	48	610	45	40
			HE	3.4	305	3.4	3.3

Life Cycle Stage/ Category	Subcategory	OES	Exposure Level	Acute MOEs for Female Workers of Reproductive Age (Benchmark = 30)			
				Inhalation MOE (DCHP COU; Exposure in DBP Equivalents)	Dermal MOE (DCHP COU; Exposure in DBP Equivalents)	Aggregate MOE (DCHP COU; Exposure in DBP Equivalents)	Cumulative MOE (Aggregate DCHP MOE + Cumulative Non-attributable) [a]
Industrial Use – Other articles with routine direct contact during normal use including rubber articles; plastic articles (hard)	Other articles with routine direct contact during normal use including rubber articles; plastic articles (hard) (*e.g.*, transportation equipment manufacturing)	Fabrication or use of final products or articles	CT	102	610	87	72
Commercial Use – Building/construction materials not covered elsewhere	Building/construction materials not covered elsewhere		HE	11.3	305	10.9	10.6
Commercial Use – Other articles with routine direct contact during normal use including rubber articles; plastic articles (hard)	Other articles with routine direct contact during normal use including rubber articles; plastic articles (hard)						
Processing – Recycling	Recycling	Recycling	CT	85	610	74	63
			HE	5.8	305	5.7	5.6
Disposal – Disposal	Disposal	Waste handling, treatment and disposal	CT	85	610	74	63
			HE	5.8	305	5.7	5.6

[a] The acute cumulative MOE is derived by summing inhalation exposure from each individual DCHP COU with dermal exposure from the same DCHP COU and the cumulative non–attributable exposure to DEHP, DBP, BBP, DIBP, and DINP. Non-attributable cumulative exposure was estimated from NHANES urinary biomonitoring data using reverse dosimetry. All exposure estimates were (1) scaled by relative potency, (2) expressed in index chemical equivalents (*i.e.*, DBP equivalents), (3) summed to calculate cumulative exposure in index chemical equivalents, and then (4) compared to the index chemical POD (*i.e.*, HED of 2.1 mg/kg-day) to calculate the cumulative MOE.

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4.4.5 Risk Estimates for Consumers Based on Relative Potency

This section summarizes cumulative risk estimates for consumers from acute duration exposures to DCHP. EPA focused its CRA on women of reproductive age and male infants and children. EPA focused its consumer CRA on these populations for the acute exposure duration because, as described in Section 4.2 and (U.S. EPA, 2024ah), these populations and exposure duration are considered most directly applicable to the common hazard outcome that serves as the basis for the cumulative assessment (*i.e.*, reduced fetal testicular testosterone). For consumers, EPA did not specifically evaluate women of reproductive age or male infants and children; however, consumer exposures of teenagers (16–20 years) and adults (21+ years) were considered a proxy for women of reproductive age, while infants (<1 year), toddlers (1–2 years), children (3–5 and 6–10 years), and young teens (11–15 years) were considered a proxy for male infants and children.

After scaling high-intensity DCHP acute exposure estimates from individual COUs by relative potency and adding non-attributable cumulative exposure (calculated from NHANES) from DEHP, DBP, BBP, DIBP, and DINP, *all high-intensity consumer COUs product and article examples had cumulative MOEs above the benchmark of 30*, ranging from 130 for acute infant exposure through outdoor seating to 455 for acute exposure to adhesives for small repairs for young teens (11–15 years) (Table 4-23).

4.4.5.1 Overall Confidence in Cumulative Consumer Risks

As discussed in Section 4.3.3, EPA has moderate to robust confidence in all of the exposure estimates for the evaluated consumer product scenarios. The Agency has robust confidence in the RPFs and index chemical POD used to calculate the cumulative MOEs. To derive RPFs and the index chemical POD, EPA integrated data from multiple studies evaluating fetal testicular testosterone using a meta-analysis approach and conducted BMD modeling. This meta-analysis and BMD modeling approach represents a refinement of the NOAEL/LOAEL approach used in the individual DCHP assessment and therefore increases EPA's confidence in risk estimates. Finally, EPA has robust confidence in the non-attributable cumulative exposure estimates for DEHP, DBP, BBP, DIBP, and DINP derived from NHANES urinary biomonitoring data using reverse dosimetry.

3400 **Table 4-23. Consumer Cumulative Risk Summary Table**

Life Cycle Stage: COU: Subcategory	Product or Article	Duration	Exposure Scenario (H, M, L) [a]	Exposure Scenario	Lifestage (Years) MOE (Based on All Exposures in Index Chemical Equivalents) (Benchmark MOE = 30)						
					Infant (<1 Year)	Toddler (1–2 Years)	Preschooler (3–5 years)	Middle Childhood (6–10 years)	Young Teen (11–15 years)	Teenager (16–20 years)	Adult (21+ years)
Consumer Uses: Adhesives and sealants: Adhesives and sealants	Adhesives for small repairs	Acute	H	Cumulative (Aggregate DCHP COU + Cumulative Non-attributable)	–	–	–	–	455	389	388
Consumer Uses: Adhesives and sealants: Adhesives and sealants	Automotive adhesives	Acute	H	Cumulative (Aggregate DCHP COU + Cumulative Non-attributable)	191	191	192	282	437	377	377
Consumer Uses: Other articles with routine direct contact during normal use including rubber articles; plastic articles (hard)	Small articles with potential for semi-routine contact: labels, nitrocellulose; ethylcellulose; chlorinated rubber; PVAc; PVC	Acute	H	Cumulative (Aggregate DCHP COU + Cumulative Non-attributable)	165	169	172	248	400	351	348
Consumer Uses: Consumer articles that contain dicyclohexyl phthalate from: Inks, toner, and colorants; Paints and coatings; Adhesives and sealants (*e.g.*, paper products, textiles, products using cellulose film, etc.)	Outdoor seating	Acute	H	Cumulative (Aggregate DCHP COU + Cumulative Non-attributable)	130	136	142	199	305	281	275
Consumer Uses: Consumer articles that contain dicyclohexyl phthalate from: Inks, toner, and colorants; Paints and coatings; Adhesives and sealants (*e.g.*, paper products, textiles, products using cellulose film, etc.)	Small articles with the potential for semi-routine contact: labels, and packaging adhesives, foil and cellophane lacquers, and printing inks	Acute	H	Cumulative (Aggregate DCHP COU + Cumulative Non-attributable)	165	169	172	248	400	351	348
Consumer Uses: Consumer articles that contain dicyclohexyl phthalate from: Inks, toner, and colorants; Paints and coatings; Adhesives and sealants (*e.g.*, paper	Electronics containing dye adhesive	Exposures not expected. Identified in dye attach adhesive used in wirebond packaging for semiconductor devices or in automotive cameras. As the adhesive is used in small quantities and contained within the electronic articles, no exposures are expected during potential use of these items.									

Life Cycle Stage: COU: Subcategory	Product or Article	Duration	Exposure Scenario (H, M, L) [a]	Exposure Scenario	Lifestage (Years) MOE (Based on All Exposures in Index Chemical Equivalents) (Benchmark MOE = 30)						
					Infant (<1 Year)	Toddler (1–2 Years)	Preschooler (3–5 years)	Middle Childhood (6–10 years)	Young Teen (11–15 years)	Teenager (16–20 years)	Adult (21+ years)
products, textiles, products using cellulose film, etc.)											

[a] Exposure scenario intensities include high (H), medium (M), and low (L).
[b] Bystander scenarios
[c] Indoor scenario

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4.4.6 Cumulative Risk Estimates for the General Population

For DCHP, EPA did not evaluate cumulative risk for the general population from environmental releases. As discussed in Section 4.1.3, the Agency employed a screening-level approach to assess risk from exposure to DCHP for the general population from environmental releases. Using this conservative screening-level approach, EPA did not identify any pathways of concern, indicating that refinement was not necessary.

4.5 Comparison of Single Chemical and Cumulative Risk Assessments

In support of the developed CRA, EPA has relied substantially on existing CRA-related work by the Agency's Risk Assessment Forum (RAF), EPA Office of Pesticide Programs (OPP), the Organisation for Economic Co-operation and Development (OECD), the European Commission, and the World Health Organization (WHO) and International Programme on Chemical Safety (IPCS), including

- *Guidelines for the Health Risk Assessment of Chemical Mixtures* (U.S. EPA, 1986);
- *Guidance for Identifying Pesticide Chemicals and Other Substances that Have a Common Mechanism of Toxicity* (U.S. EPA, 1999);
- *Supplementary Guidance for Conducting Health Risk Assessment of Chemical Mixtures* (U.S. EPA, 2000);
- *General Principles for Performing Aggregate Exposure and Risk Assessments* (U.S. EPA, 2001);
- *Guidance on Cumulative Risk Assessment of Pesticide Chemicals that Have a Common Mechanism of Toxicity* (U.S. EPA, 2002a);
- *Framework for Cumulative Risk Assessment* (U.S. EPA, 2003);
- *Concepts, Methods and Data Sources for Cumulative Health Risk Assessment of Multiple Chemicals, Exposures, and Effects: A Resource Document* (U.S. EPA, 2007);
- *Pesticide Cumulative Risk Assessment: Framework for Screening Analysis Purpose* (U.S. EPA, 2016b);
- *Advances in Dose Addition For Chemical Mixtures: A White Paper* (U.S. EPA, 2023a).
- *Phthalates and Cumulative Risk Assessment: The Tasks Ahead* (NRC, 2008);
- *State of the Art Report on Mixture Toxicity* (European Commission, 2009);
- *Risk Assessment of Combined Exposure to Multiple Chemicals: A WHO/IPCS Framework* (Meek et al., 2011); and
- *Considerations for Assessing the Risks of Combined Exposure to Multiple Chemicals* (OECD, 2018).

Herein, EPA has evaluated risks for workers (Section 4.3.2), consumers (Section 4.3.3), and the general population (Section 4.3.4) from exposure to DCHP alone, as well as cumulative risks for workers (Section 4.4.4) and consumers (Section 4.4.5) that take into account differences in relative potency and cumulative non-attributable exposure to DEHP, DBP, BBP, DIBP, and DINP from NHANES biomonitoring and reverse dosimetry.

There are several notable differences between the individual DCHP assessment (Section 4.3) and the CRA (Section 4.4). As part of the individual DCHP assessment (Section 4.3), EPA considered all human health hazards of DCHP and selected a POD based on a NOAEL for phthalate syndrome-related effects to characterize risk from exposure to DCHP. As part of its exposure assessment in the individual DCHP assessment, EPA considered acute, intermediate, and chronic exposures durations for a broad range of populations—including female workers of reproductive age, average adult workers, ONUs, the general population, and consumers of various lifestages (*e.g.*, infants, toddlers, children, adults). Furthermore, in the individual DCHP assessment, EPA evaluated inhalation and dermal exposures to workers, as well as

consumer exposure to DCHP via the inhalation, dermal, and ingestion exposure routes. In contrast, the CRA is more focused in scope (Section 4.4). First, the CRA is based on a uniform measure of hazard (*i.e.*, reduced fetal testicular testosterone) that serves as the basis for deriving RPFs and the index chemical (DBP) POD, which were derived via meta-analysis and BMD modeling (Section 4.4.1). Second, the CRA is focused on acute duration exposures and the most sensitive populations (*i.e.*, women of reproductive age, male infants, male children) (Section 4.4). Finally, for the CRA, DCHP exposures from individual consumer and worker COUs were (1) scaled by relative potency; (2) expressed in index chemical (DBP) equivalents; and (3) combined with non-attributable cumulative exposure to DEHP, DBP, BBP, DIBP, and DINP from NHANES.

Both the individual DCHP assessment (Section 4.3) and the CRA (Section 4.4) led to similar conclusions regarding risk estimates for consumers. As discussed in Section 4.3.3, high-intensity MOEs for consumer scenarios ranged from 740 to 950,000 in the individual DCHP assessment (Benchmark = 30), while cumulative consumer MOEs ranged from 130 to 455 (cumulative Benchmark = 30) (Section 4.4.5).

For workers, cumulative acute central tendency MOEs ranged from 18 to 29 for COUs covered under six OESs (Section 4.4.5). Comparatively, these same six OESs had aggregate acute MOEs that ranged from 35 to 60 in the individual DCHP assessment (Section 4.3.2). Overall, there are three primary factors that influenced differences in risk estimates between the individual DCHP assessment (Section 4.3) and the RPF analysis (Section 4.4), which are described below:

- ***Scaling by Relative Potency.*** DCHP inhalation, dermal, and ingestion exposures from individual COUs/OES were scaled by relative potency to the index chemical. The RPF for DCHP is 1.66, which means DCHP exposures when multiplied by the RPF and expressed in terms of index chemical (DBP) equivalents, increased by 66 percent. This increase in exposure expressed in terms of index chemical equivalents is the primary factor leading to lower cumulative MOEs.
- ***Index Chemical POD.*** Cumulative MOEs are calculated by dividing the index chemical POD by a cumulative exposure estimate expressed in terms of index chemical (DBP) equivalents. The POD for the index chemical (DBP) used to calculate cumulative risk is 2.1 mg/kg (based on a $BMDL_5$ for reduced fetal testicular testosterone). Comparatively, the DCHP POD used to calculate MOEs for individual DCHP COUs is 2.4 mg/kg (based on a NOAEL for phthalate syndrome-related effects). The index chemical (DBP) POD is 12.5 percent lower (*i.e.*, more sensitive) than the individual DCHP POD, which contributes to the lower cumulative MOEs.
- ***Addition of Non-attributable Cumulative Exposure.*** As part of its CRA, EPA calculated non-attributable cumulative exposure to DEHP, DBP, BBP, DIBP, and DINP using NHANES urinary biomonitoring data from the 2017 to 2018 survey reverse dosimetry (Section 4.4.2), representing exposure to a national population. *Overall, this non-attributable cumulative exposure contributes approximately 7.4 to 15.5 percent to the risk cup, depending on the population and age group.*

Ultimately, the impact of scaling by relative potency has a significant impact on the risk estimates for exposure to DCHP alone. There is little additional cumulative risk by adding the simultaneous exposure of other phthalates to the single chemical risk estimates for DCHP (*i.e.*, non-attributable cumulative exposure from NAHNES adds 7.4–15.5% to the risk cup).

EPA has robust confidence in its CRA and moderate to robust confidence in its individual assessment of DCHP for workers (Section 4.3.2.1), consumers (Section 4.3.3.1), and the general population (Section 4.3.4.1). RPFs used to scale for relative potency were calculated based on a common hazard endpoint (*i.e.*, reduced fetal testicular testosterone) from data from multiple studies evaluating effects of

phthalates on fetal testicular testosterone using a meta-analysis and BMD modeling approach for each of the six phthalates included in the cumulative chemical group (U.S. EPA, 2024ah). This analysis provides a robust basis for assessing the dose-response for the common hazard endpoint (*i.e.*, reduced fetal testicular testosterone) across the six toxicologically similar phthalates included in the CRA. For example, use of meta-analysis and BMD modeling allowed EPA to utilize more fetal testicular testosterone data in the low-end range of the dose-response curve to gain a better understanding of the hazards of DCHP at the low-end range of the dose-response curve compared to the index chemical, DBP.

5 ENVIRONMENTAL RISK ASSESSMENT

DCHP - Environmental Risk Assessment (Section 5):
Key Points

EPA evaluated the reasonably available information to support the environmental risk assessment of DCHP. The key points of the environmental risk assessment are summarized below:

- DCHP is expected to be released to the environment via air, water, biosolids, and disposal to landfills. Based on DCHP's fate parameters, concentrations of DCHP in soil and groundwater resulting from releases to the landfill or via biosolids were not quantified but discussed qualitatively because DCHP is not expected to be persistent or be mobile in soils (Section 2).
- High-end concentrations of DCHP in surface water were estimated for the purpose of risk assessment for environmental exposure. The only two OESs with estimated water releases were Plastic compounding and Recycling, with Plastic compounding being the highest release and subsequent environmental concentrations in surface water (Section 3 and (U.S. EPA, 2024p)).
- The physical and chemical properties of DCHP indicate that it has low bioaccumulation potential and is unlikely to biomagnify. Therefore, EPA did not analyze the trophic transfer of DCHP through dietary exposures to aquatic organisms (U.S. EPA, 2024p).
- EPA derived a concentration of concern (COC) for reproductive effects of chronic DCHP water exposure of 32 µg/L DCHP to an aquatic invertebrate, *Daphnia magna* (U.S. EPA, 2024o). Empirical toxicity data for laboratory rats were used to estimate a terrestrial mammal hazard threshold of 179.3 mg/kg bw/d DCHP (U.S. EPA, 2024o).
- EPA found no reasonably available definitive environmental hazard data for DCHP exposures to birds, reptiles, sediment-dwelling animals, terrestrial invertebrates, or plants (U.S. EPA, 2024o). Therefore, DCHP hazards to these organisms were not assessed.
- Based on qualitative risk characterization, EPA does not expect risk for any assessed pathways for exposure of DCHP to terrestrial organisms. Risk is not expected because exposure to terrestrial organisms in water, soil, air, and diet is expected to be low (Section 2) and no evidence of DCHP hazard to wild terrestrial organisms was reasonably available (Section 5.2). EPA considered DCHP hazard to laboratory rodents in lieu of reasonably available wild mammal hazard resulting in conservative dietary mammal exposures being at least an order of magnitude lower than the hazard threshold (Section 5.3). The Agency has robust confidence in the preliminary determination of no risk to terrestrial organisms.
- Based on qualitative risk characterization, EPA does not expect risk for acute durations of DCHP exposure to aquatic organisms because reasonably available data found no acute hazard effects up to and above the estimated upper bound of the range of probable water solubility limits (1,480 µg/L) (Section 5.3).
- Based on qualitative risk characterization, EPA does not expect risk of chronic DCHP exposure to aquatic animals. Considerable uncertainties exist about the limit of water solubility, water release estimates, and low flow surface water modeling estimates. No risk was indicated under scenarios of lower limits of water solubility, lower release estimates, more rapid stream flow, and available measured DCHP water concentrations from the literature.

5.1 Summary of Environmental Exposures

EPA assessed environmental concentrations of dicyclohexyl phthalate (DCHP) in air, water, and land (soil, biosolids, and groundwater) for use in environmental exposure. The environmental exposures are described in the *Draft Physical Chemistry and Fate and Transport Assessment for Dicyclohexyl*

Phthalate (DCHP) (U.S. EPA, 2024z) and the *Draft Environmental Media, General Population, and Environmental Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024p). DCHP will preferentially sorb into sediments, soils, particulate matter in air, and in wastewater solids during wastewater treatment. High-quality studies of DCHP biodegradation rates and physical and chemical properties indicate that DCHP will have limited persistence and mobility in soils receiving biosolids (U.S. EPA, 2024z). Surface water, pore water, and sediment concentrations of DCHP were modeled using VVWM-PSC. The PVC plastics compounding COU resulted in the highest estimated release to water, followed by Recycling. DCHP concentrations in receiving waters were estimated for these COUs and ranged from 0.057 µg/L to 165 µg/L DCHP in the water column in low flow (7Q10) conditions. For the land pathways, there are uncertainties in the relevance of limited monitoring data for biosolids and landfill leachate to the COUs considered. However, based on high-quality physical and chemical property data, EPA determined that DCHP will have low persistence potential and mobility in soils. Therefore, groundwater concentrations resulting from releases to the landfill or to agricultural lands via biosolids applications were not quantified but were discussed qualitatively.

Limited measured data were reasonably available from the scientific literature on DCHP concentrations in soils, biosolids, soils receiving biosolids, and landfills. No monitoring data of DCHP in these environments were reasonably available. Limited reasonably available information was available related to the uptake and bioavailability of DCHP soils. Based on the range of estimates of water solubility (30–1,480 µg/L) and hydrophobicity (log Kow = 4.82; log Koc = 4.47), DCHP is expected to have low bioavailability in soil. DCHP has not readily measured or monitored in aquatic or terrestrial organisms and has low bioaccumulation and biomagnification potential. Therefore, DCHP has low potential for trophic transfer through food webs. DCHP is expected to have minimal air to soil deposition.

5.2 Summary of Environmental Hazards

EPA evaluated the reasonably available information for environmental hazard endpoints associated with DCHP exposure to ecological receptors in aquatic and terrestrial ecosystems. The Agency reviewed two references from the peer-reviewed literature and four studies reported by the Japanese Ministry of the Environment that were subsequently summarized by EU ECHA. EPA determined all references had high or medium data quality. These hazards are described in the *Draft Environmental Hazard Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024o).

EPA found limited definitive environmental hazard data for DCHP. The reasonably available studies found all acute exposure hazards to fish, invertebrates, and algae to be higher than the upper bound of the range of probable water solubility limits of 1,480 µg/L DCHP. However, DCHP caused chronic reproductive effects to an aquatic invertebrate (*Daphnia magna*) and a fish species (*Danio rerio*) at concentrations below the water solubility limit. EPA derived a concentration of concern (COC) for reproductive effects of chronic DCHP water exposure of 32 µg/L DCHP.

In terrestrial habitats, the available data suggest that DCHP might cause hazard to terrestrial mammals through dietary exposures. A hazard effects threshold was estimated based on laboratory rodent experiments because wild organism hazard studies were not reasonable available. EPA determined a terrestrial mammal hazard threshold leading to reduced body weight over two generations of dietary exposure to 179.3 mg/kg bw/d DCHP.

No hazard data were reasonably available for birds, reptiles, terrestrial invertebrates, and plants. Therefore, these taxa were not assessed.

5.3 Environmental Risk Characterization

5.3.1 Risk Assessment Approach

The environmental risk characterization of DCHP was conducted to evaluate whether the potential releases and resultant exposures of DCHP in water, air, or soil will exceed the DCHP concentrations observed to result in hazardous effects to aquatic or terrestrial organisms. In evaluating the DCHP exposure concentrations, monitored and modeled DCHP concentrations in surface water were used quantitatively. Concentrations of DCHP in soil (biosolids, landfills, air deposition) and air is limited or is not expected to be bioavailable and were used qualitatively. In evaluating the environmental hazard of DCHP, a weight of evidence approach was used to select hazard threshold concentrations for the derivation of risk quotients for aquatic organisms. A weight of evidence approach was also used to select hazard threshold concentrations for a description of risk for terrestrial organisms.

Environmental risk was characterized by calculating risk quotients or RQs (U.S. EPA, 1998; Barnthouse et al., 1982). The RQ is defined in Equation 5-1 below.

Equation 5-1. Calculating the Risk Quotient

$$RQ = \frac{Predicted\ Environmental\ Concentration}{Hazard\ Threshold}$$

For aquatic organisms, the "effect level" is a derived COC based on a hazard effects concentration. The COC used to calculate RQs for aquatic organisms was derived from hazard values resulting from chronic exposures to DCHP. An RQ equal to 1 indicates that the exposures are the same as the concentration that causes effects. If the RQ exceeds 1, the exposure is greater than the effect concentration and risk is indicated. If the RQ is less than 1, the exposure is less than the effect concentration and risk is not indicated. In this assessment, an initial RQ value was determined only for surface water exposure to aquatic organisms where the worst-case scenario of release, flow, water solubility and chronic invertebrate hazard were considered. After further consideration of realistic conditions and hazards, risk was assessed qualitatively for surface water exposures and all other pathways.

In addition to modeling, environmental monitoring and biomonitoring data were reviewed and screened to assess wildlife exposure to DCHP (U.S. EPA, 2024p). EPA qualitatively assessed the trophic transfer of DCHP through food webs to wildlife using a worst-case scenario and physical and chemical properties. DCHP is not expected to be persistent in the environment as it is expected to degrade rapidly under most environmental conditions with delayed biodegradation in low-oxygen media and DCHP's bioavailability is expected to be limited (U.S. EPA, 2024z). Estimates of the DCHP limit of water solubility range from 30 to 1,480 µg/l, leading to uncertainty about DCHP dissolved in surface water. DCHP is expected to have low bioaccumulation potential, biomagnification potential, and low potential for uptake based on a log BCF (bioconcentration factor) of 2.85 and a log BAF (bioaccumulation factor) of 1.83 (U.S. EPA, 2024p, z).

5.3.2 Risk Estimates for Aquatic and Terrestrial Species

For DCHP, surface water exposure was the only scenario where modeled concentrations could be compared with a hazard threshold or a COC. Thus, EPA calculated an initial RQ for surface water DCHP concentration but did not calculate RQs for other scenarios of exposure to organisms. Instead, because either exposure or hazard effects estimates were not reasonably available for other scenarios,

environmental risk of DCHP to other organisms was characterized by a qualitative description of risk (Table 5-1).

Table 5-1. Relevant Exposure Pathway to Receptors and Corresponding Risk Assessment for the DCHP Environmental Risk Characterization

Exposure Pathway	Receptor	Risk Assessment
Surface water	Chronic exposure to aquatic species (reduced *Daphnia magna* reproduction >21 days)	Qualitative; No risk
	Acute exposure: no hazard up to and above 2,000 µg/L DCHP to fish (*Oryzias latipes*), *D. magna*, and algae (*Raphidocelis subcapitata*)	Qualitative; No risk
Trophic transfer	Terrestrial mammal	Qualitative; No risk
Biosolids	Terrestrial mammal	Qualitative; No risk
Landfills	Terrestrial mammal	Qualitative; No risk

Surface Water

The COC was derived from a study of the hazard effects due to chronic (21-day) aqueous exposures to the freshwater invertebrate, *Daphnia magna* (NITE, 2000) and determined to be 32 µg/L DCHP. The reasonably available studies on Japanese medaka (*Oryzias latipes*), *D. magna*, and the freshwater algae (*Raphidocelis subcapitata*) found no aquatic acute exposure hazards up to and above the water solubility limit of 1,480 µg/L DCHP (U.S. EPA, 2024o).

EPA found no evidence from monitoring reports or the scientific literature that DCHP occurs in surface water at the COC of 32 µg/L. However, EPA modeled surface water release under the most conservative and least likely scenario from the PVC plastics compounding COU. This conservative model included (1) the highest modeled release estimate, (2) the lowest 7-day average flow over 10 years from a generic stream, and (3) the highest modeled estimate of the limit of DCHP water solubility (1,480 µg/L). These conditions are unlikely for at least two reasons. First, it combined the highest release from a facility into a low flow scenario indicative of a small stream. Without site-specific data, EPA does not have evidence that a high release, small stream combination exists in the Unites States. Second, experimental evidence suggests that the functional limit of DCHP water solubility may be near the lower EPA estimated range of 30 µg/L rather than the upper bound of the estimated range of 1,480 µg/L. Specifically, two studies that attempted to find hazard thresholds of DCHP to aquatic organisms report their inability to keep DCHP in solution above 30 to 50 µg/L even with the aid of cosolvents (Swedish Chemicals Agency, 2023; Mathieu-Denoncourt et al., 2016). The VMM-PSC modeled concentrations were 165 µg/L DCHP in surface water and 95 µg/L in porewater over 21 days, which are below the upper bound estimate of the limit of water solubility of 1,480 µg/L (U.S. EPA, 2024aa), but over 3 times greater than the lower bound estimate of the limit of water solubility (30 µg/L) and the water solubility limit (30 µg/L) proposed by the Swedish Chemicals Agency (Swedish Chemicals Agency, 2023).

A first-tier screen computed RQs using the upper bound estimate of water solubility (1,480 µg/L), the highest release, and median low flow (7Q10) and the COC (32 µg/L) over 21 days resulting in a RQ greater than 1. However, RQs were less than 1 under all other scenarios that considered one or more of the following surface water scenarios, higher flow rates (*e.g.*, 75th percentile 7Q10), modeled central tendency release estimates (*e.g.*, 1.11 kg/day), or limits of water solubility at the lower bounded estimate (30 µg/L). Additional uncertainty about the first-tier screen RQ is due to the DCHP COC being derived

from a *Daphnia* study that found a 12.9 percent reduction in offspring reproduction after two to three generations of exposure to 572 µg/L DCHP (NITE, 2000). The exposure concentrations in this experiment were enhance by the use of dimethylformamide as a cosolvent, which resulted in DCHP concentrations well above the lower bound estimate of water solubility (30 µg/L) (NITE, 2000). Therefore, EPA determined a low likelihood of DCHP persisting in surface waters for a long enough duration (21 days) to cause chronic hazard in aquatic invertebrates, and thus a preliminary indication of no risk.

In one available study, DCHP concentrations measured in the water column did not exceed 0.014 µg/L (Keil et al., 2011). Monitoring by the Washington State Department of Ecology resulted in no DCHP detection above the detection limit (0.05 µg/L) (WA DOE, 2022). No information is available on the potential continuous or persistent nature of DCHP in the water column of natural systems or from specific release sites. Modeled concentrations from the Processing/ PVC plastics compounding COU/OES release scenarios coupled with low flow conditions predict unlikely conditions for exposure to exceed COCs. Risk of chronic DCHP exposure to aquatic invertebrates requires surface water concentrations to be three orders of magnitude greater than those reported in the literature as background concentration or at a point source (Keil et al., 2011). Modeled DCHP water concentrations from recycling release scenarios did not indicate risk even in similar low flow conditions.

Sediment and Pore Water

DCHP is expected to partition primarily to soil and sediment, regardless of the compartment of environmental release (U.S. EPA, 2024ai). DCHP is not expected to undergo long-range transport and is expected to be found predominantly in sediments near point sources, with a decreasing trend in sediment concentrations downstream due to DCHP's strong affinity and sorption potential for organic carbon in sediment. EPA's maximum modeled concentrations under low flow conditions of 112 mg/kg/d (U.S. EPA, 2024p) reflect the physical and chemical properties of DCHP and its predicted affinity for sediment (U.S. EPA, 2024z), but may be overestimated due to conservative parameters and the Variable Volume Water Model – Point Source Calculator (VVM-PSC) three compartment model. Also, DCHP is not expected to be persistent in the environment as it is expected to degrade rapidly under most environmental conditions with delayed biodegradation in low-oxygen media (U.S. EPA, 2024z).

EPA found no evidence from monitoring reports or the scientific literature that DCHP occurs in pore water at the COC of 32 µg/L. Porewater DCHP concentrations from VVM-PSC modeling resulted in a maximum of 93 µg/L, which exceeded the DCHP limit of solubility (30 µg/L). EPA found no reasonably available studies on the hazard effects of DCHP sediment exposures to aquatic organisms (U.S. EPA, 2024o). Despite this, the Agency considered the COC of DCHP to *Daphnia* (32 µg/L) to indicate chronic exposure hazard effects to sediment dwelling animals. Because of the water solubility uncertainties described for surface risk to aquatic invertebrates, EPA determined a low likelihood of DCHP persisting in sediment and pore waters for a long enough duration (21 days) to cause chronic hazard in aquatic invertebrates, and thus a preliminary indication of no risk.

Air

No studies on the hazardous effects of DCHP inhalation were reasonably available for EPA to review. Only a few studies that monitored ambient DCHP air concentrations were reasonably available for the Agency to review. DCHP in particulates averaged 0.01 ng/m^3 in one study (Lee et al., 2019). Low to negligible air concentrations are expected from TSCA COUs and air to soil modeling was not conducted. Thus, EPA qualitatively assessed risk using low exposures via air pathways and a preliminary indication of no risk.

Landfill

EPA qualitatively assessed risk of landfill to groundwater and soil DCHP exposure to aquatic and terrestrial organisms. No hazard data were reasonably available for groundwater-dwelling or soil-dwelling animals or plants. EPA considered the COC of DCHP to *Daphnia* (32 µg/L) to indicate chronic exposure hazard effects to groundwater dwelling animals. Empirical toxicity data for rats and mice were used to estimate a hazard threshold value for terrestrial mammals that may ingest soils at 179.3 mg/kg-bw/day (U.S. EPA, 2024o).

DCHP may be deposited into landfills through various waste streams, including consumer waste, residential waste, and industrial waste, as well as through municipal waste like dewatered wastewater biosolids. No studies were identified which reported the concentration of DCHP in landfills or in the surrounding land. There is limited information regarding DCHP in dewatered biosolids, which may be sent to landfills for disposal. DCHP is not expected to be persistent in the environment as it is expected to degrade rapidly under most environmental conditions with delayed biodegradation in low-oxygen media. DCHP is slightly soluble in water (range from 0.03–1,480 mg/L) and has limited potential to leach from landfills into nearby groundwater or surface water systems. However, DCHP is expected to have a high affinity to particulate (log Koc = 4.47) and organic media (log Kow = 4.82), which would cause significant retardation in groundwater and limit leaching to groundwater. Because of its high hydrophobicity and high affinity for soil sorption, it is not expected to be bioavailable for uptake. As a result, the available evidence indicates that migration from landfills to surface water and sediment is limited, and EPA did not model DCHP leaching from landfills to groundwater or surface water systems. EPA determined a low likelihood of DCHP persisting in and being bioavailable in groundwater from landfills for a long enough duration to cause chronic hazard in animals, and thus a preliminary indication of no risk.

There is limited reasonably available information related to the uptake and bioavailability of DCHP in soils. DCHPs solubility and sorption coefficients suggest that bioaccumulation and biomagnification will not be of significant concern for soil-dwelling organisms adjacent to landfills. The combination of factors such as biodegradation (U.S. EPA, 2024z) and the weight of evidence supporting a lack of bioaccumulation and lack of biomagnification supports this qualitative assessment that potential DCHP concentrations in landfills do not present concentrations greater than the hazard thresholds to terrestrial organisms. EPA determined a low likelihood of DCHP persisting and being bioavailable to solid-dwelling animals, plants, or in the diets of mammals for a long enough duration to cause chronic hazard, and thus a preliminary indication of no risk.

Biosolids

EPA qualitatively assessed risk of biosolids to soil DCHP exposure to terrestrial organisms. No hazard data were reasonably available for soil-dwelling animals or plants. Empirical toxicity data for rats and mice were used to estimate a hazard threshold value for terrestrial mammals at 179.3 mg/kg-bw/day (U.S. EPA, 2024o). DCHP may be introduced to biosolids by the absorption or adsorption of DCHP to particulate or organic material during wastewater treatment. Wastewater treatment is expected to remove up to 98 percent of DCHP during wastewater treatment via sorption of DCHP to biosolids (Wu et al., 2019). Modeling of DCHP removal in wastewater treatment predicts sorption to account for a total of 71.2 percent removal of DCHP with 70.6 percent overall removal attributed to biosolid sorption and the remaining 0.6 percent removal attributed to biological treatment (U.S. EPA, 2017). There are currently no reasonably available U.S.-based studies reporting DCHP concentration in biosolids or in soil following land application.

High-end release scenarios were considered not to be applicable to the evaluation of land application of biosolids. More specifically, high-end releases of DCHP from industrial facilities are unlikely to be discharged directly to municipal wastewater treatment plants without pre-treatment, and biosolids from industrial facilities are unlikely to be directly land applied following on-site treatment.

There is limited measured data on concentrations of DCHP in biosolids or soils receiving biosolids and there is uncertainty that concentrations used in this analysis are representative of all types of environmental releases. However, the high-quality biodegradation rates and physical and chemical properties show that DCHP will have limited persistence potential and mobility in soils receiving biosolids (U.S. EPA, 2024z). The combination of factors such as biodegradation and the weight of evidence supporting a lack of bioaccumulation and lack of biomagnification supports this qualitative assessment that potential DCHP concentrations in biosolids do not present concentrations greater than hazard threshold values to terrestrial organisms. Therefore, EPA determined a low likelihood of DCHP persisting and being bioavailable to soil-dwelling animals, plants, or in the diets of mammals for a long enough duration to cause chronic hazard, and thus a preliminary indication of no risk.

Trophic Transfer

EPA did not conduct a quantitative modeling analysis of the trophic transfer of DCHP through food webs because of the chemical properties and fate of DCHP indicate low potential for bioaccumulation or biomagnification. Specifically, the Agency does not expect DCHP to persist in surface water, groundwater, or air. DCHP is not expected to be persistent in the environment as it is expected to degrade rapidly under most environmental conditions with delayed biodegradation in low-oxygen media, and DCHP's bioavailability is expected to be limited (U.S. EPA, 2024z). Estimates of the DCHP limit of water solubility range from 30 to 1,480 µg/L, leading to uncertainty about DCHP dissolved in surface water. DCHP is expected to have low bioaccumulation potential, biomagnification potential, and low potential for uptake based on a log BCF of 2.85 and a log BAF of 1.83 (U.S. EPA, 2024p, z). For example, a worst-case scenario screening that uses the upper bound of water solubility as the water concentration (1,480 µg/L DCHP) and BAF of 67, results in 99 mg/kg-bw DCHP in fish. A similar calculation results in 11 mg/kg-bw DCHP in fish if the highest modeled concentration from EPA's VVM-PSC (164 µg/L) is used. These values are less than the terrestrial mammal threshold value of 179.3 mg/kg-bw/day over 70 days. These values would only be lower in simulations that incorporate other release and exposure scenarios in a trophic transfer model. Finally, EPA also did not find reasonably available data sources that report the aquatic bioconcentration, aquatic bioaccumulation, aquatic food web magnification, terrestrial biota-sediment accumulation, or terrestrial bioconcentration of DCHP. Therefore, EPA determined a low likelihood of DCHP transferring through food webs to reach the terrestrial mammal threshold value of 179.3 mg/kg-bw/day and thus a preliminary indication of no risk.

Distribution in Commerce

EPA evaluated activities resulting in exposures associated with distribution in commerce (*e.g.*, loading, unloading) throughout the various life cycle stages and COUs (*e.g.*, manufacturing, processing, industrial use, commercial use, disposal) rather than a single distribution scenario. The Agency lacks data to assess risks to the environment from environmental releases and exposures related to distribution of DCHP in commerce as a single OES. However, most of the releases from this COU/OES are expected to be captured within the releases of other COU/OES because most of the activities (loading, unloading) generating releases from distribution of commerce are release points of other COU/OESs.

5.3.3 Overall Confidence and Remaining Uncertainties Confidence in Environmental Risk Characterization

The environmental risk characterization of DCHP evaluated confidence from environmental exposures and environmental hazards. Exposure confidence is detailed within U.S. EPA (2024p), the TSD *Draft Environmental Media and General Population and Environmental Exposure Assessment for Dicyclohexyl Phthalate (DCHP)*, represented by modeled and monitored data. Hazard confidence was represented by evidence as reported previously in the *Draft Environmental Hazard Assessment for Dicyclohexyl Phthalate (DCHP)* U.S. EPA (2024o).

The overall confidence in the preliminary risk characterization for the aquatic assessment is robust. EPA has indicated no risk to aquatic organisms under most realistic release, flow, and solubility scenarios except in a scenario with the most conservative assumptions. The Agency has robust confidence that the conservative scenario with worst-case assumptions is unlikely for several reasons. First, EPA has determined DCHP water releases to be low due to its chemical properties and predicted fate (U.S. EPA, 2024z), making modeled exposure predictions greater than COCs unlikely. Also, DCHP is a solid at room temperature with considerable variation in the estimates of water solubility that ranges from 30 µg/L to 1,480 µg/L. Under EPA's release of DCHP to water generic scenarios, the amount of DCHP that may be released to surface water as a solid and the amount that is dissolved in water critically depends on the functional or environmentally relevant solubility of DCHP in water bodies. Evidence from the only available U.S. monitoring study reported the maximum DCHP at 0.014 µg/L (Keil et al., 2011), plus two toxicity studies that reported DCHP leaving solution above 30 µg/L (Swedish Chemicals Agency, 2023; Mathieu-Denoncourt et al., 2016) suggest that EPA's modeled high-end release and low stream flow scenario resulting 165 µg/L DCHP is unlikely to occur in aquatic ecosystems. Thus, no reasonably available evidence reports dissolved water concentrations as high as 165 µg/L and the weight of evidence points to a low likelihood of DCHP concentrations reaching 165 µg/L.

The environmental hazard to aquatic organisms is also not clear because only two peer-reviewed studies and a handful of reports are reasonably available for EPA to review. These studies have high data quality evaluation ratings, but corroborating results from additional studies would improve the accuracy and precision of the Agency's COC for chronic exposure while increasing the confidence for indications of low likelihood of risk. All but two of these studies did not find acute exposure effects at concentrations up to 2,000 µg/L, indicating that short exposure durations pose little risk to aquatic organisms. Chronic exposure effects on reproductive endpoints were documented for an invertebrate and a fish at approximately 30 µg/L DCHP concentrations. All these studies used solvent carriers to keep DCHP in solution. Taken together, it remains unclear whether high concentrations of DCHP in the water column occur in ecosystems and whether these exposure concentrations can persist long enough to incur reproductive effects on aquatic organisms. Thus, the weight of evidence summarized in this document leads to the preliminary characterization of no risk to aquatic receptors.

The overall confidence in the preliminary risk characterization for the terrestrial assessment is robust. EPA has robust confidence that DCHP is not likely to present environmental risk through most scenarios that may expose DCHP to terrestrial organisms. This confidence is due to the relatively low volumes of release across COUs, the physical and chemical properties of DCHP, and the low number of studies that document DCHP in the environment. These result in low to negligible exposure concentrations in air, landfills, biosolids and soils. Trophic transfer of DCHP through food webs is also unlikely due to DCHP's chemical and fate properties that indicate that it has low potential to bioaccumulate or biomagnify in food webs. This weight of evidence of low potential for DCHP exposures in terrestrial ecosystems—coupled with no reasonably available studies of DCHP hazard effects to wildlife and a relatively high surrogate mammal hazard threshold from laboratory rodent data—indicate exposure

above the hazard threshold is an unlikely risk to terrestrial organisms. Although the lack of reasonably available studies on the hazardous effects of DCHP on wildlife does not rule out hazard and subsequent risk, the weight of evidence summarized in this document leads to the preliminary indication that risk to terrestrial receptors is not expected.

6 UNREASONABLE RISK DETERMINATION

TSCA section 6(b)(4) requires EPA to conduct a risk evaluation to determine whether a chemical substance presents an unreasonable risk of injury to health or the environment, without consideration of costs or other non-risk factors, including an unreasonable risk to a PESS identified by EPA as relevant to the risk evaluation, under the TSCA COUs.

EPA is preliminarily determining that DCHP presents an unreasonable risk of injury to human health under the COUs. *The Agency is preliminary determining that DCHP does not present unreasonable risk of injury to the environment.* This draft unreasonable risk determination is based on the information in previous sections of this draft risk evaluation, the appendices, and the TSDs of this draft risk evaluation in accordance with TSCA section 6(b). It is also based on (1) the best available science (TSCA section 26(h)); (2) weight of scientific evidence standards (TSCA section 26(i)); and (3) relevant implementing regulations in 40 CFR part 702, including, to the extent practicable, the amendments to the procedures for chemical risk evaluations under TSCA finalized in May 2024 (89 FR 37028; May 3, 2024).

If, in the final TSCA risk evaluation for DCHP, EPA determines that DCHP presents an unreasonable risk of injury to health or the environment under the COUs, the Agency will initiate risk management for DCHP by applying one or more of the requirements under TSCA section 6(a) to the extent necessary so that DCHP no longer presents such risk. The risk management requirements will likely focus on the COUs significantly contributing to the unreasonable risk. However, under TSCA section 6(a), EPA is not limited to regulating the specific COUs found to significantly contribute to the unreasonable risk and may select from among a suite of risk management options related to manufacture, processing, distribution in commerce, commercial use, and disposal to address the unreasonable risk. For instance, EPA may regulate "upstream" COUs (*e.g.*, processing, distribution in commerce) to address "downstream" COUs that significantly contribute to unreasonable risk (*e.g.*, use)—even if the upstream activities are not significantly contributing to the unreasonable risk. The Agency would also consider whether such risk may be prevented or reduced to a sufficient extent by action taken under another federal law, such as referral to another agency under TSCA section 9(a) or use of another EPA-administered authority to protect against such risk pursuant to TSCA section 9(b), as appropriate.

As noted in the EXECUTIVE SUMMARY, DCHP is used primarily as a plasticizer to make flexible PVC. It is also used to make building and construction materials; automotive care and fuel products; and other commercial and consumer products including adhesives and sealants, paints and coatings, electrical and electronic products. Workers may be exposed to DCHP when making these products or otherwise using DCHP in the workplace. When it is manufactured or used to make products, DCHP can be released into the water, where because of its properties, most of it will end up in the sediment at the bottom of lakes and rivers. If it is released into the air, DCHP will attach to dust particles and then be deposited onto land or into water. Indoors, DCHP has the potential over time to be come out of products and adhere to dust particles. If it does, people could inhale or ingest dust that contains DCHP. In addition to DCHP, workers and consumers can be exposed to other phthalates that have the same toxicological endpoint (*i.e.*, decreased fetal testicular testosterone). EPA has authored a draft cumulative risk technical support document of DCHP and five other toxicologically similar phthalates (*i.e.*, DEHP, DBP, DIBP, BBP, and DINP) that are also being evaluated under TSCA. This TSD will allow EPA to assess the combined risk to health from multiple chemicals with similar effects simultaneously, recognizing that human exposure to phthalates is widespread and that multiple phthalates can disrupt development of the male reproductive system. The use of EPA's cumulative risk assessment (CRA) in the preliminary risk determination is discussed in more detail in Section 6.1.3 as well as the worker (Section 6.1.4) and consumer (Section 6.1.5) sections.

The COUs evaluated for DCHP are listed in Table 1-1. EPA is preliminarily determining the following COUs based on the DCHP individual analysis and the relative potency factor (RPF) analysis, significantly contribute to the unreasonable risk to workers:

- Manufacturing – domestic manufacturing;
- Processing – incorporation into formulation, mixture, or reaction product – adhesive and sealant chemicals in adhesive manufacturing;
- Processing – incorporation into formulation, mixture, or reaction product – plasticizer (adhesive manufacturing; paint and coating manufacturing; and printing ink manufacturing);
- Processing – incorporation into formulation, mixture, or reaction product – stabilizing agent (adhesive manufacturing; asphalt paving, roofing, and coating materials manufacturing; and paints and coating manufacturing)
- Industrial use – finishing agent – cellulose film production;
- Industrial use – inks, toner, and colorant products (*e.g.*, screen printing ink);
- Industrial use – Paints and coatings;
- Commercial use – inks, toner, and colorant products (*e.g.*, screen printing ink); and
- Commercial use – paints and coatings.

EPA is preliminarily determining that the following COUs do *not* significantly contribute to the unreasonable risk:

- Manufacturing – importing;
- Processing – incorporation into article – plasticizer (plastics product manufacturing and rubber product manufacturing);
- Processing – repackaging (*e.g.*, laboratory chemicals);
- Processing – recycling;
- Distribution in commerce;
- Industrial use – adhesives and sealants (*e.g.*, computer and electronic product manufacturing; transportation equipment manufacturing);
- Industrial use – other articles with routine direct contact during normal use including rubber articles; plastic articles (hard) (*e.g.*, transportation equipment manufacturing);
- Commercial use – adhesives and sealants;
- Commercial use – building/construction materials not covered elsewhere;
- Commercial use – laboratory chemicals;
- Commercial use – other articles with routine direct contact during normal use including rubber articles; plastic articles (hard);
- Consumer use – adhesives and sealants;
- Consumer use – other articles with routine direct contact during normal use including rubber articles; plastic articles (hard);
- Consumer use – other consumer articles that contain dicyclohexyl phthalate from: inks, toner, and colorants; paints and coatings; adhesives and sealants (*e.g.*, paper products, textiles, products using cellulose film, etc.); and
- Disposal.

Whether EPA makes a determination of unreasonable risk for a particular chemical substance under TSCA depends upon risk-related factors beyond exceedance of benchmarks, such as the endpoint under consideration, the reversibility of effect, exposure-related considerations (*e.g.*, duration, magnitude, frequency of exposure, population exposed), how PESS groups were considered in the assessment, and the confidence in the information used to inform the hazard and exposure values. For COUs evaluated quantitatively, EPA also considers how central tendency or high-end risk estimates represented the risk

related factors, and the Agency based the risk determination on the risk estimates that best represented the COUs. Additionally, in this draft risk evaluation, EPA describes the strength of the scientific evidence supporting the human health and environmental assessments as robust, moderate, or slight. Robust confidence suggests thorough understanding of the scientific evidence and uncertainties, as well as the supporting weight of scientific evidence, outweighs the uncertainties to the point where it is unlikely that the uncertainties could have a significant effect on the risk. Moderate confidence suggests some understanding of the scientific evidence and uncertainties, and the supporting scientific evidence weighed against the uncertainties is reasonably adequate to characterize the risk. Slight confidence is assigned when the weight of scientific evidence may not be adequate to characterize the risk, and when the Agency is making the best scientific assessment possible in the absence of complete information.

This draft risk evaluation discusses important assumptions and key sources of uncertainty in the risk characterization, and these are described in more detail in the respective weight of scientific evidence conclusions sections for fate and transport, environmental release, environmental exposures, environmental hazards, and human health hazards, respectively. It also includes overall confidence and remaining uncertainties sections for human health and environmental risk characterizations.

Additionally, EPA considered, where relevant, the Agency's analyses on aggregate exposures and cumulative risk. Aggregate exposure analyses consider effects on populations that are exposed to DCHP via multiple routes (*e.g.,* dermal contact, ingestion, and inhalation). Cumulative risk refers to human health risks related to exposures to multiple chemicals—in this case the six phthalates considered in the CRA TSD. EPA has applied the methods and principles of CRA outlined in EPA's *Draft Proposed Approach for Cumulative Risk Assessment (CRA) of High-Priority Phthalates and a Manufacturer-Requested Phthalate under the Toxic Substances Control Act* (U.S. EPA, 2023c) and EPA's *Draft Technical Support Document for the Cumulative Risk Analysis of Di(2-ethylhexyl) Phthalate (DEHP), Dibutyl Phthalate (DBP), Butyl Benzyl Phthalate (BBP), Diisobutyl Phthalate (DIBP), Dicyclohexyl Phthalate (DCHP), and Diisononyl Phthalate (DINP) Under the Toxic Substances Control Act (TSCA)* (U.S. EPA, 2024ah), to derive non-cancer risk estimates for occupational and consumer exposures. These cumulative, non-cancer risk estimates are considered in addition to the individual risk estimates for DCHP. Notably, other authoritative and regulatory agencies (*i.e.,* CPSC, Health Canada, ECHA, NICNAS, EFSA) have evaluated phthalates, including DCHP, for cumulative risk. Further, independent, expert peer reviewers on the SACC endorsed EPA's proposal to conduct a CRA of phthalates under TSCA because it represents the best available science. The Agency's approach for assessing cumulative risk, which is described in detail in the draft CRA TSD (U.S. EPA, 2024ah), incorporates feedback from the SACC (U.S. EPA, 2023f) who peer reviewed EPA's draft proposed approach in May 2023 (U.S. EPA, 2023f).

6.1 Human Health

Calculated non-cancer risk estimates (MOEs) can provide a risk profile of DCHP by presenting a range of estimates for different health effects for different COUs. When characterizing the risk to human health from occupational exposures during risk evaluation under TSCA, EPA conducts baseline assessments of risk and makes its determination of unreasonable risk from a baseline scenario that does not assume use of respiratory protection or other personal protective equipment (PPE).[5] A calculated MOE that is less than the benchmark MOE is a starting point for informing a determination of

[5] It should be noted that, in some cases, baseline conditions may reflect certain mitigation measures, such as engineering controls, in instances where exposure estimates are based on monitoring data at facilities that have engineering controls in place.

unreasonable risk of injury to health, based on non-cancer effects. It is important to emphasize that these calculated risk estimates alone are not bright-line indicators of unreasonable risk.

6.1.1 Populations and Exposures EPA Assessed for Human Health

EPA has evaluated risk to adolescent and adult workers (including ONUs and female workers of reproductive age) 16 years of age and older; consumer users and bystanders, including infants and children; and the general population, including infants and children and people who consume fish. The Agency evaluated these risks using reasonably available monitoring and modeling data for inhalation and dermal exposures, as applicable. EPA has evaluated risk from inhalation and dermal exposure of DCHP to workers, including ONUs, as appropriate for each exposure scenario, but the primary route of exposure was inhalation. The Agency evaluated risk from inhalation, dermal, and oral-exposure to consumer users and inhalation exposures to bystanders. Finally, EPA also evaluated risk from exposures from surface water, drinking water, fish ingestion, ambient air, and land pathways (*i.e.,* landfills and application of biosolids) to the general population.

Descriptions of the data used for human health exposure and human health hazards are provided in Sections 4.1 and 4.2, respectively, in this draft risk evaluation. Uncertainties for overall exposures and hazards are presented in this draft risk evaluation, the *Draft Consumer and Indoor Dust Exposure Assessment for Dicyclohexyl phthalate (DCHP)* (U.S. EPA, 2024c), the *Draft Environmental Media and General Population and Environmental Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024p), the *Draft Environmental Release and Occupational Exposure Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024q), and the *Draft Non-Cancer Human Health Hazard Assessment for Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024v) and are considered in this preliminary unreasonable risk determination.

6.1.2 Summary of Human Health Effects

EPA is preliminarily determining that the unreasonable risk presented by DCHP is due to

- non-cancer effects in workers from inhalation exposures;
- non-cancer effects in workers from aggregate exposures (*i.e.,* inhalation + dermal); and
- non-cancer effects in workers from cumulative exposures (*i.e.,* DCHP + other phthalates).

With respect to health endpoints upon which EPA is basing this preliminary unreasonable risk determination, the Agency has robust overall confidence in the proposed POD based on the developing male reproductive system for use in characterizing risk from exposure to DCHP for acute, intermediate, and chronic exposure scenarios. In addition, overall, EPA has robust confidence in the draft factors used in the RPF analysis and cumulative risk analysis. See Section 4.4 and EPA's *Draft Technical Support Document for the Cumulative Risk Analysis of Di(2-ethylhexyl) Phthalate (DEHP), Dibutyl Phthalate (DBP), Butyl Benzyl Phthalate (BBP), Diisobutyl Phthalate (DIBP), Dicyclohexyl Phthalate (DCHP), and Diisononyl Phthalate (DINP) Under the Toxic Substances Control Act (TSCA)* (U.S. EPA, 2024ah), for further description of the RPF analysis.

DCHP has not been evaluated for carcinogenicity in any two-year cancer bioassays. EPA therefore evaluated the relevance of read-across approaches to assess potential cancer hazards of DCHP based on cancer bioassays and MOA information available for other phthalates being evaluated under TSCA (*i.e.,* DEHP, DBP, BBP, DINP, DIDP) as discussed in the *Draft Cancer Human Health Hazard Assessment for Di(2-ethylhexyl) Phthalate (DEHP), Dibutyl Phthalate (DBP), Butyl Benzyl Phthalate (BBP), Diisobutyl Phthalate (DIBP), and Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2025a). Overall, based on the weight of scientific evidence, EPA preliminarily concludes that potential carcinogenicity of

DCHP is not a significant remaining source of uncertainty in the quantitative and qualitative risk characterization, despite the lack of DCHP carcinogenicity bioassays.

EPA's exposure and overall risk characterization PODs and MOEs are summarized in Section 4.3, with specific health risk estimates for workers (including ONUs), consumers, bystanders, and the general population presented in Section 4.3.2 (workers), Section 4.3.3 (consumers and bystanders), Section 4.3.4 (general population), and Section 4.3.5 (PESS). Again, these MOEs and benchmarks are not bright-lines, and EPA has discretion to consider other risk-related factors when determining if a COU significantly contributes to the unreasonable risk determination of the chemical substance.

6.1.3 Basis for Unreasonable Risk to Human Health

In developing the exposure and hazard assessments for DCHP, EPA analyzed reasonably available information to ascertain whether some human populations may have greater exposure and/or susceptibility than the general population to the hazard posed by DCHP. For this DCHP draft risk evaluation, EPA has accounted for the following PESS groups: people who are expected to have greater exposure to DCHP, such as people exposed to DCHP at work; women of reproductive age; infants and children who frequently have contact with consumer products and/or articles containing high concentrations of DCHP; those who may have greater intake of DCHP per body weight (*e.g.*, infants, children, adolescents); those exposed to DCHP through certain age-specific behaviors (*e.g.*, mouthing by infants and children); and Tribes and subsistence fishers whose diets include large amounts of fish. Additionally, EPA identified population group lifestages that may have greater susceptibility to the health effects of DCHP as PESS, including women of reproductive age, pregnant women, infants, children, and adolescents. A full PESS analysis is provided in Section 4.3.5 of this draft risk evaluation.

Risk estimates based on high-end exposure levels (*e.g.*, 95th percentile, or high intensity scenarios) are generally intended to cover individuals with sentinel exposures, whereas risk estimates at the central tendency exposure are generally estimates of average or typical exposures. For DCHP, EPA was able to calculate risk estimates for PESS groups in this assessment (*e.g.*, female workers of reproductive age, infants and children). In addition, the non-cancer PODs are based on susceptible populations. The POD—which is used for acute, intermediate, and chronic exposure durations—is based on effects observed during pregnancy whereas the intermediate and chronic PODs are based on reproductive effects observed in adolescent males. The use of either central tendency or high-end risk estimates for female workers of reproductive age to make a determination of unreasonable risk was based on assumptions about the COU using reasonably available information about a typical scenario and process within the COU. In determining whether a COU significantly contributes to the unreasonable risk to DCHP, EPA considered the central tendency for most of the occupational estimates. Central tendency values of exposure are often expected to be the most reflective of worker exposures within the DCHP COUs, as explained further in Section 6.1.3.

To make an unreasonable risk determination for consumers, EPA considered risk estimates for consumers (*e.g.*, infants and children) representing high-intensity *exposure* levels, which are distinct from the occupational central-tendency or high-end risk estimates that represent a point within the modeled distribution. For example, high-intensity consumer indoor dust exposure scenarios assumed that people are in their homes for longer periods than the medium- or lower- intensity scenarios. Health parameters were also adjusted for each population, such as inhalation rates used per lifestage.

EPA has also aggregated exposures across certain routes for workers, including ONUs, and consumers for COUs with quantitative risk estimates. For most occupational COUs, aggregation of inhalation and dermal exposures led to negligible differences in risk estimates when compared with risk estimates from

inhalation alone, because inhalation is the predominant route of exposure. For consumers, dermal, oral, and inhalation routes were aggregated, which did not result in any risk estimates below the benchmark MOE, similar to the consumer risks from individual exposure routes. The UF of 10 for human variability that EPA applied to MOEs accounts for increased susceptibility of populations such as children and elderly populations. Detailed information on how EPA characterized sentinel and aggregate risks is provided in Section 4.1.5.

In addition to the analysis done for DCHP alone (referred to as "individual analysis"), EPA applied both the methods and principles of CRA (*Draft Proposed Approach for Cumulative Risk Assessment (CRA) of High-Priority Phthalates and a Manufacturer-Requested Phthalate under the Toxic Substances Control Act* (U.S. EPA, 2023c), as well as the *Draft Technical Support Document for the Cumulative Risk Analysis of Di(2-ethylhexyl) Phthalate (DEHP), Dibutyl Phthalate (DBP), Butyl Benzyl Phthalate (BBP), Diisobutyl Phthalate (DIBP), Dicyclohexyl Phthalate (DCHP), and Diisononyl Phthalate (DINP) Under the Toxic Substances Control Act (TSCA)* (U.S. EPA, 2024ah)), to derive non-cancer risk estimates for occupational and consumer exposures. EPA's draft CRA includes cumulative exposure to other toxicologically similar phthalates being evaluated under TSCA (*i.e.,* DEHP, DBP, BBP, DIBP, and DINP) and uses an "RPF analysis" to characterize risk. Using a meta-analysis and BMD modeling approach to model decreased fetal testicular testosterone, EPA derived an RPF for DCHP of 1.66 based on BMD_{40}. This means DCHP exposures, when multiplied by the relative potency factor and expressed in terms of index chemical (*i.e.,* DBP) equivalents, increased by 66 percent.

The above approach accounts for potency differences among chemicals in a mixture and scales the dose of one chemical to an equitoxic dose of another chemical (*i.e.,* the index chemical). The chemical selected as the index chemical (*i.e.,* DBP) is the best characterized toxicologically and considered to be representative of the type of toxicity elicited by other components of the mixture, which allows EPA to utilize more fetal testicular testosterone data in the low-end range of the dose-response curve to gain a better understanding of the hazards of DCHP at the low-end range of the dose-response curve. Additionally, the index chemical (*i.e.,* DBP) POD is 12.5 percent lower (*i.e.,* more sensitive) than the individual DCHP POD, which also contributes to the lower RPF analysis MOEs as compared with the individual non-scaled DCHP risk estimates. Non-cancer risk associated with exposure to an individual phthalate or a mixture can then be assessed by calculating an MOE, which is then compared with the benchmark MOE. EPA has robust confidence in the proposed POD for the index chemical (*i.e.,* DBP) and the EPA-derived RPF for DCHP used to calculate the RPF analysis and cumulative MOEs.

The draft CRA TSD also includes the addition of a non-attributable cumulative exposure to DEHP, DBP, BBP, DIBP, and DINP as estimated from NHANES urinary biomonitoring data using reverse dosimetry. The NHANES exposure is non-attributable—meaning it cannot be attributed to specific COUs or other sources, but likely includes exposures attributable to both TSCA COUs and other sources (*e.g.,* diet, food packaging cosmetics). However, as discussed in more detail below, DCHP's toxicity reflected in the previously discussed 66 percent increase in exposure expressed in terms of index chemical equivalents is the primary factor leading to lower RPF analysis MOEs and indications of unreasonable risk. Adding in the non-attributable cumulative exposure to other phthalates contributes approximately 7.1 percent to the risk cup for female workers of reproductive age, assuming a benchmark MOE of 30 (see Section 4.4.4 for the cumulative worker risk estimates). EPA has robust confidence in the estimates of non-attributable cumulative exposure derived from NHANES urinary biomonitoring data using reverse dosimetry. Note that this draft risk evaluation has been released for public comment and will undergo independent, expert scientific peer review by the SACC. EPA will issue a final DCHP risk evaluation after considering input from the public and peer reviewers, which will include peer review of EPA's draft RPF analysis.

6.1.4 Workers

EPA took into consideration both the individual analysis and the draft RPF analysis; based on the occupational and cumulative risk estimates and related risk factors from the individual and draft RPF analyses, the Agency is preliminarily determining that the non-cancer effects from worker inhalation exposure to DCHP and worker aggregate exposures to DCHP from manufacturing and eight processing, industrial, and commercial COUs significantly contribute to the unreasonable risk.

Nearly all occupational COUs were quantitatively assessed in the individual analysis. EPA analyzed vapor/mist and/or particulate concentration inhalation exposure in the occupational scenarios, and separate estimates of central tendency and high-end exposures were made for adolescent and adult (16+ years) workers, female workers of reproductive age, and ONUs. Dermal exposure in the OESs in the individual analysis was analyzed using the acute potential dose rate. For the COUs assessed, dermal exposure for ONUs was evaluated using the central tendency estimates for workers because the risk to ONUs are assumed to be equal to or less than risk to workers who handle materials containing DCHP as a part of their job. Risk was not indicated to workers, including ONUs, for any COU at the high-end or central tendency for dermal exposure estimates. More information on occupational risk estimates is in Section 4.3.2 of this risk evaluation.

Within the individual analysis, non-cancer risk estimates were calculated from acute, intermediate, and chronic inhalation and dermal exposures. However, the draft RPF analysis focused on non-cancer risk estimates from acute exposure as there is evidence that effects on the developing male reproductive system can result from a single exposure during the critical window of development. Additionally, because relative potency factors are based on reduced fetal testicular testosterone, EPA considers the most directly applicable populations for the draft RPF analysis to be pregnant women, women of reproductive age, and male infants and male children. More information on the draft RPF analysis is provided in Section 4.4 of this risk evaluation.

In the absence of inhalation monitoring data, EPA used inhalation exposure models to estimate central tendency and high-end worker (including ONU) inhalation exposures using the Particulates Not Otherwise Regulated (PNOR) Model. In the individual analysis, there were multiple COUs where the exposure and risk estimates are based on the assumption that the concentration of DCHP in workplace dust is the same as the maximum concentration of DCHP manufactured or in the product. It is likely that workplace dusts contain a variety of constituents besides the final product, so the concentration of DCHP in workplace dust is likely less than the concentration of DCHP in the final product. Therefore, in those cases, central tendency values of exposure are expected to be the most reflective of worker exposures within the DCHP COUs, and EPA is relying on central tendency when considering estimates from the PNOR model (*i.e.,* dust) in this preliminary unreasonable risk determination.

There are notable differences in the risk estimates from the individual analysis and the RPF analysis for four OESs represented by four COUs: Domestic manufacturing; Processing – incorporation into formulation, mixture, or reaction product – adhesive and sealant chemicals in (adhesive manufacturing); Processing – incorporation into formulation, mixture, or reaction product – plasticizer in (adhesive manufacturing, paint and coating manufacturing, and printing ink manufacturing); and Processing – incorporation into formulation, mixture, or reaction product – stabilizing agent in (adhesive manufacturing, paint and coating manufacturing, and asphalt paving, roofing and coating materials manufacturing). All four COUs have the same risk estimates. At the central tendency in the individual analysis, these COUs have acute inhalation and acute aggregate risk estimates for female workers of reproductive age that initially do not appear to significantly contribute to unreasonable risk because they are slightly above the benchmark of 30 (*i.e.,* MOEs of 36 for acute inhalation and 35 for acute aggregate

exposure). However, at the central tendency using the draft RPF analysis, those same four COUs have acute inhalation and acute aggregate risk estimates for DCHP exposure expressed in index chemical equivalents that are well below the benchmark for female workers of reproductive age (*i.e.*, MOEs of 19.1 for acute inhalation and 18.5 for aggregate exposure). Adding in the non-attributable cumulative phthalate exposure (*i.e.*, NHANES) to the aggregate exposure lowers the MOE only slightly from 18.5 to 17.7. A COU example of the risk estimates is presented in Table 6-1.

Table 6-1. Example of Occupational Risk Estimates for OES Manufacturing (Female Workers of Reproductive Age and Benchmark MOE = 30)

Life Cycle Stage/ Category	Subcategory	OES	Exposure Level	Individual Analysis		RPF Analysis		
				Acute Inhalation Risk Estimates	Acute Aggregate Risk Estimates	Acute Inhalation Risk Estimates	Acute Aggregate Risk Estimates	Cumulative (Acute Aggregate + Cumulative Non-attributable)
Manufacturing – Domestic manufacturing	Domestic manufacturing	Manufacturing	High-End	3.5	3.5	1.8	1.8	1.8
			Central Tendency	36	35	19.1	18.5	17.7

Note that for DCHP, as explained in Section 6.1.3, most of the difference between the MOEs calculated using the individual analysis and the MOEs calculated using the draft RPF analysis is due to scaling DCHP to the index chemical and not to the additional, non-attributable cumulative risk from NHANES. As previously noted, the phthalate selected as the index chemical (*i.e.*, DBP) is the best characterized toxicologically and considered to be representative of the type of toxicity elicited by other components of the mixture. This allows EPA to utilize more fetal testicular testosterone data in the low-end range of the dose-response curve to gain a better understanding of the hazards of DCHP at the low-end range of the dose-response curve. This analysis provides a more robust basis for assessing the dose-response for the common hazard endpoint (*i.e.*, reduced fetal testicular testosterone) across the six toxicologically similar phthalates included in the CRA, including DCHP.

Additionally, there are two COUs associated with PVC plastics compounding, PVC plastics converting, non-PVC material compounding, and non-PVC material converting (*i.e.*, Processing – incorporation into formulation, mixture, or reaction product – plasticizer and Processing – incorporation into formulation, mixture, or reaction product – stabilizing agent) that do not indicate risk in either the individual or the RPF analysis. These OESs have acute inhalation and acute aggregate risk estimates for female workers of reproductive age above the benchmark MOE of 30 in the individual analysis (*i.e.*, MOEs range from 76–378 for acute inhalation and 71–285 for acute aggregate exposure) and for risk estimates based on the RPF analysis (*i.e.*, MOEs range from 40–199 for acute inhalation and 37–150 for acute aggregate DCHP exposure expressed in index chemical equivalents). The acute aggregate MOEs in the RPF analysis range from 34 to 110 when including non-attributable cumulative risk from NHANES.

As a result, EPA is preliminarily determining that those four COUs, with the exception of the activities associated with plastic and rubber manufacturing discussed in the previous paragraph, significantly contribute to the unreasonable risk to human health. This determination is based on the central tendency acute inhalation and aggregate (*i.e.*, inhalation plus dermal) exposure estimates for female workers of reproductive age from the individual analysis, and it takes into consideration the RPF analysis acute inhalation, aggregate and non-attributable cumulative (from NHANES) risk estimates. It is also important to note that while EPA is relying on the central tendency, as it is expected to be the most reflective of worker exposures, the high-end risk estimates for acute inhalation and aggregate risk estimates for female workers of reproductive age for these four COUs are also well below the MOE

benchmark of 30 (*i.e.*, MOEs of 3.5 for acute inhalation and 3.5 for acute aggregate exposure in the individual analysis).

- Manufacturing – domestic manufacturing;
- Processing – incorporation into formulation, mixture, or reaction product – adhesive and sealant chemicals in adhesive manufacturing;
- Processing – incorporation into formulation, mixture, or reaction product – plasticizer in adhesive manufacturing; paint and coating manufacturing; and printing ink manufacturing; and
- Processing – incorporation into formulation, mixture, or reaction product – stabilizing agent in adhesive manufacturing; asphalt paving, roofing, and coating materials manufacturing; and paints and coating manufacturing.

At the central tendency in the individual analysis, there are five other COUs (represented by two OESs that were assessed as paints and coatings both as liquids and solids) that have acute inhalation and aggregate risk estimates for female workers of reproductive age that are above the benchmark MOE of 30 (*i.e.*, MOEs of 41 for acute inhalation and 40 for aggregate exposure for liquids/spray application and MOEs of 62 for acute inhalation and 59 for aggregate exposure for solids) and risk estimates that are below the benchmark at the high-end estimates (*i.e.*, MOEs of 2 for acute inhalation and 2 for aggregate exposure for liquids/spray application and MOEs of 3.5 for acute inhalation and 3.5 for aggregate exposure for solids). As explained above, the central tendency values of exposure are expected to be the most reflective of worker exposures within the DCHP COUs when utilizing the PNOR model, such as for applications of paints and coatings *solids*—because the high-end assumption about the concentration of DCHP in workplace dust is extremely conservative and highly unlikely in actual workplaces. For paints and coatings *liquids*, in general, central tendency represents the typical exposure of most workers to DCHP through spray application; however, a confluence of a subset of variables (*e.g.*, low ventilation, high-pressure spray, *etc.*) would result in risk below the benchmark (of which EPA assessed a DCHP product that resulted in such an example). While most workers are not expected to experience elevated exposures (*i.e.*, greater than 90th percentile of mist concentration data for an 8-hour period) on a daily basis, it is considered plausible and expected for such exposures to occur in an acute 1-day scenario. Therefore, for these COUs, EPA's preliminary risk determination is based on the estimates associated with the high-end scenario. This is consistent with EPA's approach to liquid spray applications in other phthalate risk evaluations.

Additionally, at the high-end in the draft RPF analysis, those same five COUs, which are listed below, have acute inhalation and aggregate risk estimates that are well below the benchmark for female workers of reproductive age for liquids (*i.e.*, MOEs of 1 for acute inhalation and 1 for aggregate exposure for liquid application for high end). Adding in the non-attributable cumulative phthalate exposure (*i.e.*, NHANES) to the aggregate exposure does not impact the high-end estimates at all. A COU example of the risk estimates for both liquids and solids is represented in
Table 6-2; all five COUs (Industrial use of a finishing agent in cellulose film production, Industrial and commercial use of paints and coatings, and Industrial and commercial use of inks, toner, and colorant products [*e.g.*, screen printing ink]) have the same risk estimates for each scenario of liquids vs. solids.

Because risk estimates for liquids in the individual analysis, as well as the draft RPF analysis, are well below the benchmark MOE, EPA is preliminarily determining that those five COUs significantly contribute to the unreasonable risk of injury to human health based on the high-end acute inhalation and aggregate exposure estimates for female workers of reproductive age. The Agency also considered the RPF analysis acute inhalation, aggregate, and non-attributable cumulative (from NHANES) risk estimates.

- Industrial use – finishing agent – cellulose film production;
- Industrial use – inks, toner, and colorant products (*e.g.*, screen printing ink);
- Industrial use – paints and coatings;
- Commercial use – inks, toner, and colorant products (*e.g.*, screen printing ink); and
- Commercial use – paints and coatings.

Table 6-2. Example of Occupational Risk Estimates for OES Applications of Paints and Coatings (Female Workers of Reproductive Age and Benchmark MOE = 30)

Life Cycle Stage/ Category	Subcategory	OES	Exposure Level	Individual Analysis		RPF Analysis		
				Acute Inhalation Risk Estimates	Acute Aggregate Risk Estimates	Acute Inhalation Risk Estimates	Acute Aggregate Risk Estimates	Cumulative (Acute Aggregate + Cumulative Non-attributable)
Industrial Use – Finishing agent	Cellulose film production	Application of paints and coatings – liquids	High-End	2.0	2.0	1.0	1.0	1.0
			Central Tendency	41	40	21.7	21.0	19.9
Industrial Use – Finishing agent	Cellulose film production	Application of paints and coatings – solids	High-End	3.5	3.5	1.9	1.9	1.8
			Central Tendency	62	59	32.7	31.1	28.9

One COU, Distribution in commerce, did not have quantitative risk estimates for workers. For the purposes of the unreasonable risk determination and the individual analysis, distribution in commerce of DCHP includes transporting DCHP or DCHP-containing products between work sites or to final use sites, as well as loading and unloading from transport vehicles. Individuals in occupations that transport DCHP-containing products (*e.g.*, truck drivers) or workers who load and unload transport trucks may encounter DCHP or DCHP-containing products. EPA did not calculate risk estimates for the specific Distribution in commerce COU. The Agency evaluated activities resulting in exposures associated with distribution in commerce (*e.g.*, loading, unloading) throughout the various life cycle stages and COUs (*e.g.*, manufacturing, processing, industrial use, commercial use, disposal) rather than a single distribution scenario. Although some worker activities associated with distribution in commerce are similar to COUs such as manufacturing or import, it is expected that workers involved in distribution in commerce spend less time exposed to DCHP than workers in manufacturing or import facilities because only part of the workday is spent in an area with potential exposure. Therefore, occupational exposures associated with the distribution in commerce COU are expected to be less than other COUs with similar worker activities and the Agency preliminarily determines that distribution in commerce does not significantly contribute to DCHP's unreasonable risk to human health.

In the overall occupational assessment for the individual analysis, EPA has moderate confidence in the assessed occupational inhalation and dermal exposure scenarios (Table 4-5) and robust confidence in the non-cancer POD selected to characterize risk from acute, intermediate, and chronic duration exposures to DCHP. The Agency has moderate confidence in the risk estimates calculated for worker and ONU inhalation and dermal exposure scenarios. More information on EPA's confidence in these risk estimates and the uncertainties associated with them can be found in Section 4.3.2.

For the draft RPF analysis, EPA has robust confidence in the relative potency factors and index chemical POD used to calculate the MOEs. To derive RPFs and the index chemical POD, EPA integrated data from multiple studies evaluating fetal testicular testosterone using a meta-analysis

approach and conducted BMD modeling. This meta-analysis and BMD modeling approach represents a refinement of the NOAEL/LOAEL approach used in the individual DCHP assessment and therefore increases EPA's confidence in the risk estimates (for further information, see Section 4.4). Finally, EPA has robust confidence in the non-attributable cumulative exposure estimates for DEHP, DBP, BBP, DIBP, and DINP derived from NHANES urinary biomonitoring data using reverse dosimetry. Given the fast elimination kinetics of phthalates, NHANES biomonitoring data is not expected to capture low-frequency, high-intensity exposures and therefore is not intended to be an estimate of acute cumulative phthalate exposure. Overall, EPA has moderate confidence in the dermal and inhalation exposure assessments for all nine of the COUs showing risk at the central tendency in the RPF analysis.

6.1.5 Consumers

Based on the consumer risk estimates and related risk factors, EPA's preliminarily determination is that consumer uses do not significantly contribute to the unreasonable risk of DCHP. The consumer and bystander exposure scenarios described in this draft risk evaluation represent a wide selection of consumer use patterns. EPA did not find MOEs that were below the benchmark for any consumer COU.

For DCHP, EPA assessed consumer risk from inhalation, ingestion, and dermal exposures, as well as aggregated exposure across consumer COUs. Consumer and bystander populations assessed were infant (<1 year), toddler (1–2 years), preschooler (3–5 years), middle childhood (6–10 years), young teen (11–15 years), teenager (16–20), and adult (21+ years). A screening-level assessment for consumers was conducted considering high-intensity exposure scenario risk estimates, which relies on conservative assumptions to assess exposures that would be expected to be on the high-end of the expected exposure distribution. All high-end MOEs were above the benchmark MOE for all consumer COUs. MOEs for high-intensity exposure scenarios ranged from 56 to 17,000,000. In addition, the highest levels (acute durations) were calculated using the more sensitive and robust relative potency factor analysis described in Section 4.4.5 and added to estimates of national non-attributable cumulative exposure of five toxicologically similar phthalates (*i.e.*, DEHP, DBP, BBP, DIBP, and DINP) so that an estimate of cumulative risk could be considered. The cumulative risk estimates, listed in Table 4-23, also did not indicate risk to consumers and all MOEs were well above the benchmark for all COUs.

EPA has moderate and robust confidence in the assessed inhalation, ingestion, and dermal consumer exposure scenarios, and robust confidence in the acute, intermediate, and chronic non-cancer PODs selected to characterize risk from acute, intermediate, and chronic duration exposures to DCHP. No intermediate duration was assessed for any consumer use outside of automobile adhesives. The exposure doses used to estimate risk relied on conservative, health-protective inputs and parameters that are considered representative of a wide selection of use patterns. In addition, EPA has robust confidence in the RPFs and index chemical POD used to calculate the RPF analysis and cumulative MOEs as well as in the derived estimates of non-attributable cumulative exposure from NHANES urinary biomonitoring using reverse dosimetry. More information on the Agency's confidence in these risk estimates and the uncertainties associated with them can be found in this draft risk evaluation and the *Draft Consumer and Indoor Dust Exposure Assessment Dicyclohexyl Phthalate (DCHP)* (U.S. EPA, 2024c).

6.1.6 General Population

EPA employed a screening-level approach for general population exposures for DCHP because of limited environmental monitoring data for DCHP and lack of location data for DCHP releases. If risks were not indicated for an individual (adult, infant, etc.) identified as having the potential for the highest exposure associated with a COU for a given pathway of exposure (*i.e.,* at high-end or the 95th percentile), then that pathway was determined not to significantly contribute to the risk and was not further analyzed. Also, as a part of EPA's screening-level approach, the Agency considered the

environmental concentration of DCHP in a given environmental medium resulting from the OES (*e.g.*, PVC plastics compounding) that had the highest release compared with any other OES for the same releasing media. Release estimates from OESs resulting in lower environmental media concentrations were not considered for this screening-level assessment. For DCHP, EPA did not evaluate cumulative risk for the general population from environmental releases because after using the previously described conservative screening-level approach, the Agency did not identify any pathways of concern, indicating that refinement and further evaluation were not necessary. EPA evaluated surface water, sediment, drinking water, fish ingestion, and ambient air pathways quantitatively, and land pathways (*i.e.*, landfills and application of biosolids) qualitatively (see Section 4.1.3).

EPA is preliminarily determining that the COUs do not significantly contribute to the unreasonable risk of DCHP to the general population from the ambient air—including people living or working near facilities (fenceline populations)—based on analysis of non-cancer risk. Although EPA is preliminarily determining that nine COUs significantly contribute to unreasonable risk of DCHP due to occupational exposures (*e.g.*, through dust that a worker may experience in the chemicals industry; see also Section 6.1.4), the general population exposures from DCHP COUs, including those, are minimal and do not indicate unreasonable risk. This is due in part to the physical and chemical properties of DCHP; for example, it has low bioaccumulation potential, low water solubility (1.48 mg/L), low affinity for sorption to soil, and is unlikely to migrate. EPA's preliminary determination for each pathway (*e.g.*, land, surface water, fish ingestion) is discussed below in more detail.

Land Pathway

Due to DCHP's low water solubility (1.48 mg/L) and low persistence under most conditions, DCHP is unlikely to migrate from land-applied biosolids to groundwater via runoff and is unlikely to be present in landfill leachate or be mobile in soils. For these reasons, biosolids and landfill were evaluated qualitatively. As such, EPA does not expect general population exposure to DCHP to occur via the land pathway. Therefore, the Agency is preliminarily determining that the land pathway does not significantly contribute to the unreasonable risk for DCHP. For further information, see Section 4.3.4.

Drinking Water and Incidental Surface Water Ingestion and Dermal Contact

EPA used the highest possible DCHP concentration in surface water due to facility release (*i.e.*, in the immediate water body receiving the effluent) to quantitatively evaluate the risk to the general population from exposure to DCHP from drinking water or incidental ingestion and dermal contact during recreational swimming. The Agency took the high-end exposure estimates associated with the COU with the highest total water column concentration to calculate an MOE. Releases associated with the PVC plastics compounding OES (*i.e.*, plasticizer in plastic material and resin manufacturing and plastics product manufacturing and stabilizing agent in plastics product manufacturing) resulted in the highest total water column concentrations, with the lowest 30-day average flow that occurs once every 5 years (*i.e.*, 30Q5 water concentration) of 126 µg/L without wastewater treatment and 39.6 µg/L when run under an assumption of 68.6 percent wastewater treatment removal efficiency. These water column concentrations were used to estimate dermal exposure and incidental ingestion of DCHP while swimming for adults (21+ years), youths (11–15 years), and children (6–10 years). MOEs for general population exposure through incidental ingestion and dermal contact during swimming were well above the benchmark MOE of 30 and ranged from 2,171 to 6,310 for scenarios assuming no wastewater treatment and from 5,521 to 20,000 for scenarios assuming 68.6 percent wastewater treatment removal efficiency (Table 4-16).

Based on this screening level assessment, risk for non-cancer health effects is not expected for the surface water pathway. For the drinking water pathway, modeled surface water concentrations were

used to estimate drinking water exposures. Drinking water exposure to DCHP was calculated for various age groups—but even at the most susceptible lifestage, infants (birth to <1 year), risk is not expected. Acute MOEs through drinking water ingestion were 135 and 430 without and with wastewater treatment, respectively, for the lifestage (*i.e.*, infants) with the highest exposure (Table 4-16). Therefore, the drinking water pathway is not considered to be a pathway of concern for DCHP exposure for the general population and EPA is preliminarily determining that the drinking water and surface water pathway do not significantly contribute to the unreasonable risk for DCHP for the general population. For further information, see Section 4.3.4.

Fish Ingestion

EPA evaluated potential risk from exposure to DCHP through fish ingestion using a screening-level analysis based on conservative exposure estimates for adults in the general population, adult subsistence fishers, and adult Tribal populations. The Agency started with the water solubility limit as an upper limit of DCHP concentration in surface water and determined refinements were needed because the screening-level risk estimates were below the benchmark MOE of 30. Refinements using modeled concentrations at the 50th percentile (or P50 flow rate) were needed for the adult subsistence fisher and adult Tribal populations because the water solubility limit resulted in risk estimates below the benchmark. Because the P50 modeled concentrations still resulted in risk estimates below benchmarks for Tribal populations, EPA further refined its analysis by incorporating higher flow rates and treatment efficiency. Hydrologic flow data were categorized into median flow (P50), 75th percentile flow (P75), and 90th percentile flow (P90). The Agency expects high-end releases to discharge to surface waters with higher flow conditions (*e.g.*, P75 and P90). Exposure estimates based on the P50 flow rate resulted in risk estimates below the benchmark. Risk estimates for fish ingestion generated at concentrations of DCHP at the water solubility limit or at highest measured concentrations in surface water did not indicate risk to Tribal populations. MOEs based on conservative values, such as surface water concentration from a stormwater catchment area, still resulted in risk estimates that are above their benchmarks. Therefore, EPA is preliminarily determining that fish ingestion does not significantly contribute to the unreasonable risk for DCHP for Tribal members, subsistence fishers, and the general population. For further information, see Section 4.3.4.

Inhalation

EPA estimated ambient air concentrations using results from dispersion scenarios. The highest modeled 95th percentile annual ambient air concentration across all release scenarios was 67.57 µg/m^3 at 100 m from the releasing facility for the Application of paints and coatings OES. This OES was the only one assessed for the purpose of a screening-level assessment as it was associated with the highest ambient air concentration. MOEs for general population exposure through inhalation were both well above the benchmark MOE of 30 (*i.e.*, 192 for acute and 281 for chronic; see also Table 4-18). Therefore, based on this screening-level analysis, risk for non-cancer health effects is not expected for the ambient air pathway and EPA is preliminarily determining that the ambient air pathway does not significantly contribute to the unreasonable risk for DCHP for the general population. For further information, see Section 4.3.4.

EPA expects that general population inhalation exposures from distribution in commerce would be even lower than those for workers. Therefore, the Agency is preliminarily determining that distribution in commerce does not significantly contribute to the unreasonable risk of DCHP.

6.2 Environment

EPA is preliminarily determining that DCHP does not present unreasonable risk of injury to the environment. DCHP is expected to be released to the environment via air, water, biosolids, and disposal

to landfills. The physical and chemical properties of DCHP indicate that it is not expected to be persistent or be mobile in soils and that it has low bioaccumulation potential. Given these characteristics and the data available, the environmental risk characterization for DCHP involved qualitative analysis of risk to aquatic and terrestrial organisms via exposure pathways of surface water, trophic transfer, biosolids, and landfills. EPA has robust confidence in its preliminary determination that all assessed pathways of exposure to terrestrial animals do not significantly contribute to the unreasonable risk of DCHP. The Agency also has robust confidence in its preliminary determination that there is no risk for acute durations of DCHP exposure to aquatic organisms because reasonably available data found no acute hazard effects up to and above the estimated upper bound of water solubility. EPA has preliminarily determined that chronic exposure to aquatic animals does not significantly contribute to the unreasonable risk of DCHP. Considerable uncertainties exist about the limit of water solubility, water release estimates, and low-flow surface water modeling estimates. However, EPA has robust confidence in this preliminary unreasonable risk determination because no risk was indicated under realistic scenarios of lower water solubility, lower release estimates, more rapid stream flow, and available measured DCHP water concentrations from the literature.

6.2.1 Populations and Exposures EPA Assessed for the Environment

EPA assessed environmental concentrations of DCHP in air, water, and land (soil, biosolids, and groundwater) for use in environmental exposure. DCHP will preferentially sorb into sediments, soils, particulate matter in air, and in wastewater solids during wastewater treatment. High-quality studies of DCHP biodegradation rates and physical and chemical properties indicate that DCHP will have limited persistence and mobility in soils receiving biosolids (U.S. EPA, 2024z) and low bioavailability in soil. DCHP is not readily found in aquatic or terrestrial organisms and has low bioaccumulation and biomagnification potential. Therefore, DCHP has low potential for trophic transfer through food webs and DCHP is expected to have minimal air to soil deposition.

Surface water exposure was the only scenario where modeled concentrations could be compared with a COC. The reasonably available studies found all acute exposure hazards to fish, invertebrates, and algae to be higher than the water solubility limit of DCHP, so no unreasonable risk for acute exposures to DCHP in surface water was indicated. For chronic exposures, EPA derived a COC for reproductive effects of chronic DCHP water exposure to an aquatic invertebrate (*Daphnia magna*) (NITE, 2000). The Agency EPA found no evidence that DCHP occurs in surface water at the COC of 32 µg/L. EPA modeled surface water concentrations and under the most conservative and least likely scenario, estimated a high-end concentration of 165 µg/L DCHP and a RQ greater than 1. However, all other scenarios with more realistic release values, stream flow rates, or DCHP water solubility had RQs less than 1. Therefore, EPA determined a low likelihood of DCHP persisting in surface waters for a long enough duration (21 days) to cause chronic hazard in aquatic invertebrates, and thus a preliminary determination that chronic exposure to aquatic animals does not significantly contribute to the unreasonable risk of DCHP.

6.2.2 Summary of Environmental Effects

EPA qualitatively assessed risk via release to surface water and subsequent deposition to sediment as well as the ambient air exposure pathway for its limited contribution via deposition to soil, water, and sediment and is preliminarily identifying

- No adverse effects to aquatic organisms;
- No adverse effects to aquatic dependent mammals; and
- No adverse effects to terrestrial mammals.

EPA did not conduct a quantitative modeling analysis of the trophic transfer of DCHP through food webs because the chemical properties and fate of DCHP indicate low potential for bioaccumulation or biomagnification. Specifically, the Agency does not expect DCHP to persist in surface water, groundwater, or air. DCHP may persist in sediment, soil, biosolids, or landfills after release to these environments, but DCHP's bioavailability is expected to be limited. Finally, EPA also did not find reasonably available data sources that report the aquatic bioconcentration, aquatic bioaccumulation, aquatic food web magnification, terrestrial biota-sediment accumulation, or terrestrial bioconcentration of DCHP. Therefore, the Agency determined a low likelihood of DCHP transferring through food webs thus a preliminary indication of no risk.

As explained in Section 5.3.1, EPA used a screening level approach in this draft risk evaluation using conservative environmental release estimates for occupational COUs with the highest releases to determine whether there is risk to the environment and the general population. The Agency first characterized risk based upon the COU with the highest estimated concentrations for a given pathway, based on the OES and the associated environmental media assessed in the draft risk evaluation. If this exposure concentration did not exceed the hazard thresholds harmful to organisms, EPA based the draft risk determination on this maximum exposure scenario to be most inclusive and protective by encompassing the exposures from other COUs within the OES. The Agency determined that the hazard data for fish, aquatic invertebrates, sediment-dwelling organisms, algae, terrestrial invertebrates, and terrestrial mammals indicated no adverse effects from exposures up to and exceeding the limit of water solubility.

EPA expects that environmental releases from distribution in commerce will be similar or less than the exposure estimates from the COUs evaluated qualitatively, which did not exceed hazard to ecological receptors. Therefore, the Agency has preliminarily determined that distribution in commerce also would not result in exposures that significantly contribute to the unreasonable risk of DCHP.

EPA evaluated down-the-drain releases of DCHP for consumer COUs qualitatively. Although the Agency acknowledges that there may be DCHP releases to the environment via the cleaning and disposal of adhesives, sealants, paints, and coatings, EPA did not quantitatively assess down-the drain and disposal scenarios of consumer products due to limited information from monitoring data and limited availability of modeling tools. However, modeling tools and consideration of the physical and chemical properties of DCHP allows the Agency to conduct a qualitative assessment. DCHP is expected to be persistent as it leaches from consumer products disposed of in landfills. Due to low water solubility, DCHP is likely to be present in landfill leachate up to its aqueous limit of solubility. However, due to its affinity for organic carbon, DCHP is expected to be immobile in groundwater, and even in cases where landfill leachate containing DCHP were to migrate to groundwater, DCHP would likely partition from groundwater to organic carbon present in the subsurface. Therefore, EPA is preliminarily determining that the consumer COUs do not significantly contribute to the unreasonable risk of DCHP due to down-the-drain releases.

6.2.3 Basis for No Unreasonable Risk of Injury to the Environment

Based on the draft risk evaluation for DCHP—including the risk estimates, the environmental effects of DCHP, the exposures, physical and chemical properties of DCHP, and consideration of uncertainties—EPA did not identify risk of injury to the environment that would significantly contribute to the unreasonable risk determination for DCHP. For aquatic organisms, surface water was determined to be the driver of exposure, but the Agency does not expect this pathway to significantly contribute to unreasonable risk to the environment. EPA does not expect exposure to DCHP via water, land, or

dietary pathways to significantly contribute to unreasonable risk to the environment. The overall confidence in the preliminary risk characterizations for aquatic and terrestrial assessments is robust.

6.3 Additional Information Regarding the Basis for Unreasonable Risk

Table 6-3 summarizes the basis for this unreasonable risk determination of injury to human health presented in this draft DCHP risk evaluation. In these tables, a checkmark (✓) indicates how the COU significantly contributes to the unreasonable risk by identifying the type of effect (*e.g.*, non-cancer for human health) and the exposure route to the population that results in such significant contribution. As explained in Section 6.1, for this draft unreasonable risk determination, EPA has considered the effects of DCHP to human health at the central tendency and high-end, as well as effects of DCHP to human health and the environment from the exposures associated with the COU, risk estimates, and uncertainties in the analysis. In addition, certain exposure routes for some COUs were not assessed because it was determined that there was no viable exposure pathway. These COUs and their respective exposure routes are grayed-out in Table 6-3. Checkmarks in Table 6-3 represent risk at the high-end and central tendency exposure level as discussed in Section 6.1. See Sections 4.3 and 5.3 for a summary of risk estimates.

4536 **Table 6-3. Supporting Basis for the Draft Unreasonable Risk Determination for Human Health[a] (Occupational COUs)**

Life Cycle Stage	Category	Subcategory	Population	Exposure Route [b]	Acute	Life Cycle Stage	Category
Manufacturing	Domestic manufacturing	Domestic manufacturing	Average Adult Worker	Dermal			
				Inhalation			
				Aggregate			
			Female Worker of Reproductive Age [c]	Dermal			
				Inhalation	✓		
				Aggregate	✓		
			ONU	Dermal			
				Inhalation			
	Importing	Importing	Average Adult Worker	Dermal			
				Inhalation			
				Aggregate			
			Female Worker of Reproductive Age	Dermal			
				Inhalation			
				Aggregate			
			ONU	Dermal			
				Inhalation			
	Processing – incorporation into formulation, mixture, or reaction product	Adhesive and sealant chemicals in: – Adhesive Manufacturing	Average Adult Worker	Dermal			
				Inhalation			
				Aggregate			
			Female Worker of Reproductive Age	Dermal			
				Inhalation	✓		
				Aggregate	✓		
			ONU	Dermal			
				Inhalation			
		Plasticizer in: –Adhesive manufacturing – Paint and coating manufacturing – Printing ink manufacturing	Average Adult Worker	Dermal			
				Inhalation			
				Aggregate			

Life Cycle Stage	Category	Subcategory	Population	Exposure Route [b]	Acute	Life Cycle Stage	Category
Processing	Processing – incorporation into formulation, mixture, or reaction product	Plasticizer in: –Adhesive manufacturing – Paint and coating manufacturing – Printing ink manufacturing	Female Worker of Reproductive Age	Dermal			
				Inhalation	✓		
				Aggregate	✓		
			ONU	Dermal			
				Inhalation			
		Plasticizer in: – Plastic material and resin manufacturing – Plastics product manufacturing – Rubber product manufacturing	Average Adult Worker	Dermal			
				Inhalation			
				Aggregate			
			Female Worker of Reproductive Age	Dermal			
				Inhalation			
				Aggregate			
			ONU	Dermal			
				Inhalation			
		Stabilizing agent in: – Adhesive manufacturing – Asphalt paving, roofing, and coating materials manufacturing – Paint and coating manufacturing	Average Adult Worker	Dermal			
				Inhalation			
				Aggregate			
			Female Worker of Reproductive Age	Dermal			
				Inhalation	✓		
				Aggregate	✓		
			ONU	Dermal			
				Inhalation			
		Stabilizing agent in: – Plastics product manufacturing	Average Adult Worker	Dermal			
				Inhalation			
				Aggregate			
			Female Worker of Reproductive Age	Dermal			
				Inhalation			
				Aggregate			

Life Cycle Stage	Category	Subcategory	Population	Exposure Route [b]	Acute	Life Cycle Stage	Category
Processing			ONU	Dermal			
				Inhalation			
	Processing – incorporation into article	Plasticizer in: – Plastics product manufacturing – Rubber product manufacturing	Average Adult Worker	Dermal			
				Inhalation			
				Aggregate			
			Female Worker of Reproductive Age	Dermal			
				Inhalation			
				Aggregate			
			ONU	Dermal			
				Inhalation			
	Repackaging	Repackaging (*e.g.*, laboratory chemical)	Average Adult Worker	Dermal			
				Inhalation			
				Aggregate			
			Female Worker of Reproductive Age	Dermal			
				Inhalation			
				Aggregate			
			ONU	Dermal			
				Inhalation			
	Recycling	Recycling	Average Adult Worker	Dermal			
				Inhalation			
				Aggregate			
			Female Worker of Reproductive Age	Dermal			
				Inhalation			
				Aggregate			
			ONU	Dermal			
				Inhalation			

Life Cycle Stage	Category	Subcategory	Population	Exposure Route [b]	Acute	Life Cycle Stage	Category
Distribution in Commerce	Distribution in Commerce	Distribution in commerce	Worker	Dermal			
				Inhalation			
			ONU	Dermal			
				Inhalation			
Industrial Use	Adhesive and sealants	Adhesives and sealants (*e.g.*, computer and electronic product manufacturing; transportation equipment manufacturing)	Average Adult Worker	Dermal			
				Inhalation			
				Aggregate			
			Female Worker of Reproductive Age	Dermal			
				Inhalation			
				Aggregate			
			ONU	Dermal			
				Inhalation			
	Finishing agent	Cellulose film production	Average Adult Worker	Dermal			
				Inhalation			
				Aggregate			
			Female Worker of Reproductive Age	Dermal			
				Inhalation	✓		
				Aggregate	✓		
			ONU	Dermal			
				Inhalation			
	Inks, toner, and colorant products	Inks, toner, and colorant products (*e.g.*, screen printing ink)	Average Adult Worker	Dermal			
				Inhalation			
				Aggregate			
			Female Worker of Reproductive Age	Dermal			
				Inhalation	✓		
				Aggregate	✓		
			ONU	Dermal			

Life Cycle Stage	Category	Subcategory	Population	Exposure Route [b]	Acute	Life Cycle Stage	Category
Industrial Use				Inhalation			
	Paints and coatings	Paints and coatings	Average Adult Worker	Dermal			
				Inhalation			
				Aggregate			
			Female Worker of Reproductive Age	Dermal			
				Inhalation	✓		
				Aggregate	✓		
			ONU	Dermal			
				Inhalation			
	Other articles with routine direct contact during normal use including rubber articles; plastic articles (hard)	Other articles with routine direct contact during normal use including rubber articles; plastic articles (hard) (*e.g.*, transportation equipment manufacturing)	Average Adult Worker	Dermal			
				Inhalation			
				Aggregate			
			Female Worker of Reproductive Age	Dermal			
				Inhalation			
				Aggregate			
			ONU	Dermal			
				Inhalation			
Commercial Use	Adhesives and sealants	Adhesives and sealants	Average Adult Worker	Dermal			
				Inhalation			
				Aggregate			
			Female Worker of Reproductive Age	Dermal			
				Inhalation			
				Aggregate			
			ONU	Dermal			
				Inhalation			
		Building/construction materials not covered elsewhere	Average Adult Worker	Dermal			
				Inhalation			

Life Cycle Stage	Category	Subcategory	Population	Exposure Route [b]	Acute	Life Cycle Stage	Category
Commercial Use	Building/construction materials not covered elsewhere			Aggregate			
			Female Worker of Reproductive Age	Dermal			
				Inhalation			
				Aggregate			
			ONU	Dermal			
				Inhalation			
	Inks, toner, and colorant products	Inks, toner, and colorant products (*e.g.*, screen printing ink)	Average Adult Worker	Dermal			
				Inhalation			
				Aggregate			
			Female Worker of Reproductive Age	Dermal			
				Inhalation	✓		
				Aggregate	✓		
			ONU	Dermal			
				Inhalation			
	Laboratory chemicals	Laboratory chemicals	Average Adult Worker	Dermal			
				Inhalation			
				Aggregate			
			Female Worker of Reproductive Age	Dermal			
				Inhalation			
				Aggregate			
			ONU	Dermal			
				Inhalation			
	Paints and coatings	Paints and coatings	Average Adult Worker	Dermal			
				Inhalation			
				Aggregate			
			Female Worker of Reproductive Age	Dermal			
				Inhalation	✓		

Life Cycle Stage	Category	Subcategory	Population	Exposure Route [b]	Acute	Life Cycle Stage	Category
Commercial Use				Aggregate	✓		
			ONU	Dermal			
				Inhalation			
	Other articles with routine direct contact during normal use including rubber articles; plastic articles (hard)	Other articles with routine direct contact during normal use including rubber articles; plastic articles (hard)	Average Adult Worker	Dermal			
				Inhalation			
				Aggregate			
			Female Worker of Reproductive Age	Dermal			
				Inhalation			
				Aggregate			
			ONU	Dermal			
				Inhalation			
Disposal	Disposal	Disposal	Average Adult Worker	Dermal			
				Inhalation			
				Aggregate			
			Female Worker of Reproductive Age	Dermal			
				Inhalation			
				Aggregate			
			ONU	Dermal			
				Inhalation			

[a] Grayed-out boxes indicate certain exposure routes that were not assessed because it was determined that there was no viable exposure pathway.
[b] Inhalation, dermal, and aggregate risk estimates were generated for each COU for workers (average adult and women of reproductive age) and ONUs if it was determined that there was a viable exposure pathway.
[c] EPA analyzed and presented risk for female workers of reproductive age, which are a subset of the average adult worker population, separately due to the greater susceptibility of developing fetuses to adverse health effects from phthalate exposure.

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APPENDICES

Appendix A KEY ABBREVIATIONS AND ACRONYMS

ADD	Average daily dose
ADC	Average daily concentration
BBP	Butyl benzyl phthalate
BLS	Bureau of Labor Statistics
CASRN	Chemical Abstracts Service Registry Number
CBI	Confidential business information
CDR	Chemical Data Reporting
CEHD	Chemical Exposure Health Data
CEM	Consumer Exposure Model
CFR	Code of Federal Regulations
COC	Concentration of concern
CPSC	Consumer Product Safety Commission
CRA	Cumulative risk assessment
DBP	Dibutyl phthalate
DCHP	Dicyclohexyl phthalate
DEHP	Diethylhexyl phthalate
DIBP	Diisobutyl phthalate
DIDP	Diisodecyl phthalate
DINP	Dicyclohexyl phthalate
DIY	Do-it-yourself
EPA	Environmental Protection Agency
ESD	Emission scenario document
EU	European Union
FDA	Food and Drug Administration
GS	Generic scenario
K_{OC}	Soil organic carbon: water partitioning coefficient
K_{OW}	Octanol: water partition coefficient
HEC	Human equivalent concentration
HED	Human equivalent dose
IADD	Intermediate average daily dose
IR	Ingestion rate
LCD	Life cycle diagram
LOAEL	Lowest-observed-adverse-effect level
Log K_{OC}	Logarithmic organic carbon: water partition coefficient
Log K_{OW}	Logarithmic octanol: water partition coefficient
MOA	Mode of action
MOE	Margin of exposure
NAICS	North American Industry Classification System
NHANES	National Health and Nutrition Examination Survey
NICNAS	National Industrial Chemicals Notification and Assessment Scheme
NOAEL	No-observed-adverse-effect level
NPDES	National Pollutant Discharge Elimination System
OCSPP	Office of Chemical Safety and Pollution Prevention
OECD	Organisation for Economic Co-operation and Development
OES	Occupational exposure scenario

OEV	Occupational exposure value
ONU	Occupational non-user
OPPT	Office of Pollution Prevention and Toxics
OSHA	Occupational Safety and Health Administration
PBZ	Personal breathing zone
PESS	Potentially exposed or susceptible subpopulations
PND	Postnatal day
PNOR	Particulates not otherwise regulated
POD	Point of departure
PV	Production volume
PVC	Polyvinyl chloride
RPF	Relative potency factor
RQ	Risk quotient
SACC	Science Advisory Committee on Chemicals
SDS	Safety data sheet
SOC	Standard occupational classification
SpERC	Specific emission release category
TRI	Toxic Release Inventory
TRV	Toxicity reference value
TSCA	Toxic Substances Control Act
TSD	Technical support document
TWA	Time-weighted average
UF	Uncertainty factor
U.S.	United States
WWTP	Wastewater treatment plant
7Q10	The lowest 7-day average flow that occurs (on average) once every 10 years
30Q5	The lowest 30-day average flow that occurs (on average) once every 5 years

Appendix B REGULATORY AND ASSESSMENT HISTORY

B.1 Federal Laws and Regulations

Table_Apx B-1. Federal Laws and Regulations

Statutes/Regulations	Description of Authority/Regulation	Description of Regulation
EPA statutes/regulations		
Toxic Substances Control Act (TSCA) – section 6(b)	EPA is directed to identify high-priority chemical substances for risk evaluation; and conduct risk evaluations on at least 20 high priority substances no later than 3.5 years after the date of enactment of the Frank R. Lautenberg Chemical Safety for the 21st Century Act.	DCHP is one of the 20 chemicals EPA designated as a high-priority substance for risk evaluation under TSCA (84 FR 71924, December 30, 2019). Designation of DCHP as high-priority substance constitutes the initiation of the risk evaluation on the chemical.
Toxic Substances Control Act (TSCA) – section 8(a)	The TSCA section 8(a) CDR Rule requires manufacturers (including importers) to give EPA basic exposure-related information on the types, quantities, and uses of chemical substances produced domestically and imported into the United States.	DCHP manufacturing (including importing), processing and use information is reported under the CDR rule (85 FR 20122, April 9, 2020).
Toxic Substances Control Act (TSCA) – section 8(b)	EPA must compile, keep current and publish a list (the TSCA Inventory) of each chemical substance manufactured (including imported) or processed in the United States.	DCHP was on the initial TSCA Inventory and therefore was not subject to EPA's new chemicals review process under TSCA Section 5 (60 FR 16309, March 29, 1995).
Clean Water Act (CWA) – sections 301, 304, 306, 307, and 402	Clean Water Act section 307(a) established a list of toxic pollutants or combination of pollutants under the CWA. The statute specifies a list of families of toxic pollutants also listed in the Code of Federal Regulations at 40 CFR part 401.15. The "priority pollutants" specified by those families are listed in 40 CFR part 423 Appendix A. These are pollutants for which best available technology effluent limitations must be established on either a national basis through rules (sections 301(b), 304(b), 307(b), 306) or on a case-by-case best professional judgement basis in NPDES permits, see section 402(a)(1)(B). EPA identifies the best available technology that is economically achievable for that industry after considering statutorily prescribed factors and sets regulatory requirements based on the performance of that technology.	As a phthalate ester, DCHP is designated as a toxic pollutant under section 307(a)(1) of the CWA, and as such is subject to effluent limitations (40 CFR 401.15).
Other federal statutes/regulations		

Statutes/Regulations	Description of Authority/Regulation	Description of Regulation
Federal Food, Drug, and Cosmetic Act (FFDCA)	Provides the Food and Drug Administration (FDA) with authority to oversee the safety of food, drugs, and cosmetics, except residues of pesticides in food are regulated by EPA under FFDCA section 408 (discussed above where applicable).	DCHP is listed as an optional substance to be used in: adhesives to be used as components of articles intended for use, in accordance with prescribed conditions, in packaging, transporting, or holding food (21 CFR section 175.105); the base sheet and coating of cellophane (21 CFR section 177.1200); plasticizers in polymeric substances (21 CFR section 178.3740).
Consumer Product Safety Improvement Action of 2008 (CPSIA)	Under section 108 of the Consumer Product Safety Improvement Act of 2008 (CPSIA), CPSC prohibits the manufacture for sale, offer for sale, distribution in commerce or importation of eight phthalates in toys and childcare articles at concentrations >0.1%: DEHP, DBP, BBP, DINP, DIBP, DPENP, DHEXP and DCHP.	The use of DCHP at concentrations >0.1% is banned in toys and childcare articles (16 CFR part 1307).

B.2 State Laws and Regulations

Table_Apx B-2. State Laws and Regulations

State Actions	Description of Action
Chemicals of High Concern to Children	Several states have adopted reporting laws for chemicals in children's products containing DCHP, including Maine (38 MRSA Chapter 16-D) and Washington State (Wash. Admin. Code 173-334-130).
Other	DCHP is listed as a Candidate Chemical under California's Safer Consumer Products Program established under Health and Safety Code section 25252 and 25253 (California, Candidate Chemical List. Accessed April 16, 2019). California lists DCHP as a designated priority chemical for biomonitoring under criteria established by California SB 1379 (Biomonitoring California, Priority Chemicals, February 2019). Oregon lists DCHP as a toxic air contaminant (OAR 340-245-8020 Table 2).

B.3 International Laws and Regulations

Table_Apx B-3. International Laws and Regulations

Country/ Organization	Requirements and Restrictions
European Union	On June 27, 2018, DCHP was listed on the Candidate List as a Substance of Very High Concern (SVHC) under regulation (EC) No 1907/2006 - REACH (Registration, Evaluation, Authorization and Restriction of Chemicals because it is toxic for reproduction (Article 57(c) and has endocrine disrupting properties (Article 57(f) - human health). DCHP was evaluated under the 2017 Community rolling action plan (CoRAP) under regulation (European Commission [EC]) No1907/2006 - REACH (Registration, Evaluation, Authorization and Restriction of Chemicals) (European Chemicals Agency (ECHA) database. Accessed April 16, 2019).

Country/ Organization	Requirements and Restrictions
Australia	DCHP was assessed under Human Health Tier II of the Inventory Multi-Tiered Assessment and Prioritization (IMAP) as part of the C4-6 side chain transitional phthalates. Uses reported include in adhesives and printing inks (NICNAS, 2016, Human Health Tier II assessment for C4-6 side chain transitional phthalates). In addition, DCHP was assessed under Environment Tier II of IMAP as part of the phthalate esters. In 2015, DCHP was also assessed as a Priority Existing Chemical (Assessment Report No. 40) (National Industrial Chemicals Notification and Assessment Scheme (NICNAS). Chemical inventory. Database accessed April 3, 2019).
Japan	DCHP is regulated in Japan under the following legislation: • Act on the Evaluation of Chemical Substances and Regulation of Their Manufacture, etc. (Chemical Substances Control Law; CSCL) • Act on Confirmation, etc. of Release Amounts of Specific Chemical Substances in the Environment and Promotion of Improvements to the Management Thereof. (National Institute of Technology and Evaluation [NITE] Chemical Risk Information Platform [CHRIP]. Accessed April 16, 2019).
Austria, Denmark, Ireland, New Zealand, United Kingdom	Occupational exposure limits for DCHP (GESTIS International limit values for chemical agents (Occupational exposure limits, OELs) database. Accessed April 18, 2017). Austria, Ireland, New Zealand and the United Kingdom have an eight-hours limit of 5 mg/m^3. Denmark has an eight-hours limit of 3 mg/m^3 and a short-term limit of 6 mg/m^3.

B.4 Assessment History

Table_Apx B-4. Assessment History of DCHP

Authoring Organization	Publication
U.S. EPA publications	
–	–
Other U.S.-based organizations	
U.S. Consumer Product Safety Commission (CPSC)	Chronic Hazard Panel on Phthalates and Phthalate Alternatives Final Report (with Appendices) (U.S. CPSC, 2014) Toxicity Review of DCHP (U.S. CPSC, 2010)
International	
European Union, European Chemicals Agency (ECHA)	Committee for Risk Assessment RAC Opinion proposing harmonised classification and labelling at EU level of DCHP, EC number: 201-545-9, CAS number: 84-61-7 (ECHA, 2014)
Government of Canada, Environment Canada, Health Canada	Screening Assessment: Phthalate Substance Grouping (ECCC/HC, 2020) State of the science report: Phthalate substance grouping: Medium-chain phthalate esters: Chemical Abstracts Service Registry Numbers: 84-61-7; 84-64-0; 84-69-5; 523-31-9; 5334-09-8;16883-83-3; 27215-22-1; 27987-25-3; 68515-40-2; 71888-89-6 (EC/HC, 2015)

Authoring Organization	Publication
National Industrial Chemicals Notification and Assessment Scheme (NICNAS), Australian Government	C4-6 side chain transitional phthalates: Human health tier II assessment (NICNAS, 2016) Phthalates hazard compendium: A summary of physicochemical and human health hazard data for 24 ortho-phthalate chemicals (NICNAS, 2008)

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Appendix C LIST OF TECHNICAL SUPPORT DOCUMENTS

Appendix C incudes a list and citations for all supplemental documents included in the Draft Risk Evaluation for DCHP.

Associated **Systematic Review Protocol and Data Quality Evaluation and Data Extraction** Documents – Provide additional detail and information on systematic review methodologies used as well as the data quality evaluations and extractions criteria and results.

Draft Systematic Review Protocol for Dicyclohexyl Phthalate (DCHP) (U.S. EPA, 2024ag) – In lieu of an update to the *Draft Systematic Review Protocol Supporting TSCA Risk Evaluations for Chemical Substances*, also referred to as the "2021 Draft Systematic Review Protocol" (U.S. EPA, 2021a), this systematic review protocol for the Draft Risk Evaluation for DCHP describes some clarifications and different approaches that were implemented than those described in the 2021 Draft Systematic Review Protocol in response to (1) SACC comments, (2) public comments, or (3) to reflect chemical-specific risk evaluation needs. This supplemental file may also be referred to as the "DCHP Systematic Review Protocol."

Draft Data Quality Evaluation and Data Extraction Information for Physical and Chemical Properties for Dicyclohexyl Phthalate (DCHP) (U.S. EPA, 2024j) – Provides a compilation of tables for the data extraction and data quality evaluation information for DCHP. Each table shows the data point, set, or information element that was extracted and evaluated from a data source that has information relevant for the evaluation of physical and chemical properties. This supplemental file may also be referred to as the "DCHP Data Quality Evaluation and Data Extraction Information for Physical and Chemical Properties."

Draft Data Quality Evaluation and Data Extraction Information for Environmental Fate and Transport for Dicyclohexyl Phthalate (DCHP) (U.S. EPA, 2024h) – Provides a compilation of tables for the data extraction and data quality evaluation information for DCHP. Each table shows the data point, set, or information element that was extracted and evaluated from a data source that has information relevant for the evaluation for Environmental Fate and Transport. This supplemental file may also be referred to as the "DCHP Data Quality Evaluation and Data Extraction Information for Environmental Fate and Transport."

Draft Data Quality Evaluation and Data Extraction Information for Environmental Release and Occupational Exposure for Dicyclohexyl Phthalate (DCHP) (U.S. EPA, 2024i) – Provides a compilation of tables for the data extraction and data quality evaluation information for DCHP. Each table shows the data point, set, or information element that was extracted and evaluated from a data source that has information relevant for the evaluation of environmental release and occupational exposure. This supplemental file may also be referred to as the "DCHP Data Quality Evaluation and Data Extraction Information for Environmental Release and Occupational Exposure."

Draft Data Quality Evaluation Information for General Population, Consumer, and Environmental Exposure for Dicyclohexyl Phthalate (DCHP) (U.S. EPA, 2024l) – Provides a compilation of tables for the data quality evaluation information for DCHP. Each table shows the data point, set, or information element that was evaluated from a data source that has information relevant for the evaluation of general population, consumer, and environmental exposure. This supplemental file may also be referred to as the "DCHP Data Quality Evaluation Information for General Population, Consumer, and Environmental Exposure."

Draft Data Extraction Information for General Population, Consumer, and Environmental Exposure for Dicyclohexyl Phthalate (DCHP) (U.S. EPA, 2024g) – Provides a compilation of tables for the data extraction for DCHP. Each table shows the data point, set, or information element that was extracted from a data source that has information relevant for the evaluation of general population, consumer, and environmental exposure. This supplemental file may also be referred to as the "DCHP Data Extraction Information for General Population, Consumer, and Environmental Exposure."

Draft Data Quality Evaluation Information for Human Health Hazard Epidemiology for Dicyclohexyl Phthalate (DCHP) (U.S. EPA, 2024n) – Provides a compilation of tables for the data quality evaluation information for DCHP. Each table shows the data point, set, or information element that was evaluated from a data source that has information relevant for the evaluation of epidemiological information. This supplemental file may also be referred to as the "DCHP Data Quality Evaluation Information for Human Health Hazard Epidemiology."

Draft Data Quality Evaluation Information for Human Health Hazard Animal Toxicology for Dicyclohexyl Phthalate (DCHP) (U.S. EPA, 2024m) – Provides a compilation of tables for the data quality evaluation information for DCHP. Each table shows the data point, set, or information element that was evaluated from a data source that has information relevant for the evaluation of human health hazard animal toxicity information. This supplemental file may also be referred to as the "DCHP Data Quality Evaluation Information for Human Health Hazard Animal Toxicology."

Draft Data Quality Evaluation Information for Environmental Hazard for Dicyclohexyl Phthalate (DCHP) (U.S. EPA, 2024k) – Provides a compilation of tables for the data quality evaluation information for DCHP. Each table shows the data point, set, or information element that was evaluated from a data source that has information relevant for the evaluation of environmental hazard toxicity information. This supplemental file may also be referred to as the "DCHP Data Quality Evaluation Information for Environmental Hazard."

Draft Data Extraction Information for Environmental Hazard and Human Health Hazard Animal Toxicology and Epidemiology for Dicyclohexyl Phthalate (DCHP) (U.S. EPA, 2024f) – Provides a compilation of tables for the data extraction for DCHP. Each table shows the data point, set, or information element that was extracted from a data source that has information relevant for the evaluation of environmental hazard and human health hazard animal toxicology and epidemiology information. This supplemental file may also be referred to as the "DCHP Data Extraction Information for Environmental Hazard and Human Health Hazard Animal Toxicology and Epidemiology."

Associated **Technical Support Documents (TSDs)** – Provide additional details and information on exposure, hazard, and risk assessments.

Draft Physical Chemistry and Fate and Transport Assessment for Dicyclohexyl Phthalate (DCHP) (DCHP) (U.S. EPA, 2024z).

Draft Environmental Release and Occupational Exposure Assessment for Dicyclohexyl Phthalate (DCHP) (U.S. EPA, 2024q).

Draft Consumer and Indoor Dust Exposure Assessment for Dicyclohexyl Phthalate (DCHP) (U.S. EPA, 2024c).

Draft Environmental Media and General Population and Environmental Exposure Assessment for Dicyclohexyl Phthalate (DCHP) (U.S. EPA, 2024p).

Draft Environmental Hazard Assessment for Dicyclohexyl Phthalate (DCHP) (U.S. EPA, 2024o).

Draft Non-Cancer Human Health Hazard Assessment for Dicyclohexyl Phthalate (DCHP) (U.S. EPA, 2024v).

Draft Cancer Human Health Hazard Assessment for Di(2-ethylhexyl) Phthalate (DEHP), Dibutyl Phthalate (DBP), Butyl Benzyl Phthalate (BBP), Diisobutyl Phthalate (DIBP), and Dicyclohexyl Phthalate (DCHP) (U.S. EPA, 2024b).

Draft Consumer Risk Calculator for Dicyclohexyl Phthalate (DCHP) (U.S. EPA, 2024e).

Draft Consumer Exposure Analysis for Dicyclohexyl Phthalate (DCHP) (U.S. EPA, 2024d).

Draft Risk Calculator for Occupational Exposures for Dicyclohexyl Phthalate (DCHP) (U.S. EPA, 2024ab).

Draft Fish Ingestion Risk Calculator for Dicyclohexyl Phthalate (DCHP) (U.S. EPA, 2024r).

Draft Surface Water Human Exposure Risk Calculator for Dicyclohexyl Phthalate (DCHP) for P50 Flow Rates (U.S. EPA, 2024ad).

Draft Surface Water Human Exposure Risk Calculator for Dicyclohexyl Phthalate (DCHP) for P75 Flow Rates (U.S. EPA, 2024ae).

Draft Surface Water Human Exposure Risk Calculator for Dicyclohexyl Phthalate (DCHP) for P90 Flow Rates (U.S. EPA, 2024af).

Draft Ambient Air Exposure Assessment for Dicyclohexyl Phthalate (DCHP) (U.S. EPA, 2024a).

Draft Occupational and Consumer Cumulative Risk Calculator for Dicyclohexyl Phthalate (DCHP) (U.S. EPA, 2024y).

Draft Meta-Analysis and Benchmark Dose Modeling of Fetal Testicular Testosterone for Di(2-ethylhexyl) Phthalate (DEHP), Dibutyl Phthalate (DBP), Butyl Benzyl Phthalate (BBP), Diisobutyl Phthalate (DIBP), and Dicyclohexyl Phthalate (DCHP) (U.S. EPA, 2024s).

Draft Technical Support Document for the Cumulative Risk Analysis of Di(2-ethylhexyl) Phthalate (DEHP), Dibutyl Phthalate (DBP), Butyl Benzyl Phthalate (BBP), Diisobutyl Phthalate (DIBP), Dicyclohexyl Phthalate (DCHP), and Diisononyl Phthalate (DINP) Under the Toxic Substances Control Act (TSCA) (U.S. EPA, 2024ah).

Draft Summary of Facility Release Data for Di(2-ethylhexyl) Phthalate (DEHP), Dibutyl Phthalate (DBP), and Butyl Benzyl Phthalate (BBP) (U.S. EPA, 2024ac).

Appendix D UPDATES TO THE DCHP CONDITIONS OF USE TABLE

After the final scope document (U.S. EPA, 2020b), EPA received updated submissions under the 2020 CDR reported data. In addition to new submissions received under the 2020 CDR, the reporting name codes changed for the 2020 CDR reporting cycle. Therefore, the Agency is amending the description of certain DCHP COUs based on those new submissions and new reporting name codes. Also, EPA received information from stakeholders on specific uses of DCHP. Table_Apx D-1 summarizes the changes to the COUs based on the new reporting codes in the 2020 CDR and any other new information since the publication of the final scope.

Table_Apx D-1. Additions and Name Changes to Categories and Subcategories of Conditions of Use Based on CDR Reporting and Stakeholder Engagement

Life Cycle Stage and Category	Original Subcategory in the Final Scope Document	Occurred Change	Revised Subcategory in the 2024 Draft Risk Evaluation
Processing, Processing as a reactant	Processing aids not otherwise listed in: – Miscellaneous manufacturing	Consolidated into a category and associated subcategory under "processing, incorporation into formulation, mixture, or reaction product, stabilizing agent" based on further consultations with the submitters of the CDR data, review of their 2020 CDR cycle submissions, and given EPA's refined understanding of how DCHP is used (U.S. EPA, 2024aj, 2020a).	Processing – Incorporation in formulation, mixture, or reaction product – Stabilizing agent (plastics product manufacturing)
Processing, Processing as a reactant	Process regulator in: – Paint and coating manufacturing – Plastic material and resin manufacturing – Plastics product manufacturing – Rubber product manufacturing	Consolidated category and associated subcategories under "processing, incorporation into formulation, mixture, or reaction products" based on further consultations with the submitters of the CDR data, review of their 2020 CDR cycle submissions, and given EPA's refined understanding of how DCHP is used (U.S. EPA, 2024aj, 2020a).	Processing – Incorporation in formulation, mixture, or reaction product – Plasticizer (plastic material and resin manufacturing; rubber product manufacturing) And Processing – Incorporation in formulation, mixture, or reaction product – Stabilizing agent (paint and coating manufacturing; plastics product manufacturing)
Processing, Incorporation into formulation, mixture, or reaction product	Filler in: – Rubber product manufacturing	Removed COU based on further consultations with the submitters of the CDR data and review of their 2020 CDR cycle submissions (U.S. EPA, 2024aj, 2020a). DCHP is not used as a hardener, or the previously reported CDR code of "filler" (Nouryon Chemicals LLC, 2024).	N/A
Processing, Incorporation into formulation,	Laboratory chemical	Consolidated category and associated subcategory under "repackaging" as an example based	Processing – Repackaging – Repackaging (*e.g.*, laboratory chemical)

Life Cycle Stage and Category	Original Subcategory in the Final Scope Document	Occurred Change	Revised Subcategory in the 2024 Draft Risk Evaluation
mixture, or reaction product		on further review of the COUs. DCHP is not being reformulated or used in laboratory manufacturing, rather it is being used as a technical standard or reference reagent (U.S. EPA, 2020d).	
Processing, Incorporation into formulation, mixture, or reaction product	Paint additives and coating additives not described by other codes: – Printing ink manufacturing	Consolidated category and associated subcategory under a COU that was reported in a more recent CDR cycle.	Processing – Incorporation in formulation, mixture, or reaction product – Plasticizer (printing ink manufacturing)
Processing, Incorporation into formulation, mixture, or reaction product	N/A	Updated the subcategory to reflect the 2020 CDR cycle.	Processing – Incorporation in formulation, mixture, or reaction product – Plasticizer (plastic material and resin manufacturing)
Processing, Incorporation into formulation, mixture, or reaction product	Processing aids not otherwise listed: – Services – Paint and coating manufacturing – Asphalt paving, roofing, and coating materials manufacturing – Adhesive manufacturing	Consolidated category and associated subcategories as a "stabilizing agent" based on further consultations with the submitters of the CDR data and review of their 2020 CDR cycle submissions (U.S. EPA, 2024aj; Nouryon Chemicals LLC, 2020; U.S. EPA, 2020a, 2019c).	Processing – Incorporation in formulation, mixture, or reaction product – Stabilizing agent (adhesive manufacturing; asphalt paving, roofing, and coating materials manufacturing; paint and coating manufacturing)
Processing, Incorporation into formulation, mixture, or reaction product	Process regulator in: – Adhesive manufacturing	Consolidated category and associated subcategory under a COU that was both reported in a more recent CDR cycle and more appropriate given EPA's understanding of how DCHP is used.	Processing – Incorporation in formulation, mixture, or reaction product – Stabilizing agent (adhesive manufacturing)
Processing; Incorporation into formulation, mixture, or reaction product	N/A	Updated the subcategory to reflect the 2020 CDR cycle.	Processing – Incorporation in formulation, mixture, or reaction product – Stabilizing agent (paints and coating manufacturing)
Processing, Incorporation into formulation, mixture, or reaction product	N/A	Updated the subcategory to reflect the 2020 CDR cycle.	Processing – Incorporation in formulation, mixture, or reaction product – Stabilizing agent (plastics product manufacturing)
Industrial Use, Adhesives and sealants	Adhesives and sealants in: – Transportation equipment manufacturing – Computer and electronic product manufacturing	Updated the category and subcategory to add "computer and electronic product manufacturing" and "transportation equipment manufacturing" as examples to not preclude other industrial sectors.	Industrial Use – Adhesives and sealants (*e.g.*, computer and electronic product manufacturing; transportation equipment manufacturing)

Life Cycle Stage and Category	Original Subcategory in the Final Scope Document	Occurred Change	Revised Subcategory in the 2024 Draft Risk Evaluation
Industrial Use	N/A	Added the COU "paints and coatings" to the new life cycle stage of "industrial use" based on a new understanding of information from an SDS that explained the use could take place on an industrial scale (Carboline, 2019b).	Industrial Use – Paints and coatings
Industrial Use, Plastic and rubber products not covered elsewhere	Plastic and rubber products not covered elsewhere in: – Transportation equipment manufacturing	Updated the category and subcategory to better reflect 2020 CDR reporting codes and to add "transportation equipment manufacturing" as an example to not preclude other industrial sectors.	Industrial Use – Other articles with routine direct contact during normal use including rubber articles; plastic articles (hard) (*e.g.*, transportation equipment manufacturing)
Commercial Use, Plastic and rubber products not covered elsewhere	Plastic and rubber products not covered elsewhere	Updated the category and subcategory to reflect the 2020 CDR cycle.	Commercial Use – Other articles with routine direct contact during normal use including rubber articles; plastic articles (hard)
Consumer Use, Arts, crafts, and hobby materials	Arts, crafts, and hobby materials (*e.g.*, modeling clay)	Removed this COU upon further review, concluding it was no longer reasonably foreseen.	N/A
Consumer Use, Plastic and rubber products not covered elsewhere	Plastic and rubber products not covered elsewhere	Updated the category and subcategory to reflect the 2020 CDR cycle.	Consumer Use – Other articles with routine direct contact during normal use including rubber articles; plastic articles (hard)

As indicated in Table_Apx D-1, the changes are based on close examination of the CDR reports, including the 2020 CDR reports that were received after the scope was completed, additional research on the COUs, additional comments from stakeholders, and overall systematic review of the use information.

When developing this draft risk evaluation, EPA concluded that some subcategories of the COUs listed in the final scope document (U.S. EPA, 2020b) were redundant and consolidation was needed to avoid evaluation of the same COU multiple times. The Agency further concluded that there were some instances where subcategory information on the processing and uses of DCHP was misreported by CDR reporters based on outreach with stakeholders. For these instances, EPA recategorized the activity described in the COU listed in the scope to fit the description of the COU included in this draft risk evaluation.

In addition, EPA did further analysis of the following COUs, which resulted in the changes presented on the table that warrant further explanation because these COUs were changed significantly between the final scope and this draft risk evaluation:

- Processing, Processing as a reactant, "processing aids not otherwise listed in miscellaneous manufacturing; process regulator in paint and coating manufacturing, plastic material and resin manufacturing, plastics product manufacturing, and rubber product manufacturing" were all removed from the COUs as it was determined (due in part to a refined understanding of how

DCHP is used and stakeholder outreach) that DCHP is not used as a reactant and it is more appropriately characterized as "Processing – incorporated into a formula, mixture or reaction product." These uses are better captured under other processing COUs that more accurately reflect EPA's understanding of how DCHP is used.

EPA has also included further information about any other COUs (reported in the 2020 CDR cycle (U.S. EPA, 2020a) or otherwise) that are not included in the draft DCHP risk evaluation:

- Processing, Processing as a reactant, "plasticizer in plastics product manufacturing; intermediate in all other basic organic chemical manufacturing; stabilizing agent in paint and coating manufacturing and plastics product manufacturing; and processing aids not otherwise specified in plastics product manufacturing" were reported in the 2020 CDR cycle and were not included in the draft risk determination analysis as it was determined that DCHP is not used as a reactant and it is more appropriately characterized as "Processing – incorporated into a formula, mixture or reaction product." These uses are better captured under other processing COUs that more accurately reflect EPA's understanding of how DCHP is used.

- Processing, Processing as a reactant, "hardener in paint and coating manufacturing; and plastics product manufacturing" were reported in the 2020 CDR cycle and were not included in the draft risk determination analysis as it was determined that DCHP is not used as a reactant and is more appropriately characterized as "Processing – incorporated into a formula, mixture or reaction product." Additionally, based on Agency research and communication with stakeholders it is EPA's understanding that the use of "hardener" is better captured as a "stabilizing agent" for the draft DCHP risk evaluation (U.S. EPA, 2024aj). Ultimately, these uses are better captured under other processing COUs that more accurately reflect EPA's understanding of how DCHP is used.

- Processing, Processing incorporation into formulation, mixture, or reaction product, "processing aids not otherwise specified in plastics product manufacturing" was reported in the 2020 CDR cycle and was not included in the draft risk determination analysis after additional research and communication with stakeholders (U.S. EPA, 2024aj). It is EPA's understanding that this COU is more appropriately consolidated into Processing, Processing incorporation into formulation, mixture, or reaction product, "stabilizing agent."

- Note that in the final scope document for DCHP (U.S. EPA, 2020b), EPA removed the consumer use of dicyclohexyl phthalate in toys, playground, and sporting equipment as a COU for numerous reasons, which include: a public comment received on the draft DCHP scoping document (Vertellus LLC, 2020); the Consumer Product Safety Commission's (CPSC) Chronic Hazard Advisory Panel (CHAP) report from 2014 (U.S. CPSC, 2014) that states, "DCHP is currently not found in children's toys or child care articles, and it is not widely found in the environment" (page 117); the preamble of the 2017 CPSC final rule titled "Prohibition of Children's Toys and Child Care Articles Containing Specified Phthalates," which explains that ". . . the CPSC staff has not detected DCHP in toys and child care articles during routine compliance testing thus far. . ." (U.S. CPSC, 2017); and CPSC's final rule, which prohibits manufacture for sale, offer for sale, distribution in commerce, and importation into the United States of any children's toy or child care article that contains more than 0.1 percent of dicyclohexyl phthalate as it "would prevent [DCHP's] use as a substitute for other banned phthalates" (82 FR 49982 (2017); 16 CFR 1307.3). As a result, EPA has no reasonably available information demonstrating that the consumer use of dicyclohexyl phthalate in toys, playground, and sporting equipment is intended, known, or reasonably foreseen, and therefore removed this COU from the final scope and has not included it in the analysis for this draft risk evaluation of DCHP.

Appendix E CONDITIONS OF USE DESCRIPTIONS

The following descriptions are intended to include examples of uses, so as not to exclude other activities that may also be included in the COUs of the chemical substance. To better describe the COU, EPA considered CDR submissions from previous CDR cycles for DCHP (CASRN 84-61-7), and the COU descriptions reflect what the Agency identified as the best fit for those submissions. Examples of articles, products, or activities are included in the following descriptions to help describe the COU but are not exhaustive. EPA uses the terms "articles" and "products" or product mixtures in the following descriptions and is generally referring to articles and products as defined by 40 CFR part 751. There may be instances where the terms are used interchangeably by a company or commenters, or by EPA in reference to a code from CDR reports that are referenced (*e.g.*, "plastics products manufacturing," or "fabric, textile, and leather products"), EPA will clarify as needed when these references are included throughout the COU descriptions below.

5.1 Manufacturing – Domestic Manufacturing

Domestic manufacture means to manufacture or produce DCHP within the United States. For purposes of the DCHP risk evaluation, this includes the extraction of DCHP from a previously existing chemical substance or complex combination of chemical substances and loading and repackaging (but not transport) associated with the manufacturing or production of DCHP.

DCHP is typically manufactured in a closed system through catalytic esterification of phthalic anhydride and cyclohexanol in solvent at elevated temperatures (130 °C) (U.S. CPSC, 2010). After the reaction, excess alcohol is recovered and DCHP is purified through vacuum distillation or activated charcoal (U.S. EPA, 2020b). Based on manufacturing operations for similar phthalates, activities may also include filtrations and quality control sampling of the DCHP product. Additionally, manufacturing operations include equipment cleaning/reconditioning and product transport to other areas of the manufacturing facility or offsite shipment for downstream processing or use. Current manufacturing processes can achieve a DCHP purity of 99 percent or greater, with some impurities of water and phthalic acid (U.S. CPSC, 2010). This COU includes the typical manufacturing process and any other similar production of DCHP.

Examples of CDR Submissions.
In the 2016 CDR cycle, one company reported domestic manufacturing of DCHP (CASRN 84-61-7) as large crystal pellets.

In the 2020 CDR cycle, two companies reported domestic manufacturing of DCHP (CASRN 84-61-7). One CDR company reported domestic manufacturing of DCHP as pellets or large crystals, while the second company reported domestic manufacturing of DCHP as a dry powder.

E.2 Manufacturing – Importing

Import refers to the import of DCHP into the customs territory of the United States. In general, chemicals may be imported into the United States in bulk via water, air, land, and intermodal shipments, and loading and repackaging (but not transport) associated with the import of DCHP (Tomer and Kane, 2015). These shipments take the form of oceangoing chemical tankers, railcars, tank trucks, and intermodal tank containers (U.S. EPA, 2020b).

Imported DCHP is shipped in either dry powder, liquid, water or solvent wet solid form (U.S. EPA, 2020a). Import sites unload the import containers and transfer DCHP into smaller containers (bags or supersacks) for downstream processing, use within the facility, or offsite use. Operations may include

quality control sampling of DCHP product and equipment cleaning. No changes to chemical composition occur during importation of this COU (U.S. EPA, 2022a).

Examples of CDR Submissions.
In the 2016 CDR cycle, one company reported importation of DCHP (CASRN 84-61-7) in a solid form.

In the 2020 CDR cycle, two companies reported importation of DCHP (CASRN 84-61-7). One CDR company reported importation of DCHP as dry powder, liquid, while the second company reported importation of DCHP as water or a solvent wet solid.

E.3 Processing – Incorporation into Formulation, Mixture, or Reaction Product – Adhesive and Sealant Chemicals in Adhesive Manufacturing

This COU refers to the preparation of a product; that is, the incorporation of DCHP into formulation, mixture, or a reaction product that occurs when a chemical substance is added to a product (or product mixture), after its manufacture, for distribution in commerce. In this case, processing of DCHP into an adhesive and sealant in adhesive manufacturing.

Based on the 2009 Emission Scenario Document (ESD) on the Manufacture of Adhesives, a typical adhesive incorporation site receives and unloads DCHP into adhesive and sealant formulations in industrial mixing vessels as a batch blending or mixing process, with no reactions or chemical changes occurring to the plasticizer (*i.e.*, DCHP) during the mixing process (OECD, 2009a). Process operations may also include quality control sampling. EPA expects that sites will load DCHP-containing adhesive and sealant products into bottles, small containers, or drums depending on the product type. (OECD, 2009a).

Examples of CDR Submissions.
In the 2016 cycle, one company reported the use of DCHP (CASRN 84-61-7) as adhesive and sealant chemicals in adhesive manufacturing.

E.4 Processing – Incorporation into Formulation, Mixture, or Reaction Product – Plasticizer (Adhesive Manufacturing; Paint and Coating Manufacturing; Plastic Material and Resin Manufacturing; Plastics Product Manufacturing; Printing Ink Manufacturing; and Rubber Product Manufacturing)

This COU refers to the preparation of a product; that is, the incorporation of DCHP into formulation, mixture, or a reaction product that occurs when a chemical substance is added to a product (or product mixture) after its manufacture, for distribution in commerce—in this case as a plasticizer in various industrial sectors and uses, specifically as an adhesive, paint and coating, plastic material and resin, plastic product, printing or PVC plastisol ink and as a rubber product.

The American Coatings Association explained that DCHP is a plasticizer, additive and impurity in adhesives in amounts less than 1 percent (ACA, 2019) and according to information provided to EPA, DCHP is also used within products or formulations for the manufacture, operation and maintenance of aerospace products (AIA, 2019). More specifically, the Aerospace Industries Association explained that DCHP can be used as a plasticizer for nitrocellulose, chlorinated rubber polyvinyl chloride and other polymers and adhesives.

In manufacturing of plastic material and resin through non-PVC and PVC compounding, DCHP is blended into polymers. Compounding involves the mixing of the polymer with the plasticizer and other chemical such as fillers and heat stabilizers. The plasticizer needs to be absorbed into the particle to impart flexibility to the polymer. For PVC compounding, compounding occurs through mixing of ingredients to produce a powder (dry blending) or a liquid (plastisol blending). The most common process for dry blending involves heating the ingredients in a high intensity mixer and transfer to a cold mixer. The plastisol blending is done at ambient temperature using specific mixers that allow for the breakdown of the PVC agglomerates and the absorption of the plasticizer into the resin particle. EPA is also aware that DCHP may be incorporated into PVC plastisol inks and inks for screen printing (Hallstar, 2022; LANXESS, 2021; Gans Ink and Supply, 2018; U.S. CPSC, 2015).

Examples of CDR Submissions

In the 2016 CDR cycle, one company reported the use of DCHP (CASRN 84-61-7) as a plasticizer in plastics product manufacturing and one CDR company reported the use of DCHP as a plasticizer in printing ink manufacturing.

In the 2020 CDR cycle, one company reported the use of DCHP (CASRN 84-61-7) as a plasticizer in plastics material and resin manufacturing and one CDR company reported the use of DCHP as a plasticizer in adhesive manufacturing.

E.5 Processing – Incorporation into Formulation, Mixture, or Reaction Product – Stabilizing Agent (Adhesive Manufacturing; Asphalt Paving, Roofing, and Coating Materials Manufacturing; Paints and Coating Manufacturing; and Plastics Product Manufacturing)

This COU refers to the preparation of a product; that is, the incorporation of DCHP into formulation, mixture, or a reaction product that occurs when a chemical substance is added to a product (or product mixture), after its manufacture, for distribution in commerce. In this case DCHP is used as a stabilizing agent, specifically as a phlegmatizer (a compound that minimizes the explosive tendency of another compound or material) for dibenzoyl peroxide (BPO) and peroxide-based formulations to improve the safety and handling properties and to prevent explosions (U.S. EPA, 2024aj; AIA, 2019). These BPO mixtures (in which DCHP is present) are then used as a curing agent for unsaturated polyesters or methyl methacrylate (MMA) systems, which is used in various industrial sectors and uses including asphalt, roofing, and flooring systems, coatings, adhesives, and within the aerospace industry (U.S. EPA, 2024aj; Nouryon Chemicals LLC, 2020; AIA, 2019; U.S. EPA, 2019c). EPA has confirmed that this COU has recently been discontinued with the CDR submitter. However, the use of DCHP as a stabilizing agent was only recently ceased (*i.e.*, in 2021) and the available information regarding DCHP suggests that this COU could occur. Therefore, it is included in EPA's evaluation.

Examples of CDR Submissions

In the 2016 CDR cycle, one company reported the use of DCHP (CASRN 84-61-7) as a process regulator in paints and coating manufacturing, which has been recategorized in the COU table to "stabilizing agent" after discussions with the company that purchased the previous 2016 reporting company (U.S. EPA, 2024aj, 2019c). See Appendix D for more information on the changes from the COU from the *Final Scope of the Risk Evaluation for Dicyclohexyl Phthalate (DCHP); CASRN 84-61-7* (U.S. EPA, 2020b).

In the 2020 CDR cycle, one company reported the use of DCHP (CASRN 84-61-7) as a stabilizing agent in paints and coating manufacturing.

E.6 Processing – Incorporation into Articles – Plasticizer (Plastics Product Manufacturing and Rubber Product Manufacturing)

This COU refers to the preparation of an article; that is, the incorporation of DCHP into articles, meaning DCHP becomes an integral component of the article, after its manufacture, for distribution in commerce. In this case, DCHP is present in a raw material such as rubber or plastic that contains a mixture of plasticizers and other additives, and this COU refers to the manufacturing of PVC and non-PVC articles including rubber, plastic, and miscellaneous articles using those raw materials. According to information provided to EPA, DCHP is used as a plasticizer in plastic and rubber articles used in the aerospace industry (AIA, 2019), and a variety of articles in transportation equipment such as automotive vehicles (MEMA, 2019). Simple and complex plastic and rubber articles containing DCHP are also assumed to be used in electronics (U.S. CPSC, 2015), as well as a variety of other industrial and commercial end uses. DCHP is also assumed to be used as a plasticizer in a variety of other simple and complex articles such those found in building and construction materials (LANXESS, 2021).

Examples of CDR Submissions

In the 2016 CDR cycle, one company reported the use of DCHP (CASRN 84-61-7) as a plasticizer in plastics products manufacturing, one company reported the commercial and consumer use of DCHP in plastic and rubber products not covered elsewhere.

In the 2020 CDR cycle, one company reported the commercial and consumer use of DCHP (CASRN 84-61-7) as a plasticizer in other articles with routine direct contact during normal use including rubber articles; plastic articles (hard), which is a further refined description compared with the 2016 CDR cycle code of "plastic and rubber products not covered elsewhere."

E.7 Processing – Repackaging (*e.g.*, Laboratory Chemical)

Repackaging refers to the preparation of DCHP for distribution in commerce in a different form, state, or quantity than originally received or stored by various industrial sectors, including chemical product and preparation manufacturing, wholesale and retail trade, and laboratory chemicals manufacturing. This COU includes the transferring of DCHP from a bulk container into smaller containers. One company explained that DCHP and phthalates more generally are domestically repackaged for laboratory use (U.S. EPA, 2020d). This COU would not apply to the relabeling or redistribution of a chemical substance without removing the chemical substance from the original container it was supplied in. No changes to chemical composition occur during repackaging of this COU (U.S. EPA, 2022a).

This COU was not reported in the 2016 or 2020 CDR cycles.

E.8 Processing – Recycling

This COU refers to the process of treating generated waste streams (*i.e.*, which would otherwise be disposed of as waste) containing DCHP that are collected, either on-site or at a third-party site, for commercial purpose. DCHP is primarily recycled industrially in the form of DCHP-containing PVC/plastic waste streams. New PVC can be manufactured from recycled and virgin materials at the same facility. Some (ENF Plastic, 2024) estimate a total of 228 plastics recyclers operating in the United States of which 58 accept PVC wastes for recycling. It is unclear if the total number of sites includes some or all circular recycling sites—facilities where new PVC can be manufactured from recycled and virgin materials on the same site. Articles containing DCHP from inks, coatings, etc., may also be recycled (U.S. EPA, 2020b). EPA notes that although DCHP was not reported for recycling in the 2016 or 2020 CDR reporting periods, EPA is assuming that recycling waste streams could contain DCHP.

E.9 Distribution in Commerce

For purposes of assessment in this draft risk evaluation, distribution in commerce consists of the transportation associated with the moving of DCHP or DCHP-containing products between sites manufacturing, processing or recycling DCHP or DCHP-containing products, or to final use sites, or for final disposal of DCHP or DCHP-containing products. More broadly under TSCA, "distribution in commerce" and "distribute in commerce" are defined under TSCA section 3(5). No changes to chemical composition occur during transportation of DCHP (U.S. EPA, 2022a).

E.10 Industrial Use – Adhesive and Sealants (*e.g.*, Computer and Electronic Product Manufacturing; Transportation Equipment Manufacturing)

This COU refers to DCHP as it is used in various industrial sectors as a component of adhesive or sealant mixtures. Meaning the use of DCHP after it has already been incorporated into an adhesive and/or sealant product or mixture, as opposed to when it is used upstream (*e.g.*, when DCHP is processed into the adhesive and sealant formulation). The American Coatings Association explained that DCHP is a plasticizer, additive, and impurity in adhesives in amounts less than 1 percent (ACA, 2019).

According to information provided to EPA, DCHP is used as an adhesive within the aerospace industry (AIA, 2019) and as an adhesive sealant for body panel assemblies and parts by automobile manufacturers applications (MEMA, 2019). EPA has also identified several examples of specific products for this COU, such as a nonconductive die attach adhesive containing DCHP at concentrations of 0.1 to 1 percent. This adhesive has been formulated for use in high throughput die attach applications within the semi-conductor industry within various types of electronics (*e.g.*, automotive cameras) (Henkel, 2024, 2019, 2017).

Examples of CDR Submissions

In the 2016 CDR cycle, one company reported the use of DCHP (CASRN 84-61-7) as adhesive and sealant chemicals in adhesive manufacturing.

In the 2020 CDR cycle, one company reported the use of DCHP (CASRN 84-61-7) as a plasticizer in adhesive manufacturing.

E.11 Industrial Use – Finishing Agent – Cellulose Film Production

This COU refers to the use of DCHP as a component of the finishing agent used in cellulose film production. Meaning the use of DCHP after it has already been incorporated into the finishing agent itself, as opposed to when it is used upstream (*e.g.*, when DCHP is processed into the finishing agent or paint and coating formulation).

CDR described a "finishing agent" as a chemical substance used to impart such functions as softening, static-proofing, wrinkle resistance, and water repellence. Substances may be applied to textiles, paper, and leather. In this case DCHP is used during the cellulose film production to bathe or coat the film, giving it barrier properties as well as promoting heat seal. This cellulose film is then used in a variety of labeling, and packaging end uses (U.S. EPA, 2020c; Earthjustice, 2019).

This COU was not reported in the 2016 or 2020 CDR reporting cycles.

E.12 Industrial Use – Inks, Toner, and Colorant Products

This COU refers to the use of DCHP in various industrial sectors as a component in ink, toner, and colorant products. Meaning the use of DCHP after it has already been incorporated into ink, toner,

and/or colorant products, or while it is being applied to various articles, as opposed to when it is used upstream (*e.g.,* when DCHP is processed into the ink, toner, and colorant product formulation).

According to information provided to EPA in 2021, DCHP (referred to in this case as Uniplex 250) has been used as an element of PVC inks/PVC plastisol formulations (Hallstar, 2022; LANXESS, 2021; U.S. EPA, 2021c, 2019e). Uniplex 250 is also marketed as being used as a polymer additive in labels and printing ink formulations (Hallstar, 2022) and DCHP has been used as part of the screen-printing process for textiles (Gans Ink and Supply, 2018). Printing inks are composed of colorants (*e.g.,* pigments, dyes and toners) dispersed in a formulation to form a paste, liquid or solid, which can be applied to a substrate surface and dried (U.S. EPA, 2010). Screen printing requires a mesh screen to transfer the ink to a substrate, whereas digital printing allows for the transfer of a digital image directly onto a substrate. Inkjet printing is the most common form of digital printing. It involves the application of small drops of ink onto a substrate, with direct contact between the ink nozzle and the substrate (U.S. EPA, 2010).

Examples of CDR Submissions

In the 2016 CDR cycle, one company reported the use of DCHP (CASRN 84-61-7) as a plasticizer in printing ink manufacturing.

E.13 Industrial Use – Paints and Coatings

This COU refers to the use of DCHP in various industrial sectors as a component in paints and coating mixtures. This is a use of DCHP after it has already been incorporated into paint and coating or BPO mixtures, or while it is being applied to various articles, as opposed to when it is used upstream (*e.g.,* when DCHP is processed into adhesive, sealant or BPO formulation).

EPA has identified an example of an industrial paint and coating product for this COU; a single-component silicone acrylic finish that air dries and is suitable for high temperature exposures up to 500 °F with DCHP concentrations of 2.5 to less than 10 percent. This paint and coating is applied via pressurized or conventional spray and can be used to protect various elements, equipment, etc. in an industrial or manufacturing setting (Carboline, 2019a, b; U.S. EPA, 2019d).

EPA expects that products under this COU would be applied in the industrial sector; however, note that it is possible for these products to be purchased by commercial users and applied in the commercial sector as well.

Examples of CDR Submissions

In the 2016 CDR cycle, one company reported the use of DCHP (CASRN 84-61-7) as a process regulator in paints and coating manufacturing, which has been recategorized in the COU table to "stabilizing agent" after discussions with the company that purchased the previous 2016 reporting company (U.S. EPA, 2024aj). See Appendix D for more information on the changes from the COUs from the *Final Scope of the Risk Evaluation for Dicyclohexyl Phthalate (DCHP) CASRN 84-61-7* (U.S. EPA, 2020b).

In the 2020 CDR cycle, one company reported the use of DCHP (CASRN 84-61-7) as a stabilizing agent in paints and coating manufacturing.

E.14 Industrial Use – Other Articles with Routine Direct Contact During Normal Use Including Rubber Articles; Plastic Articles (Hard) (*e.g.*, Transportation Equipment Manufacturing)

This COU refers to the use of DCHP in rubber and plastic products in various industrial sectors, such as transportation equipment manufacturing. Meaning the use of DCHP after it has already been incorporated into a plastic or rubber product, as opposed to when it is used upstream (*e.g.*, when DCHP is processed into the plastic/rubber product).

According to information provided to EPA, DCHP is used as a plasticizer in plastic and rubber products used in the aerospace industry (AIA, 2019) and a variety of transportation equipment such as both vehicles production parts and replacement parts (MEMA, 2019). The Alliance of Automobile Manufacturers and the Motor & Equipment Manufacturers Association did explain that "[t]he average scope of the relative mass of DCHP in the parts from the Alliance's data collection is 0.24 gram. Excluding body/exterior parts, that average drops below 0.01 gram" (MEMA, 2019).

As such, workers would be expected to handle or touch products covered by this COU with their hands and be exposed to DCHP through dermal contact.

Examples of CDR Submissions

In the 2016 CDR cycle, one company reported the commercial use of DCHP (CASRN 84-61-7) in plastic and rubber products not covered elsewhere.

In the 2020 CDR cycle, the same company reported the commercial use of DCHP (CASRN 84-61-7) as a plasticizer in other articles with routine direct contact during normal use including rubber articles; plastic articles (hard), which is a further refined description compared to the 2016 CDR cycle code of "plastic and rubber products not covered elsewhere".

E.15 Commercial Use – Adhesives and Sealants

This COU is referring to the commercial use of DCHP in adhesives and sealants. Meaning the use of DCHP-containing adhesives and sealants in a commercial setting, such as a business or at a job site, as opposed to upstream use of DCHP (*e.g.*, when DCHP is processed into the adhesive and sealant formulation) or use in an industrial setting.

Workers in a commercial setting generally apply adhesives and sealants that already have DCHP incorporated as a plasticizer or combine two-part adhesives where DCHP acts as a phlegmatizer with BPO in unsaturated polyesters or MMA systems (U.S. EPA, 2024aj). The American Coatings Association explained that DCHP is a plasticizer, additive and impurity in adhesives in amounts less than one percent (ACA, 2019). According to information provided to EPA, DCHP is used as an adhesive within the aerospace industry (AIA, 2019), and an adhesive sealant for body panel assemblies and parts by automobile manufacturers applications (MEMA, 2019).

Commercial adhesives and sealants that are used to fasten other materials together or to prevent the passage of liquid or gas are captured under this COU. For example, products under this COU can be two-part adhesives, glues or caulks, which are stored in separate parts, generally a base and an activator or a resin and a hardener that may undergo a reaction or cure once combined. EPA expects that some commercial applications of adhesives and sealants containing DCHP may occur using non-pressurized methods, but that most commonly, the products containing DCHP are more likely applied via a syringe or caulk gun. More specifically, EPA has identified several examples of products for this COU, such as

a metal bonding adhesive used in variety of automotive care applications (*e.g.*, panel bonding, weld and rivet bonding of quarter panels, rear body panels, roof panels, door skins, van side panels and outer truck bed panels) that contain DCHP concentrations of one to five percent (Lord Corporation, 2021, 2020, 2017) as well as a similar metal bonding product with DCHP concentrations from three to less than five percent (Ford Motor Company, 2015). EPA also identified various two-part adhesive anchoring systems, such as a two-part hammer-capsule system designed for use in the installation of a threaded rod into solid concrete and masonry materials that contained DCHP concentrations of 1 to 2.5 percent (DeWalt, 2024b, 2022, 2020), as well as another two-part polyester liquid system to be used once again in construction and building environments (MKT, 2023a, b, 2018).

EPA expects that the use of these types of products would occur in commercial applications; however, EPA notes that these products are likely to be sourced by DIY consumers through various online vendors as well (DeWalt, 2024a; Lord Corporation, 2024; MKT, 2024).

Examples of CDR Submissions

In the 2016 CDR cycle, one company reported the use of DCHP (CASRN 84-61-7) as adhesive and sealant chemicals in adhesive manufacturing.

In the 2020 CDR cycle, one company reported the use of DCHP (CASRN 84-61-7) as a plasticizer in adhesive manufacturing.

E.16 Commercial Use – Building/Construction Materials Not Covered Elsewhere

This COU is referring to the commercial use of DCHP in building/construction materials not covered elsewhere. Meaning the use of DCHP-containing building/construction materials in a commercial setting, such as at a business or at a job site, as opposed to upstream use of DCHP (*e.g.*, when DCHP is processed into articles).

According to information provided to EPA in 2021, DCHP (referred to in this case as Uniplex 250) has been used as an article in a "range of construction products-boards" (LANXESS, 2021). These boards are presumed to be used in a variety of commercial applications and settings.

Examples of CDR Submissions

In the 2012 CDR cycle, one company reported the commercial use of DCHP (CASRN 84-61-7) as building/construction materials not covered elsewhere.

E.17 Commercial Use – Ink, Toner, and Colorant Products

This COU refers to the commercial use of DCHP in ink, toner, and colorant products. Meaning the use of DCHP-containing ink, toner, and/or colorant products in a commercial setting, such as a business or at a job site, as opposed to upstream use of DCHP (*e.g.*, when DCHP is processed into the ink, toner, and colorant product formulation) or use in an industrial setting.

According to information provided to EPA in 2021, DCHP (referred to in this case as Uniplex 250) has been used as an element of PVC inks/PVC plastisol formulations (LANXESS, 2021; U.S. EPA, 2021c, 2019e). Uniplex 250 is also marketed as being used as a polymer additive in labels and printing ink formulations (Hallstar, 2022) and has been used as part of the screen-printing process for textiles (Gans Ink and Supply, 2018). The expected users of these products would be specific to the printing

community and these inks would likely be applied through mechanical methods or as part of the screen-printing process.

Examples of CDR Submissions

In the 2016 CDR cycle, one company reported the use of DCHP (CASRN 84-61-7) as a plasticizer in printing ink manufacturing.

E.18 Commercial Use – Laboratory Chemicals

This COU is referring to the commercial use of DCHP in laboratory chemicals. DCHP can be used as a laboratory chemical, such as a chemical standard or reference material during analyses. Some laboratory chemical manufacturers identify use of DCHP as a certified reference material and research chemical (Restek Corporation, 2024; Sigma-Aldrich, 2024a, b; U.S. EPA, 2020d; SPEX CertiPrep, 2019). Users of the products under this category would be expected to apply these products through general laboratory use applications. According to information provided to EPA by NASA, the Agency indicated that DCHP is used as a laboratory chemical in applications such as analytical standards, research, equipment calibration and sample preparation (NASA, 2020).

DCHP has also been used as the powder in a two-part laboratory acrylic mounting system for laboratory specimens that are sensitive to high pressures and temperatures, as well as an embedding polymer resin kit intended for preparation for samples for high resolution light microscopy (Ted Pella, 2024, 2017). DCHP in this case is used as part of a BPO catalyst.

This use was not reported to EPA in the 2016 or 2020 CDR cycles.

E.19 Commercial Use – Paints and Coatings

This COU is referring to the commercial use of DCHP as a plasticizer and stabilizer (*i.e.*, phlegmatizer) in paints and coating systems. Meaning the use of DCHP-containing paints and coatings in a commercial setting, such as at a business or at a job site, as opposed to upstream use of DCHP (*e.g.*, when DCHP is processed into the paint, coating, or BPO formulation) or use in an industrial setting.

Workers in a commercial setting generally apply paints and coatings that already have DCHP incorporated as a plasticizer or combine two (or even sometimes three) part paints and coatings where DCHP acts as a phlegmatizer with BPO in unsaturated polyesters or MMA systems (U.S. EPA, 2024aj). The solid DCHP/BPO product often acts as a catalyst or curing agent when mixed with a second, often liquid, component by workers at the end use site before application. This mixing begins the polymerization reaction or process. Workers are expected to be potentially exposed when mixing components to form a liquid paint/coating, when transferring the liquid mixture to the application equipment if necessary, and/or when applying the coating or system itself to the substrate (U.S. EPA, 2014b; OECD, 2009b; U.S. EPA, 2004d). End use sites may also receive liquid paint and coating formulations already containing DCHP as a single component, making the need to mix two components obsolete. Application methods for DCHP-containing paints and coatings may include spray, brush, and/or trowel coating.

Various paints and coatings that utilize DCHP are applied in commercial settings such as in roofing, construction, and in cement/protection for high traffic areas, etc. often to provide waterproofing, UV protection and/or chemical resistance. More specifically, EPA has identified several examples of products for this COU, such as a single-component silicone acrylic finish that air dries and is suitable for high temperature exposures up to 500 °F with DCHP concentrations of 2.5 to less than 10 percent. This paint and coating is applied via pressurized spray and can be used to protect various elements,

equipment, and so on, in an industrial or manufacturing setting (Carboline, 2019a, b; U.S. EPA, 2019d). EPA also identified various two or even multi-part paints and coatings systems including: a vinyl ester silicone filled mortar; a three component, MMA-based grout; a poly methyl-methacrylate (PMMA) resin used in roofing and waterproofing applications; a polyurethane modified methyl methacrylate (PUMMA) vehicular and pedestrian traffic coating system; and a MMA resin used as a penetrating crack healer/sealer or to fortify extremely porous concrete substrates.

The vinyl ester silicone filled mortar contained concentrations of DCHP at less than 0.005 percent and when used with chemical-resistant masonry units and the proper membrane, it will protect concrete and steel substrates from chemical attack and physical abuse. The mortar is a two-part system including a liquid and the powder (which contains DCHP), which must be mixed together (3.25 parts powder to 1 part liquid) prior to trowel based application of an average one-eighth inch thick bed directly on top of membrane or preceding course of brickwork. According to the company, this product is used in the construction of floors, sumps, trenches, tanks, vessels and bleach towers in chemical processing; food and beverage plants; dairies; laboratories; and textile, steel and pulp and paper mills (Sauereisen, 2024, 2022).

The three component MMA based grout is flowable, non-shrink, durable polymer grout that according to the company's website, can be used as the grouting of bearing plates on bridges and trestles, rehabilitation of bridge decks, airport runways, expansion joints and column grouting. DCHP can be found in the catalyst or Part B in concentrations of 50 to 51 percent. Seven to 14 fluid ounces (oz) (depending on the ambient air temperature) of the catalyst/Part B, is mixed with 1 gallon of Part A resin, and 70 lb of Part C grout aggregate. Once mixed, the company directs workers to distribute the blended resin over the surface and brush in or prepare a form and pour the material into place (ChemMasters, 2024, 2018, 2017a, b).

The PMMA resin is used in roofing and waterproofing applications through a two-part plus fleece/membrane self-flashing and self-adhering system, which according to the company is used in structural below-grade concrete surfaces, and protected roof and split-slab decks (CETCO, 2024, 2018a, b, c). DCHP has been identified in the catalyst powder at 50 percent which is then mixed with the resin at various ratios ranging from 2 to 6 percent depending on the weight of the resin used and temperature.

The polyurethane modified methyl methacrylate (PUMMA) vehicular and pedestrian traffic coating system, is specifically designed for use in parking structures, balconies, stadium seating, walkways, plaza decks, etc. (Hydro-Gard, 2012a, b). This is a multi-component system, which uses a catalyst that contains DCHP in concentrations of 40 to 55 percent combined with a resin and a flashing or polyester fleece to create a liquid applied waterproofing membrane/coating (Hydro-Gard, 2024, 2017a, b).

Finally, the last product example for commercial paints and coatings is an MMA resin that is used as a penetrating crack healer/sealer or to fortify extremely porous concrete substrates, such as parking and bridge decks, loading docks and warehouses. DCHP can be found in the initiator component in concentrations of 50 to less than 100 percent. To begin the hardening process the workers must add roughly 0.5 oz to a gallon of resin at around 32 to 39 degrees, increasing up to 2 oz at 90 to 105 degrees Fahrenheit. The product is then recommended to be spread evenly on the surface as a flood coat with a squeegee or rollers and allowed to absorb completely into the concrete substrate (Euclid Chemical Company, 2019a, b, 2018).

Note these listed examples are not all inclusive of every product under this COU, and that EPA expects that these types of products would be purchased by commercial operations and applied by professional

contractors in various commercial settings. The Agency also expects that some of these products are likely to be used for industrial applications; however, they would be available and used in smaller scale commercial settings for similar purposes (*e.g.*, protection on structural components, construction).

Examples of CDR Submissions

In the 2016 CDR cycle, one company reported the use of DCHP (CASRN 84-61-7) as a process regulator in paints and coating manufacturing, which has been recategorized in the COU table to "stabilizing agent" after discussions with the company that purchased the previous 2016 reporting company (U.S. EPA, 2024aj). See Appendix D for more information on the changes from the COUs from the *Final Scope of the Risk Evaluation for Dicyclohexyl Phthalate (DCHP); CASRN 84-61-7* (U.S. EPA, 2020b).

In the 2020 CDR cycle, one company reported the use of DCHP (CASRN 84-61-7) as a stabilizing agent in paints and coating manufacturing.

E.20 Commercial Use – Other Articles with Routine Direct Contact During Normal Use Including Rubber Articles; Plastic Articles (Hard)

This COU is referring to the commercial use of DCHP in various rubber and plastic articles that are intended for routine direct contact. The 2020 CDR reporting category "other articles with routine direct contact during normal use including rubber articles; plastic articles (hard)" is intended to capture items such as gloves, boots, clothing, rubber handles, gear levers, steering wheels, handles, pencils, and handheld device casing. Given the use of DCHP as a general-purpose plasticizer for PVC and non-PVC applications, EPA expects that this use of DCHP has been identified in previous CDR reports as "plastic and rubber products not covered elsewhere."

According to information provided to EPA, DCHP is used as a plasticizer in plastic and rubber products used in the aerospace industry (AIA, 2019) and a variety of transportation equipment such as both vehicles production parts and replacement parts (*e.g.*, brake calipers, fender shim, disc brake assembly) (MEMA, 2019). The Alliance of Automobile Manufacturers and the Motor & Equipment Manufacturers Association did explain that "[t]he average scope of the relative mass of DCHP in the parts from the Alliance's data collection is 0.24 gram. Excluding body/exterior parts, that average drops below 0.01 gram" (MEMA, 2019).

As such, workers would be expected to handle or touch products covered by this COU with their hands and be exposed to DCHP through dermal contact.

Examples of CDR Submissions

In 2016 one CDR company reported the commercial use of DCHP (CASRN 84-61-7) in plastic and rubber products not covered elsewhere.

In 2020 the same CDR company reported the commercial use of DCHP (CASRN 84-61-7) as a plasticizer in other articles with routine direct contact during normal use including rubber articles; plastic articles (hard), which is a further refined description compared to the 2016 CDR cycle code of "plastic and rubber products not covered elsewhere."

E.21 Consumer Use – Adhesives and Sealants

This COU is referring to the consumer use of DCHP in adhesives and sealants. According to information provided to EPA, the American Coatings Association explained that DCHP is a plasticizer,

additive, and impurity in adhesives in amounts less than 1 percent (ACA, 2019). EPA has identified DCHP in a multi-purpose nitrocellulose household glue at one to five percent with suggested applications of china, vases, plastic, wood, metal, and crafts (ITW Permatex, 2024; Midwest Technology Products, 2024; ITW Permatex, 2021) as well as adhesives and sealants meant for the industrial and commercial automotive industry that are also available to consumer customers (Lord Corporation, 2021, 2020, 2017). For example, the two-part metal bonding adhesive is meant for use in various elements of an automotive (*e.g.,* panel bonding, weld and rivet bonding of quarter panels, rear body panels, roof panels, door skins, van side panels and outer truck bed panels) and has a DCHP concentration of one to five percent (Lord Corporation, 2017). EPA has also identified various two-part adhesive anchoring systems, such as a two-part hammer-capsule system designed for use in the installation of a threaded rod into solid concrete and masonry materials that contained DCHP concentrations of 1 to 2.5 percent (DeWalt, 2024b, 2022, 2020), as well as another two-part polyester liquid system to be used once again in construction and building environments (MKT, 2023a, b, 2018).

Aside from the household glue, EPA expects that the primary use of several of these products is meant to occur in industrial/commercial applications only; however, the Agency notes that several of these products can be sourced by DIY consumers through various online vendors (DeWalt, 2024a; Lord Corporation, 2024; MKT, 2024).

This COU was not reported in the 2016 or 2020 CDR cycles.

E.22 Consumer Use – Other Articles with Routine Direct Contact During Normal Use Including Rubber Articles; Plastic Articles (Hard)

This COU is referring to the consumer use of DCHP in various rubber and plastic articles that are intended for consumer use through routine direct contact. The 2020 CDR reporting category "other articles with routine direct contact during normal use including rubber articles; plastic articles (hard)" is intended to capture items such as gloves, boots, clothing, rubber handles, gear levers, steering wheels, handles, pencils, and handheld device casing. Given the use of DCHP as a general-purpose plasticizer for PVC and non-PVC applications, EPA expects that this use of DCHP has been identified in previous CDR reports as "plastic and rubber products not covered elsewhere."

According to information provided to EPA, DCHP is used as a plasticizer in plastic and rubber products used in the aerospace industry (AIA, 2019) as well as a variety of transportation equipment such as both vehicles production parts and replacement parts (MEMA, 2019). The Alliance of Automobile Manufacturers and the Motor & Equipment Manufacturers Association did explain that "[t]he average scope of the relative mass of DCHP in the parts from the Alliance's data collection is 0.24 gram. Excluding body/exterior parts, that average drops below 0.01 gram" (MEMA, 2019).

According to additional information provided to EPA in 2021, DCHP (referred to in this case as Uniplex 250) has been used as an article in a "range of construction products-boards" (LANXESS, 2021). These boards are presumed to be used in a variety of commercial applications and settings; however, could still be a source of exposure for consumers.

As such, consumers would be expected to handle or touch products covered by this COU with their hands and be exposed to DCHP through dermal contact.

Examples of CDR Submissions

In the 2016 CDR cycle, one company reported the consumer use of DCHP (CASRN 84-61-7) in plastic and rubber products not covered elsewhere.

In the 2020 CDR cycle, the same company reported the consumer use of DCHP (CASRN 84-61-7) as a plasticizer in other articles with routine direct contact during normal use including rubber articles; plastic articles (hard), which is a further refined description compared to the 2016 CDR cycle code of "plastic and rubber products not covered elsewhere."

E.23 Consumer Use – Other Consumer Articles that Contain DCHP from: Inks, Toner, and Colorants; Paints and Coatings; and Adhesives and Sealants

This COU is referring to the consumer use of articles that contain DCHP from inks, toner, and colorants, paints and coatings and adhesives and sealants.

According to information provided to EPA in 2021, DCHP (referred to in this case as Uniplex 250) has been used as an element of PVC inks/PVC plastisol formulations (LANXESS, 2021; U.S. EPA, 2019e). Uniplex 250 is also marketed as being used as a polymer additive in labels and printing ink formulations (Hallstar Website) and has been used as part of the screen-printing process for textiles (Gans Ink and Supply, 2018). EPA expects consumers to exposed to DCHP through various products, such as textiles, labels, packaging, etc.

The Agency has also identified several examples of commercial paints and coatings that already have DCHP incorporated as a plasticizer or combine two (or even multiple) components where DCHP acts as a phlegmatizer with BPO in unsaturated polyesters or MMA systems (U.S. EPA, 2024aj). These paints and coatings that utilize DCHP, are often applied in commercial settings such as in roofing, construction, and in cement/protection for high traffic areas (etc.)—often to provide waterproofing, UV protection and/or chemical resistance. In particular, EPA identified a product that is used as a vehicular and pedestrian traffic coating system, specifically designed for use in parking structures, balconies, stadium seating, walkways, plaza decks, etc. (Hydro-Gard, 2024, 2017a, b, 2012a, b). EPA expects consumers to be exposed to DCHP through this coating in areas where consumer access is presumed, such as balconies and stadium seating.

Additionally, DCHP is used during the cellulose film production to bathe or coat the film, giving it barrier properties as well as promoting heat seal. This cellulose film is then used in a variety of labeling, and packaging end uses (U.S. EPA, 2020c; Earthjustice, 2019). Any packaging or cellulose film end uses that are not subject to the U.S. Food and Drug Administration (FDA) regulations, would be captured under this COU. EPA would expect dermal exposure to DCHP through handling cellulose film.

Finally, EPA has identified commercial or industrial adhesives and sealants that already have DCHP incorporated as a plasticizer or combine a two-part adhesive where DCHP acts as a phlegmatizer in unsaturated polyesters or MMA systems (U.S. EPA, 2024aj). The American Coatings Association explained that DCHP is a plasticizer, additive, and impurity in adhesives in amounts less than one percent (ACA, 2019). According to information provided to EPA, DCHP is used as an adhesive within the aerospace industry (AIA, 2019), and an adhesive sealant for body panel assemblies and parts by automobile manufacturers applications (MEMA, 2019). EPA has also identified various industrial and commercial applications of adhesives and sealants in the construction industry, electronics etc. As a result, the Agency expects consumer to be exposed to DCHP through various complex articles that used an adhesive and sealant that contained DCHP, such as electronics, cars, airplanes, and building/construction materials.

Examples of CDR Submissions

In the 2016 CDR cycle, one company reported the use of DCHP (CASRN 84-61-7) as a plasticizer in printing ink manufacturing. One company reported the use of DCHP as a process regulator in paints and coating manufacturing, which has been recategorized in the COU table to "stabilizing agent" after discussions with the company that purchased the previous 2016 reporting company (U.S. EPA, 2024aj). Another company reported the use of DCHP as an adhesive and sealant chemicals in adhesive manufacturing.

In the 2020 CDR cycle, one company reported the use of DCHP (CASRN 84-61-7) as a stabilizing agent in paints and coating manufacturing and one company reported the use of DCHP as a plasticizer in adhesive manufacturing.

E.24 Disposal

Each of the COUs of DCHP may generate waste streams of the chemical. For purposes of the DCHP risk evaluation, this COU refers to the DCHP in a waste stream that is collected from facilities and households and are unloaded at and treated or disposed at third-party sites. This COU also encompasses DCHP contained in wastewater discharged by consumers or occupational users to a POTW or other, non-POTW for treatment, as well as other wastes.

DCHP is expected to be released to other environmental media, such as introductions of biosolids to soil or migration to water sources, through waste disposal (*e.g.*, disposal of formulations containing DCHP, plastic and rubber products, and transport containers). Disposal may also include destruction and removal by incineration. Recycling of DCHP and DCHP containing products is considered a different COU. Environmental releases from industrial sites are assessed in each COU.

Appendix F DRAFT OCCUPATIONAL EXPOSURE VALUE DERIVATION

EPA has calculated a draft 8-hour existing chemical occupational exposure value to summarize the occupational exposure scenario and sensitive health endpoints into a single value. This calculated draft value may be used to support risk management efforts for DCHP under TSCA section 6(a), 15 U.S.C. section 2605. EPA calculated the draft value rounded to 0.63 mg/m^3 for inhalation exposures to DCHP as an 8-hour time-weighted average (TWA) and for consideration in workplace settings (see Appendix F.1) based on the acute, non-cancer human equivalent concentration (HEC) for developmental toxicity (*i.e.*, phthalate syndrome-related effects on the developing male reproductive system).

TSCA requires risk evaluations to be conducted without consideration of costs and other non-risk factors, and thus this draft occupational exposure value represents a risk-only number. If risk management for DCHP follows the finalized risk evaluation, EPA may consider costs and other non-risk factors, such as technological feasibility, the availability of alternatives, and the potential for critical or essential uses. Any existing chemical exposure limit used for occupational safety risk management purposes could differ from the draft occupational exposure value presented in this appendix based on additional consideration of exposures and non-risk factors consistent with TSCA section 6(c).

This calculated draft value for DCHP represents the exposure concentration below which exposed workers and ONUs are not expected to exhibit any appreciable risk of adverse toxicological outcomes, accounting for PESS. It is derived based on the most sensitive human health effect (*i.e.*, effects on the developing male reproductive system) and exposure duration (*i.e.*, acute) relative to benchmarks and a standard occupational scenario assumption of an 8-hour workday.

EPA expects that at the draft occupational exposure value of 0.047 ppm (0.63 mg/m^3), a worker or ONU also would be protected against developmental toxicity from intermediate and chronic duration occupational exposures if ambient exposures are kept below this draft occupational exposure value. The Agency has not separately calculated a draft short-term (*i.e.*, 15-minute) occupational exposure value because EPA did not identify hazards for DCHP associated with this very short duration.

EPA did not identify a government-validated method for analyzing DCHP in air.

The Occupational Safety and Health Administration (OSHA) has not set a permissible exposure limit (PEL) as an 8-hour TWA for DCHP. EPA located several occupational exposure limits for DCHP (CASRN 84-61-7) in other countries (https://ilv.ifa.dguv.de/limitvalues/20258). Identified 8-hour TWA values range from 3 mg/m^3 in Denmark to 5 mg/m^3 in Austria, Ireland, New Zealand, South Africa, and the United Kingdom. Additionally, EPA found that New Zealand and the United Kingdom have an established occupational exposure limit of 5 mg/m^3 (8-hour TWA) in each country's code of regulation that is enforced by each country's worker safety and health agency.

F.1 Draft Occupational Exposure Value Calculations

This appendix presents the calculations used to estimate draft occupational exposure values using inputs derived in this draft risk evaluation. Multiple values are presented below for hazard endpoints based on different exposure durations. For DCHP, the most sensitive occupational exposure value is based on non-cancer developmental effects and the resulting 8-hour TWA is rounded to 0.63 mg/m^3.

Draft Acute Non-cancer Occupational Exposure Value

The draft acute occupational exposure value (EV_{acute}) was calculated as the concentration at which the acute MOE would equal the benchmark MOE for acute occupational exposures using Equation_Apx F-1:

Equation_Apx F-1.

$$EV_{acute} = \frac{HEC_{acute}}{Benchmark\ MOE_{acute}} * \frac{AT_{HECacute}}{ED} * \frac{IR_{resting}}{IR_{workers}} =$$

$$\frac{0.95\ \text{ppm}}{30} * \frac{\frac{24h}{d}}{\frac{8h}{d}} * \frac{0.6125\frac{m^3}{hr}}{1.25\frac{m^3}{hr}} = 0.047\ \text{ppm}$$

$$EV_{acute}\left(\frac{mg}{m^3}\right) = \frac{EV\ ppm\ * MW}{Molar\ Volume} = \frac{0.047\ \text{ppm} * 330.4\frac{g}{mol}}{24.45\ \frac{L}{mol}} = 0.63\ \frac{mg}{m^3}$$

Draft Intermediate Non-cancer Occupational Exposure Value

The draft intermediate occupational exposure value ($EV_{intermediate}$) was calculated as the concentration at which the intermediate MOE would equal the benchmark MOE for intermediate occupational exposures using Equation_Apx F-2:

Equation_Apx F-2.

$$EV_{intermediate} = \frac{HEC_{intermediate}}{Benchmark\ MOE_{intermediate}} * \frac{AT_{HEC\ intermediate}}{ED*EF} * \frac{IR_{resting}}{IR_{workers}}$$

$$= \frac{0.95\ \text{ppm}}{30} * \frac{\frac{24h}{d} * 30d}{\frac{8h}{d} * 22d} * \frac{0.6125\frac{m^3}{hr}}{1.25\frac{m^3}{hr}} = 0.063\ \text{ppm} = 0.86\ \frac{mg}{m^3}$$

Draft Chronic Non-cancer Exposure Value

The draft chronic occupational exposure value ($EV_{chronic}$) was calculated as the concentration at which the chronic MOE would equal the benchmark MOE for chronic occupational exposures using Equation_Apx F-3:

Equation_Apx F-3.

$$EV_{chronic} = \frac{HEC_{chronic}}{Benchmark\ MOE_{chronic}} * \frac{AT_{HEC\ chronic}}{ED*EF*WY} * \frac{IR_{resting}}{IR_{workers}}$$

$$= \frac{0.95\ \text{ppm}}{30} * \frac{\frac{24h}{d}*\frac{365d}{y}*40\ y*0.6125\frac{m^3}{hr}}{\frac{8h}{d}*\frac{250d}{y}*40\ y*1.25\frac{m^3}{hr}} = 0.068\ \text{ppm} = 0.92\ \frac{mg}{m^3}$$

Where:

AT_{hecate} = Averaging time for the POD/HEC used for evaluating non-cancer

			acute occupational risk based on study conditions and HEC adjustments (24 h/day).
	$AT_{HECintermediate}$	=	Averaging time for the POD/HEC used for evaluating non-cancer intermediate occupational risk based on study conditions and/or any HEC adjustments (24 h/day for 30 days).
	$AT_{HECchronic}$	=	Averaging time for the POD/HEC used for evaluating non-cancer chronic occupational risk based on study conditions and/or HEC adjustments (24 h/day for 365 days/year) and assuming the same number of years as the high-end working years (WY, 40 years) for a worker.
	Benchmark MOE_{acute}	=	Acute non-cancer benchmark margin of exposure, based on the total uncertainty factor of 30
	Benchmark $MOE_{intermediate}$	=	Intermediate non-cancer benchmark margin of exposure, based on the total uncertainty factor of 30
	Benchmark $MOE_{chronic}$	=	Chronic non-cancer benchmark margin of exposure, based on the total uncertainty factor of 30
	EV_{acute}	=	Acute occupational exposure value
	$EV_{intermediate}$	=	Intermediate occupational exposure value
	$EV_{chronic}$	=	Chronic occupational exposure value
	ED	=	Exposure duration (8 h/day)
	EF	=	Exposure frequency (1 day for acute, 22 days for intermediate, and 250 days/year for chronic and lifetime)
	HEC	=	Human equivalent concentration for acute, intermediate, or chronic non-cancer occupational exposure scenarios
	IR	=	Inhalation rate (default is 1.25 m^3/h for workers and 0.6125 m^3/h assumed from "resting" animals from toxicity studies)
	Molar Volume	=	24.45 L/mol, the volume of a mole of gas at 1 atm and 25 °C
	MW	=	Molecular weight of DCHP (330.4 g/mole)
	WY	=	Working years per lifetime at the 95th percentile (40 years).

Unit conversion:

1 ppm = 13.51 mg/m^3 (see equation associated with the EV_{acute} calculation)