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United States
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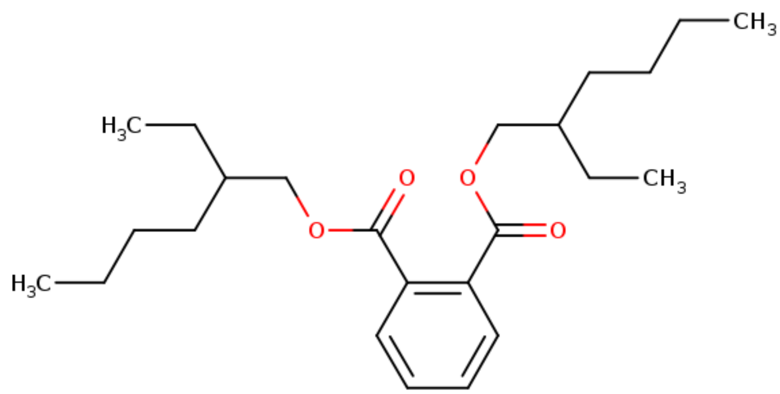
Risk Evaluation for Diethylhexyl Phthalate (DEHP)

CASRN 117-81-7



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Docket

Supporting information can be found in the public docket, Docket ID EPA-HQ-OPPT-2018-0433.

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EXECUTIVE SUMMARY

Background

EPA has evaluated the health and environmental risks of the chemical diethylhexyl phthalate (DEHP) under section 6 of the Toxic Substances Control Act (TSCA). In this risk evaluation, the Agency has determined that DEHP presents an unreasonable risk of injury to human health and the environment under the conditions of use (COUs) driven by significant contributions to risk from specific COUs**.** Of the 44 COUs evaluated, a total of 20 COUs significantly contribute to unreasonable risk to the environment based on chronic exposure to aquatic vertebrates and sediment-dwelling invertebrates. Of those 20 COUs, 10 COUs also significantly contribute to human health risk to workers driven by inhalation exposure to DEHP—including risks to occupational non-users (ONUs) under 8 of these COUs. No TSCA COUs for DEHP significantly contribute to unreasonable risk to consumers or the general population.

In December 2019, EPA designated DEHP as a high-priority substance for TSCA risk evaluation and in August 2020 released the final scope of the risk evaluation (U.S. EPA, 2020c). EPA released a *Draft Risk Evaluation for Diethylhexyl Phthalate (DEHP)* (U.S. EPA, 2025q) in May 2025 for public comment and external peer review. In August 2025, the draft was independently peer reviewed by the Science Advisory Committee on Chemicals (SACC) in August 2025. This final risk evaluation was revised to incorporate recommendations from the SACC (U.S. EPA, 2025ag) and public commenters.

DEHP is primarily used as a plasticizer for polyvinyl chloride (PVC) in consumer, commercial, and industrial applications; it is also used in adhesives, sealants, paints, coatings, rubber products, and non-PVC plastics as well as other applications. Workers may be exposed to DEHP when making these products or otherwise using DEHP in the workplace (Section 4.1.1). When it is manufactured or used to make products, DEHP can be released into water, where because of its properties, most will end up in the sediment of nearby lakes and rivers (Sections 3.2 and Section 3.3.1.1). If released into the air (Section 3.3.1.2), DEHP will attach to dust particles and deposit on land or into water. Indoors, DEHP has the potential over time to be released from products and adhere to dust particles (Section 4.1.2). If it does, people could inhale or ingest dust that contains DEHP.

Laboratory animal studies have been conducted to study DEHP to determine whether it causes health effects in people, including non-cancer effects and cancer. After reviewing the reasonably available studies, the Agency concludes that there is robust evidence that DEHP exposure can cause developmental and reproductive toxicity (non-cancer human health hazards; see Section 4.2). The most sensitive adverse developmental effects include adverse effects on the developing male reproductive system consistent with a disruption of androgen action—known as *phthalate syndrome*—which results from decreased fetal testicular testosterone.

EPA has developed a cumulative risk analysis (CRA) technical support document including DEHP and five other phthalate chemicals that can all cause phthalate syndrome (Section 4.4) (U.S. EPA, 2025al). 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 common basis for adding risk across the six phthalates included in the cumulative assessment.[1] Notably, assessments by Health Canada, U.S. Consumer Product Safety Commission (U.S. CPSC), European Chemicals Agency (ECHA), and the

[1] The six phthalates in the CRA are butyl benzyl phthalate (BBP), dibutyl phthalate (DBP), dicyclohexyl phthalate (DCHP), DEHP, diisobutyl phthalate (DIBP), and diisononyl phthalate (DINP).

Australian National Industrial Chemicals Notification and Assessment Scheme (NICNAS) have reached similar conclusions regarding the developmental effects of DEHP. They have also conducted CRAs of phthalates based on these chemicals' shared ability to cause phthalate syndrome. Furthermore, independent, expert peer reviewers endorsed EPA's proposal to conduct a CRA of phthalates under TSCA during the May 2023 meeting of the SACC because humans are co-exposed to multiple toxicologically similar phthalates that cause effects on the developing male reproductive system consistent with a disruption of androgen action and phthalate syndrome (U.S. EPA, 2023f). In this risk evaluation, EPA has evaluated cumulative exposure to phthalates using human urinary biomonitoring data obtained through the Centers for Disease Control's (CDC) National Health and Nutrition Examination Survey (NHANES), which provides relevant information to understand exposures to chemical substances. Note that these cumulative phthalate exposures cannot be attributed to specific COUs or other sources. This non-attributable cumulative exposure and risk, representing the national population, was taken into consideration by the Agency in its risk evaluation for DEHP. EPA has included the phthalate CRA as part of its risk characterization for DEHP in alignment with the 2008 National Research Council Report: *Phthalates and Cumulative Risk Assessment: The Task Ahead* (NRC, 2008). This risk evaluation describes analyses considering DEHP exposure under the COUs as the "individual assessment" or "single chemical assessment" and analysis also considering background exposure to other phthalates (*i.e.*, NHANES) as the "cumulative assessment."

In December 2019, EPA designated DEHP as a high-priority substance for TSCA risk evaluation and in August 2020 released the *Final Scope of the Risk Evaluation for DEHP; CASRN 117-81-7* (U.S. EPA, 2020c). This risk evaluation assesses human health risk to workers, including ONUs, consumers, including bystanders, and the general population exposed to environmental releases. It also assesses risk to the environment, including risk to aquatic and terrestrial species. Manufacturers report DEHP production volumes through the Chemical Data Reporting (CDR) rule under the associated CAS Registry Number (CASRN) 117-81-7. The DEHP annual production volume range for the 2015 and 2019 reporting years was 10 to 50 million pounds (lb) based on the 2020 CDR data (U.S. EPA, 2020b). This represents the total annual DEHP production volume from all reporting sites for each of those reporting years. This aggregated production must be presented as a range to protect sites that claimed their production volume as confidential business information (CBI). Agency has evaluated DEHP across its COUs, ranging from manufacture to disposal.

Past assessments of DEHP from other government agencies that addressed a broad range of uses, which may have included some COUs assessed in this risk evaluation and have concluded that DEHP can pose risk to human health 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, neither assessment specifically considered exposure to workers. In the United States, Canada, and the European Union, the use of DEHP in children's toys and childcare products is restricted, with weight fraction limits on how much DEHP can be present in these articles (see Appendix B for an overview of existing regulations on DEHP). Limits on DEHP concentrations in the air in the workplace exist in the United States, Canada, the European Union, Australia, and elsewhere. A summary of these and additional international restrictions and labeling requirements for the use of DEHP exist and are also included in Appendix B.

In this risk evaluation, EPA evaluated whether manufacturing, processing, distribution in commerce, use, or disposal of DEHP presents unreasonable risk to human health or the environment under the COUs. Human or environmental exposure to DEHP through uses that are not subject to TSCA (*e.g.*, use in cosmetics, medical devices, food additives) were not evaluated by the Agency in reaching its determination of unreasonable risk of injury to human health. This is because these uses are excluded from TSCA's definition of chemical substance under TSCA section 3(2)(B). Thus, though EPA has determined in this risk evaluation that 20 specific TSCA COUs significantly contribute to its unreasonable risk finding for DEHP, this determination cannot be extrapolated to form conclusions about uses of DEHP that are not subject to TSCA and that EPA did not evaluate.

Determining Unreasonable Risk to Human Health

In TSCA existing chemical risk evaluations, EPA must determine whether a chemical substance presents unreasonable risk of injury to health or the environment, under the COUs. The Agency must use the best available science in making this determination. The Agency, in determining whether DEHP presents unreasonable risk to human health, considers risk-related factors as described in its risk evaluation framework rule (U.S. EPA, 2024b) 89 Fed. Reg. 37028, 37037 (May 3, 2024); see also TSCA section 6(b)(4)(F)(iv). Risk-related factors beyond consideration of benchmark levels of DEHP that EPA has identified include the following: 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 inform the evaluation of hazard and exposure to DEHP. If an estimate of risk for a specific COU indicate risk (*e.g.*, margin of exposure below the benchmark for non-cancer health effects) then the formal determination of whether those risks significantly contribute to unreasonable risk under TSCA is both case-by-case and context-driven. EPA considers all the aforementioned risk-related factors when making a determination of whether a COU significantly contributes to unreasonable risk under TSCA.

EPA evaluated the risks to workers, ONUs, consumers, and the general population from DEHP exposure. In its human health evaluation, the Agency used a tiered approach to assess how people might be exposed to DEHP through breathing or ingesting dust or other particulates, as well as through skin contact. Inhalation has been determined to be the primary route of DEHP exposure that drives the significant contributions to unreasonable risk to workers.

EPA included DEHP in the CRA along with five other phthalates that can cause effects on laboratory animals consistent with phthalate syndrome, as described in the *Technical Support Document for the Cumulative Risk Analysis of DEHP, DBP, BBP, DIBP, DCHP, and DINP Under TSCA* (U.S. EPA, 2025al). In this risk evaluation, the Agency addressed cumulative exposure to phthalates using human biomonitoring data. Note that these cumulative phthalate exposures cannot be attributed to specific COUs or other sources under TSCA. This non-attributable cumulative exposure and risk, representing the national population, was taken into consideration by EPA in its risk evaluation for DEHP.

In determining whether DEHP presents an unreasonable risk of injury to human health, EPA considered the following potentially exposed and susceptible subpopulations (PESS) in its assessment: females of reproductive age, pregnant women, infants, children and adolescents, people who frequently use consumer products and/or articles containing high concentrations of DEHP, people exposed to DEHP in the workplace, people in close proximity to releasing facilities (fenceline communities), and tribal and subsistence fishers whose diets include large amounts of fish. These subpopulations are PESS because some have greater exposure to DEHP per body weight (*e.g.*, infants, children, adolescents) while others may experience exposure from multiple sources or experience higher exposures than others.

Determining Unreasonable Risk to The Environment
In determining whether DEHP presents an unreasonable risk of injury to the environment, EPA considered the following groups of organisms in its assessment: aquatic vertebrates, invertebrates, plants and algae; sediment-dwelling invertebrates; soil invertebrates, and terrestrial mammals and plants.

Summary, Considerations, and Next Steps
EPA evaluated 44 COUs for DEHP. For consumers and for the general population the Agency determined that no COUs significantly contribute to unreasonable risk. EPA determined that the following 10 COUs significantly contribute to unreasonable risk of DEHP to workers due to acute, intermediate, and chronic inhalation exposures:

- Manufacturing – importing (inhalation exposure for workers)
- Processing – incorporation into formulation, mixture, or reaction product - plasticizer in plastic material and resin manufacturing; synthetic rubber manufacturing; basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint and coating manufacturing; adhesive manufacturing; basic inorganic chemical manufacturing; wholesale and retail trade; services; and ink, toner, and colorant manufacturing (inhalation exposure for workers and ONUs)
- Processing – incorporation into article – plasticizer in basic organic chemical manufacturing; plastics product manufacturing; rubber product manufacturing; miscellaneous manufacturing; and PVC extruding (inhalation exposure for workers and ONUs)
- Processing – repackaging – repackaging in wholesale and retail trade and in paint and coating manufacturing (inhalation exposure for workers)
- Industrial use – construction, paint, electrical, and metal products – paints and coatings (inhalation exposure for workers and ONUs)
- Industrial use – construction, paint, electrical, and metal products – adhesives and sealants (inhalation exposure for workers and ONUs)
- Commercial use – construction, paint, electrical, and metal products – adhesives and sealants (inhalation exposure for workers and ONUs)
- Commercial use – construction, paint, electrical, and metal products – paints and coatings (inhalation exposure for workers and ONUs)
- Commercial use – furnishing, cleaning, treatment care products – all-purpose waxes and polishes (inhalation exposure for workers and ONUs)
- Commercial use – packaging, paper, plastic, toys, hobby products – inks, toner, and colorants (workers and ONUs)

EPA has determined that 20 COUs significantly contribute to unreasonable risk of DEHP to the environment. Eighteen of those 20 COUs significantly contribute to unreasonable risk of DEHP to both aquatic vertebrates and sediment-dwelling invertebrates through chronic exposure to DEHP in surface water and sediment pore water, respectively, while the remaining 2 COUs significantly contribute to unreasonable risk of DEHP to aquatic vertebrates only through surface water. These 20 COUs are provided below:

- Manufacturing – manufacturing (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water)
- Manufacturing – importing (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water)
- Processing – incorporation into formulation, mixture, or reaction product – plasticizer in plastic material and resin manufacturing; synthetic rubber manufacturing; basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint

and coating manufacturing; adhesive manufacturing; basic inorganic chemical manufacturing; wholesale and retail trade; services; and ink, toner, and colorant manufacturing (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water)

- Processing – incorporation into article – plasticizer in basic organic chemical manufacturing; plastics product manufacturing; rubber product manufacturing; miscellaneous manufacturing; and PVC extruding (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water)
- Processing – repackaging – repackaging in wholesale and retail trade and in paint and coating manufacturing (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water)
- Processing – other uses – miscellaneous processing (cyclic crude and intermediate manufacturing; processing aid specific to hydraulic fracturing) (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water)
- Industrial use – construction, paint, electrical, and metal products – paints and coatings (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water)
- Industrial use – construction, paint, electrical, and metal products – adhesives and sealants (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);
- Industrial use – other uses – hydraulic fracturing (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water)
- Industrial use – other uses – solid rocket motor insulation and other aerospace applications (aquatic vertebrates through surface water only)
- Industrial use – other uses – automotive articles (aquatic vertebrates through surface water only)
- Commercial use – construction, paint, electrical, and metal products – adhesives and sealants (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water)
- Commercial use – construction, paint, electrical, and metal products – paints and coatings (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water)
- Commercial use – furnishing, cleaning, treatment care products – all-purpose waxes and polishes (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water)
- Commercial use – furnishing, cleaning, treatment care products – fabric enhancer (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water)
- Commercial use – furnishing, cleaning, treatment care products – fabric, textile, and leather products; furniture and furnishings (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water)
- Commercial use – packaging, paper, plastic, toys, hobby products – ink, toner, and colorants (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);
- Commercial use – other uses – laboratory chemicals (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water)
- Commercial use – other uses – automotive articles and products (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water); and
- Disposal (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water)

EPA determined that the remaining 24 COUs do *not* significantly contribute to unreasonable risk:

- Distribution in commerce
- Recycling
- Commercial use – automotive, fuel, agriculture, outdoor use products – lawn and garden care products
- Commercial use – construction, paint, electrical, and metal products – batteries and capacitors

- Commercial use – construction, paint, electrical, and metal products – construction and building materials covering large surface areas, including paper articles; metal articles; stone, plaster, cement, glass and ceramic articles
- Commercial use – construction, paint, electrical, and metal products – machinery, mechanical appliances, electrical/electronic articles
- Commercial use – furnishing, cleaning, treatment care products – floor coverings; construction and building materials covering large surface areas including stone, plaster, cement, glass and ceramic articles; fabrics, textiles, and apparel
- Commercial use – packaging, paper, plastic, toys, hobby products – packaging (excluding food packaging) and other articles with routine direct contact during normal Use, including rubber articles; plastic articles (hard); plastic articles (soft)
- Commercial use – packaging, paper, plastic, toys, hobby products – packaging (excluding food packaging), including paper articles
- Commercial use – packaging, paper, plastic, toys, hobby products – toys, playground, and sporting equipment
- Consumer use – automotive, fuel, agriculture, outdoor use products – lawn and garden care products
- Consumer use – construction, paint, electrical, and metal products – adhesives and sealants
- Consumer use – construction, paint, electrical, and metal products – batteries
- Consumer use – construction, paint, electrical, and metal products – construction, and building materials covering large surface areas, including paper articles; metal articles; stone, plaster, cement, glass and ceramic articles
- Consumer use – construction, paint, electrical, and metal products – machinery, mechanical appliances, electrical/electronic articles
- Consumer use – construction, paint, electrical, and metal products – paints and coatings
- Consumer use – furnishing, cleaning, treatment care products – fabric, textile, and leather products; furniture and furnishings
- Consumer use – furnishing, cleaning, treatment care products – floor coverings; construction and building materials covering large surface areas including stone, plaster, cement, glass and ceramic articles; fabrics, textiles, and apparel
- Consumer use – packaging, paper, plastic, toys, hobby products – ink, toner, and colorants
- Consumer use – packaging, paper, plastic, toys, hobby products – packaging (excluding food packaging) and other articles with routine direct contact during normal use, including rubber articles; plastic articles (hard); plastic articles (soft)
- Consumer use – packaging, paper, plastic, toys, hobby products – packaging (excluding food packaging), including paper articles
- Consumer use – packaging, paper, plastic, toys, hobby products – toys, playground, and sporting equipment
- Consumer use – other uses – novelty articles
- Consumer use – other uses – automotive articles

There were no COUs that significantly contribute to unreasonable risk for consumers or the general population.

This risk evaluation was released for public comment and was peer reviewed by the SACC in August 2025 (U.S. EPA, 2025ag). This final DEHP risk evaluation takes into consideration input from the public and recommendations received from SACC (U.S. EPA, 2025ag). Additional inhalation exposure data was received through public comment and incorporated into the Plastic Compounding, Plastic Converting, and Recycling occupational exposure scenarios.

In this final risk evaluation, the Agency determined that DEHP presents unreasonable risk to human health and the environment driven by significant contributions to unreasonable risk for 20 COUs. As a next step, EPA will initiate regulatory action under TSCA section 6(a) to the extent necessary so that DEHP no longer presents such risk. The Agency expects risk management requirements to focus on those COUs that significantly contribute to the unreasonable risk of DEHP. As inhalation risk presented in the single chemical analysis for DEHP is the driver of the unreasonable risk to human health, EPA's risk management will focus on the risk presented in the single chemical analysis of DEHP for the inhalation pathway.

1 INTRODUCTION

EPA has evaluated di-ethylhexyl phthalate (DEHP) pursuant to section 6(b) of the Toxic Substances Control Act (TSCA). DEHP is a colorless, oily liquid that is used primarily as a plasticizer in polyvinyl chloride (PVC) plastics—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 DEHP risk evaluation and provides information on production volume, a life cycle diagram (LCD), TSCA conditions of use (COUs), conceptual models used for DEHP, and an overview of the populations (including subpopulations) and durations of exposure assessed. Section 1.2 presents the organization of the remainder of the 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.

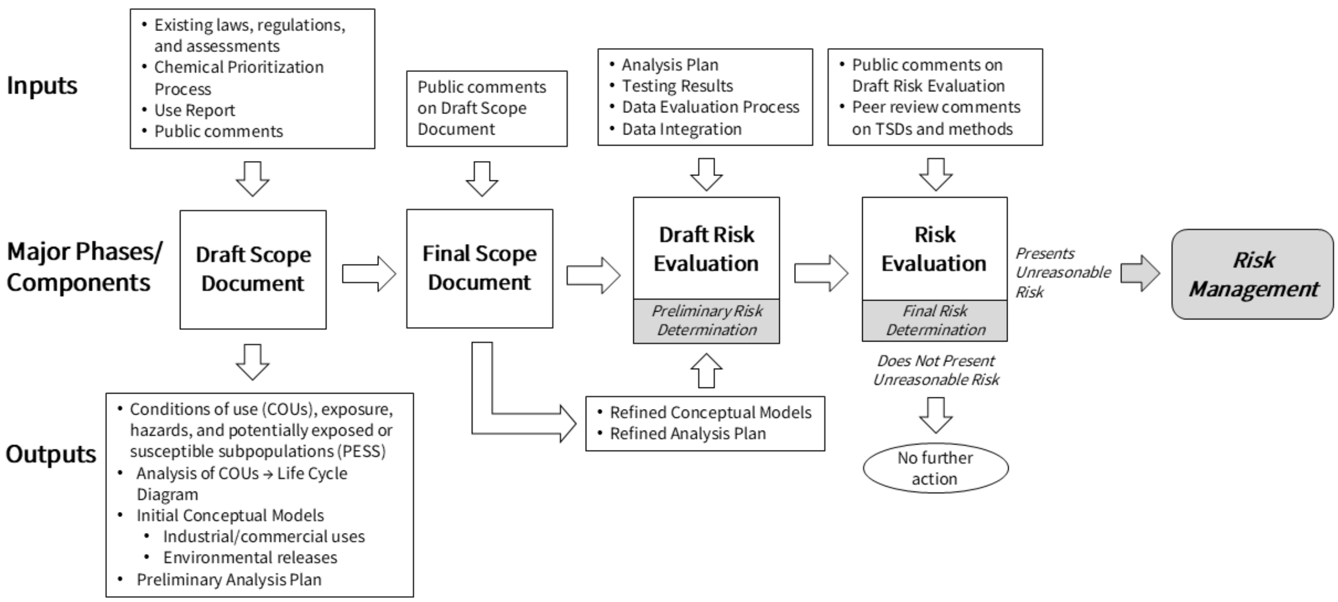

Figure 1-1. Overview of TSCA Existing Chemical Risk Evaluation Process

1.1 Scope of the Risk Evaluation

EPA evaluated risk to human and environmental populations for DEHP. Specifically for human populations, the Agency evaluated risk to workers including occupational non-users (ONUs) via inhalation and dermal routes; risk to consumers via inhalation, dermal, and oral routes; and risk to bystanders via the inhalation route. Additionally, EPA incorporated the following potentially exposed and susceptible populations (PESS) into its assessment—females of reproductive age, pregnant women, infants, children and adolescents, people who frequently use consumer products and/or articles containing high-concentrations of DEHP, people exposed to DEHP in the workplace, and Tribes whose diets include large amounts of fish. As described further in Section 4.1.3, using a screening level analysis, EPA assessed risks to the general population, which considered risk from exposure to DEHP via inhalation, dermal, and oral routes. 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, 2023d), EPA has also authored a cumulative risk technical support document (TSD) of DEHP and five other toxicologically similar phthalates (*i.e.*, butyl benzyl phthalate [BBP], dibutyl phthalate [DBP], diisobutyl phthalate [DIBP], dicyclohexyl phthalate [DCHP], 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) (U.S. EPA, 2025al). 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 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. Further, EPA's 2023 proposal to conduct a CRA of phthalates under TSCA was endorsed by the Science Advisory Committee on Chemicals (SACC) because humans are co-exposed to multiple toxicologically similar phthalates that cause effects on the developing male reproductive system consistent with a disruption of androgen action and phthalate syndrome (U.S. EPA, 2025ag, 2023f). As described further in Section 4.4, cumulative risk considerations focus on acute duration exposures to the most susceptible subpopulations: female workers and consumers of reproductive age (aged 16–49 years) as well as male infants and male children (3–15 years) exposed to consumer products and articles.

The DEHP risk evaluation comprises a series of TSDs. Each TSD contains sub-assessments that inform adjacent, "downstream" TSDs. 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 TSD 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 risk evaluation for DEHP.

These TSDs leveraged the data and information sources already identified in the *Final Scope of the Risk Evaluation for Diethylhexyl Phthalate (DEHP); CASRN 117-81-7* (also called the "final scope document") (U.S. EPA, 2020c). OPPT conducted a comprehensive search for reasonably available information to identify relevant DEHP data for use in the risk evaluation as required by the TSCA statute. The approach used to identify specific relevant risk assessment information was discipline-specific and is detailed in the *Systematic Review Protocol for DEHP* (U.S. EPA, 2025ak), or as otherwise noted in the relevant TSDs.

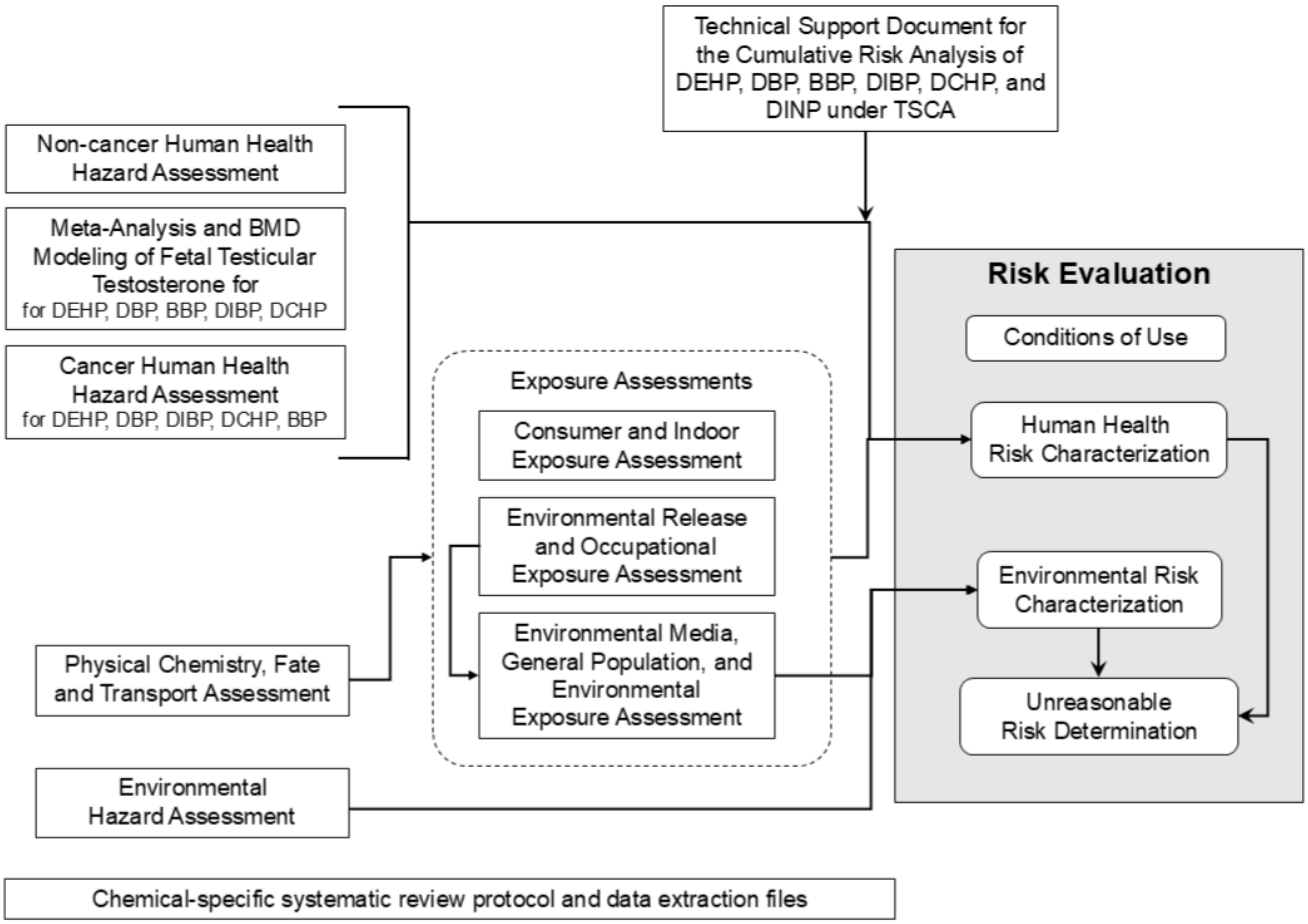

Figure 1-2. DEHP Risk Evaluation Document Summary Map

1.1.1 Life Cycle and Production Volume

The LCD shown in Figure 1-3 depicts the COUs assessed in this risk evaluation during various life cycle stages, including manufacturing, processing, distribution, use (industrial, commercial, consumer), and disposal. The LCD has been updated since its original 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 DEHP from the final scope document to this 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 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, 2020, and 2024.

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, 2020b). The descriptions provide a brief overview of the use category; the *Environmental Release and Occupational Exposure Assessment for Diethylhexyl Phthalate (DEHP)* (U.S. EPA, 2025u) contains more detailed descriptions (*e.g.*, process descriptions, worker activities, process flow diagrams, equipment illustrations) for each manufacturing, processing, use, and disposal category.

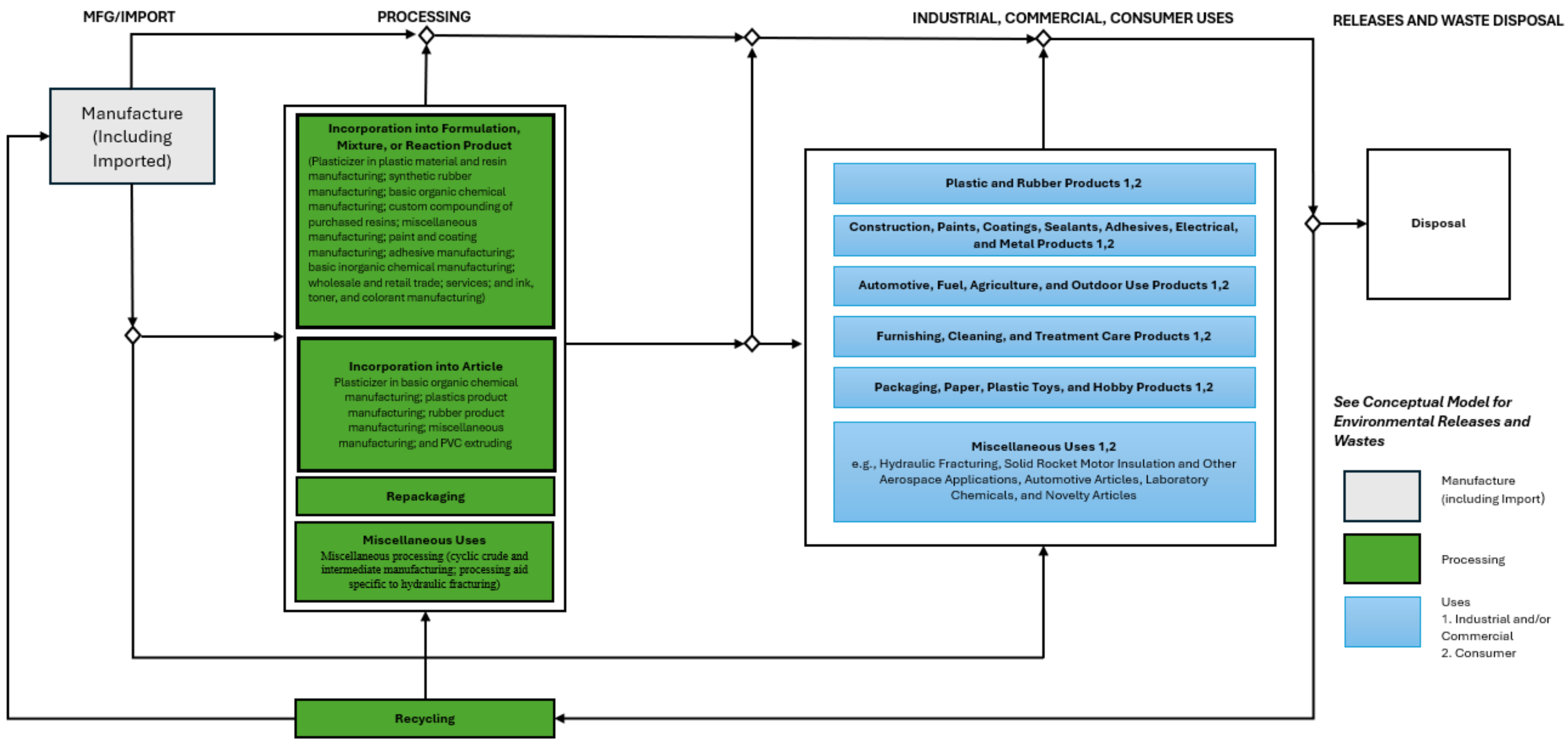

Figure 1-3. DEHP Life Cycle Diagram

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

The manufacture of DEHP has decreased significantly in the past two decades. In 2002, annual U.S. production of DEHP was reported to range from roughly 265 million to 4 billion pounds (U.S. CPSC, 2015). The exact amount is available for one year, 2011, in which 152,694,720 lbs of DEHP was produced or imported. The U.S. EPA Chemical Data Access Tool (CDAT) reports that the 2012 national production volume was 152,694,720 lb/yr and shows at least 15 companies listed as importing or manufacturing DEHP. Subsequent years show the number remains between 100 and 500 million through 2015 and decreased to 50 to 100 million pounds in 2019 based on the 2020 CDR data (U.S. EPA, 2020b). Review of preliminary 2024 CDR data shows that the national aggregate DEHP production volume is expected to be comparable to the previously reported national aggregate production volume range from the 2020 CDR. EPA presents production volumes as a range to protect data claimed as confidential business information (CBI). For the 2016 and 2020 CDR cycles, 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).

1.1.2 Conditions of Use Included in the Risk Evaluation

The final scope document (U.S. EPA, 2020c) identified and described the life cycle stages, categories, and subcategories that comprise COUs that EPA planned to consider in the risk evaluation. All COUs for DEHP included in this 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 DEHP.

In this risk evaluation, EPA made updates to the COUs listed in the final scope document (U.S. EPA, 2020c). These updates reflect EPA's improved understanding of the COUs based on further outreach, public comments, and updated industry code names under the CDR for 2020. Updates included (1) additions and clarification of COUs based on new reporting in CDR for 2020 or information received from stakeholders; (2) consolidation of redundant COUs from the processing life stage based on inconsistencies found in CDR reporting for DEHP processing and uses as well as communications with stakeholders about the use of DEHP in industry; and (3) correction of typos or edits for consistency. A complete list of updates and explanations of the updates made to COUs for DEHP from the final scope document to this risk evaluation is provided in Appendix D. EPA further refined the COU descriptions for DEHP included in the final risk evaluation based upon further outreach (see Appendix D and Appendix E for information regarding the COUs). Table 1-1 presents the revised COUs that were included and evaluated in this risk evaluation for DEHP. Appendix E contains descriptions of each COU.

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

Life Cycle Stage [a]	Category [b]	Subcategory [c]	Reference(s)
Manufacturing	Domestic manufacturing	Domestic manufacturing	(U.S. EPA, 2020a, 2019b)
	Importing	Importing	(U.S. EPA, 2020a, 2019b)
Processing	Incorporation into formulation, mixture, or reaction product	Plasticizer in plastic material and resin manufacturing; synthetic rubber manufacturing; basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint and coating manufacturing; adhesive manufacturing; basic inorganic chemical manufacturing; wholesale and retail trade; services; and ink, toner, and colorant manufacturing	(U.S. EPA, 2020a, 2019b; Just In Time Chemical, 2015)
	Incorporation into article	Plasticizer in basic organic chemical manufacturing; plastics product manufacturing; rubber product manufacturing; miscellaneous manufacturing; and PVC extruding	(U.S. EPA, 2020a, 2019a, b; Just In Time Chemical, 2015)
	Repackaging	Repackaging in wholesale and retail trade and in paint and coating manufacturing	(U.S. EPA, 2020a, 2019b)
	Other uses	Miscellaneous processing (cyclic crude and intermediate manufacturing; processing aid specific to hydraulic fracturing)	(U.S. EPA, 2019b); EPA-600-R-16-236Fb
	Recycling	Recycling	(U.S. EPA, 2020a, 2019b)
Distribution in Commerce	Distribution in commerce	Distribution in commerce	
Industrial Use	Construction, paint, electrical, and metal products	Paints and coatings	(Wasser Corporation, 2021; Wasser Technologies, 2021; 3M Company, 2019) EPA-HQ-OPPT-2019-0501-0043; EPA-HQ-OPPT-2018-0433-0004
		Adhesives and sealants	(Morgan Advanced Materials Wesgo Metals, 2016a, b); EPA-HQ-OPPT-2019-0501-0043; EPA-HQ-OPPT-2018-0433-0004
	Other uses	Hydraulic fracturing	EPA-HQ-OPPT-2019-0131-0054; EPA-600-R-16-236Fb
		Solid rocket motor insulation and other aerospace applications	EPA-HQ-OPPT-2019-0501-0043; EPA-HQ-OPPT-2018-0433-0004

Life Cycle Stage [a]	Category [b]	Subcategory [c]	Reference(s)
		Automotive articles	EPA-HQ-OPPT-2019-0131-0022
Commercial Use	Automotive, fuel, agriculture, outdoor use products	Lawn and garden care products	(Scopetani et al., 2023; U.S. EPA, 2020a)
	Construction, paint, electrical, and metal products	Adhesives and sealants	(U.S. Chemical & Plastics, 2020; U.S. EPA, 2020a; 3M, 2019; Morgan Advanced Materials Wesgo Metals, 2016a, b; Tremco, 2015); EPA-HQ-OPPT-2018-0433-0004
		Batteries and capacitors	(Kastar, 2024; Spypoint, 2024; Thumper Massager Inc, 2024; Just In Time Chemical, 2015)
		Construction and building materials covering large surface areas, including paper articles; metal articles; stone, plaster, cement, glass and ceramic articles	(U.S. EPA, 2020a, 2019b; Hsu et al., 2017; Rockwool, 2017; Valero, 2014)
		Machinery, mechanical appliances, electrical/electronic articles	(ESAB, 2024; QuickCable Corporation, 2024; U.S. EPA, 2020a, 2019b; Just In Time Chemical, 2015)
		Paints and coatings	(Axalta Coating Systems LLC, 2024; Axalta Coating Systems, 2023; Wasser Corporation, 2021; U.S. EPA, 2020a; The Sherwin-Williams Company, 2019; U.S. EPA, 2019b; Eagle I.F.P. Company, 2015a, b)
	Furnishing, cleaning, treatment care products	All-purpose waxes and polishes	(U.S. EPA, 2020a)
		Fabric enhancer	(U.S. EPA, 2020a)
		Fabric, textile, and leather products; furniture and furnishings	(Kinco, 2024; U.S. EPA, 2019b)
		Floor coverings; construction and building materials covering large surface areas including stone, plaster, cement, glass and ceramic articles; fabrics, textiles, and apparel	(Duro Dyne Corporation, 2024; U.S. EPA, 2020a; WE Cork, 2001)
	Packaging, paper, plastic, toys, hobby products	Ink, toner, and colorants	(Identity Group, 2016); EPA-HQ-OPPT-2018-0433-0004
		Packaging (excluding food packaging) and other articles with routine direct contact during normal Use, including rubber articles; plastic articles (hard); plastic articles (soft)	(Quad City Safety Inc, 2024a, b; Washington Department of Ecology, 2021; U.S. EPA, 2020a, 2019b; BriteLine, 2018); EPA-HQ-OPPT-2018-0433-0004

Life Cycle Stage [a]	Category [b]	Subcategory [c]	Reference(s)
		Packaging (excluding food packaging), including paper articles	(U.S. EPA, 2020a)
		Toys, playground, and sporting equipment	(Armada et al., 2022; U.S. EPA, 2020a, 2019b, e)
	Other uses	Laboratory chemicals	(Chem Service Inc, 2018; Phenova, 2018); EPA-HQ-OPPT- 2019-0501-0043
		Automotive articles and products	(Westin Automotive Products Inc, 2024; Reddam and Volz, 2021; U.S. EPA, 2019e; 3M, 2017); EPA-HQ-OPPT-2019-0131-0022
Consumer Use	Automotive, fuel, agriculture, outdoor use products	Lawn and garden care products	(U.S. EPA, 2020a)
	Construction, paint, electrical, and metal products	Adhesives and sealants	(U.S. Chemical & Plastics, 2020; U.S. EPA, 2020a)
		Batteries	(Kastar, 2024; Spypoint, 2024; Thumper Massager Inc, 2024)
		Construction and building materials covering large surface areas, including paper articles; metal articles; stone, plaster, cement, glass and ceramic articles	(U.S. EPA, 2020a; Hsu et al., 2017)
		Machinery, mechanical appliances, electrical/electronic articles	(U.S. EPA, 2019b; Just In Time Chemical, 2015)
		Paints and coatings	(U.S. EPA, 2020a; The Sherwin-Williams Company, 2019; U.S. EPA, 2019b; Eagle I.F.P. Company, 2015a, b)
	Furnishing, cleaning, treatment care products	Fabric, textile, and leather products; furniture and furnishings	(Equifit, 2024; Kinco, 2024; Mandal et al., 2022; U.S. EPA, 2019b)
		Floor coverings; construction and building materials covering large surface areas including stone, plaster, cement, glass and ceramic articles; fabrics, textiles, and apparel	(U.S. EPA, 2020a; WE Cork, 2001)
	Packaging, paper, plastic, toys, hobby products	Ink, toner, and colorants	(Identity Group, 2016)
		Packaging (excluding food packaging) and other articles with routine direct contact during normal use, including rubber articles; plastic articles (hard); plastic articles (soft)	(Quad City Safety Inc, 2024a, b; Washington Department of Ecology, 2021; U.S. EPA, 2020a, 2019b; BriteLine, 2018); EPA-HQ-OPPT-2018-0433-0004
		Packaging (excluding food	(U.S. EPA, 2020a)

Life Cycle Stage [a]	Category [b]	Subcategory [c]	Reference(s)
		packaging), including paper articles	
		Toys, playground, and sporting equipment	(Armada et al., 2022; U.S. EPA, 2019e)
	Other uses	Novelty articles	(Stabile, 2013)
		Automotive articles	(Westin Automotive Products Inc, 2024; Armada et al., 2022; Reddam and Volz, 2021; U.S. EPA, 2019e); EPA-HQ-OPPT-2019-0131-0022
Disposal	Disposal	Disposal	

[a] Life Cycle Stage Use Definitions (40 CFR 711.3)

- "Industrial use" means use at a site at which 1 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.

These categories of COUs appear in the LCD reflect CDR codes and broadly represent COUs of DEHP in industrial and/or commercial settings.

[b] These subcategories reflect more specific COUs of DEHP.

[c] In the final scope document, EPA added the COU for DEHP for processing, incorporation into formulation, mixture, or reaction product solid rocket motor insulation based on consultation with industry (EPA-HQ-OPPT-2018-0433-0038).

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 DEHP. There is potential for exposures to workers and/or ONUs via inhalation and via dermal contact. The conceptual model also includes potential ONU dermal exposure to DEHP 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), as well as qualitatively through a single distribution scenario.

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.

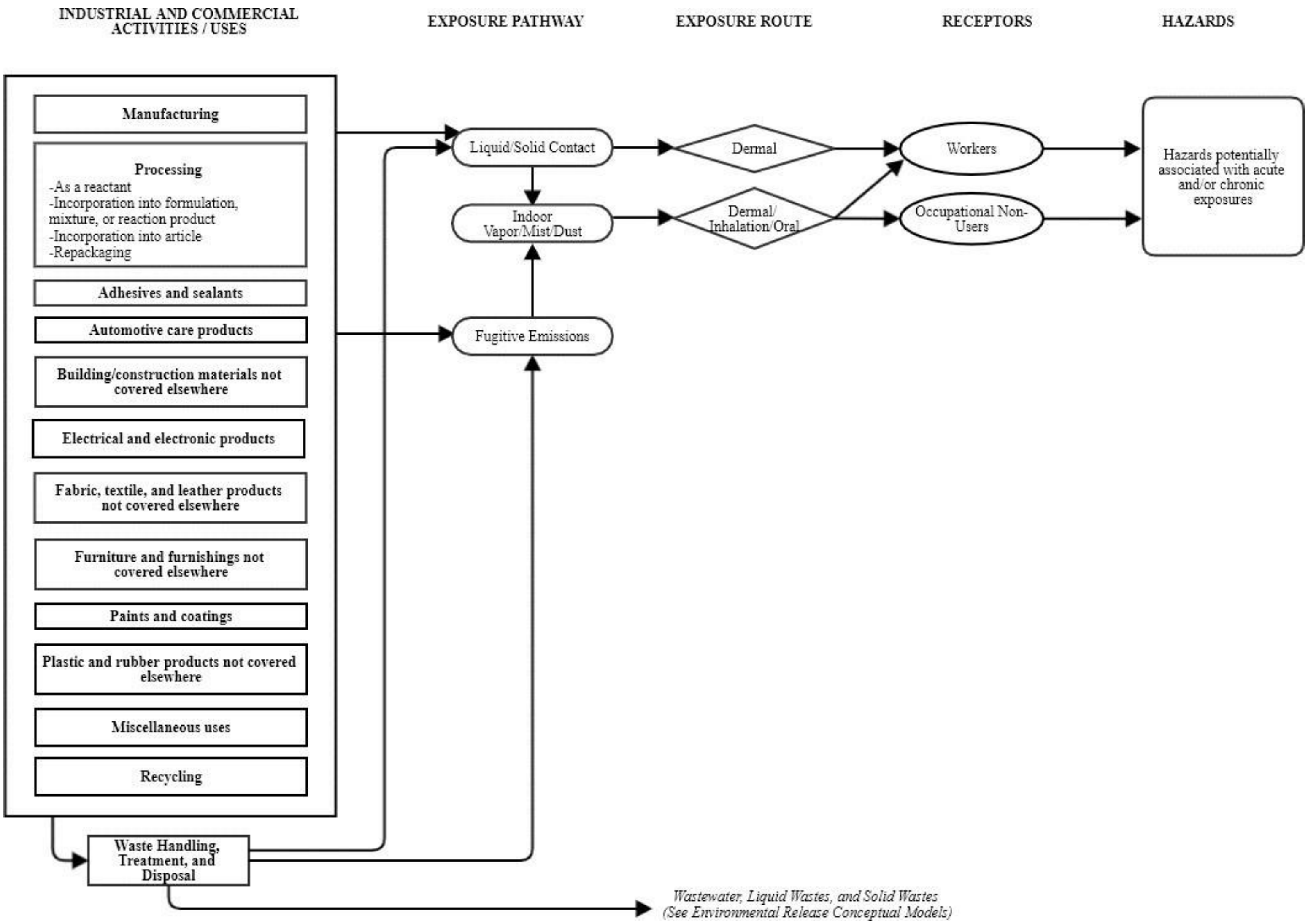

Figure 1-4. DEHP Conceptual Model for Industrial and Commercial Activities and Uses: Potential Exposure and Hazards

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

[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.

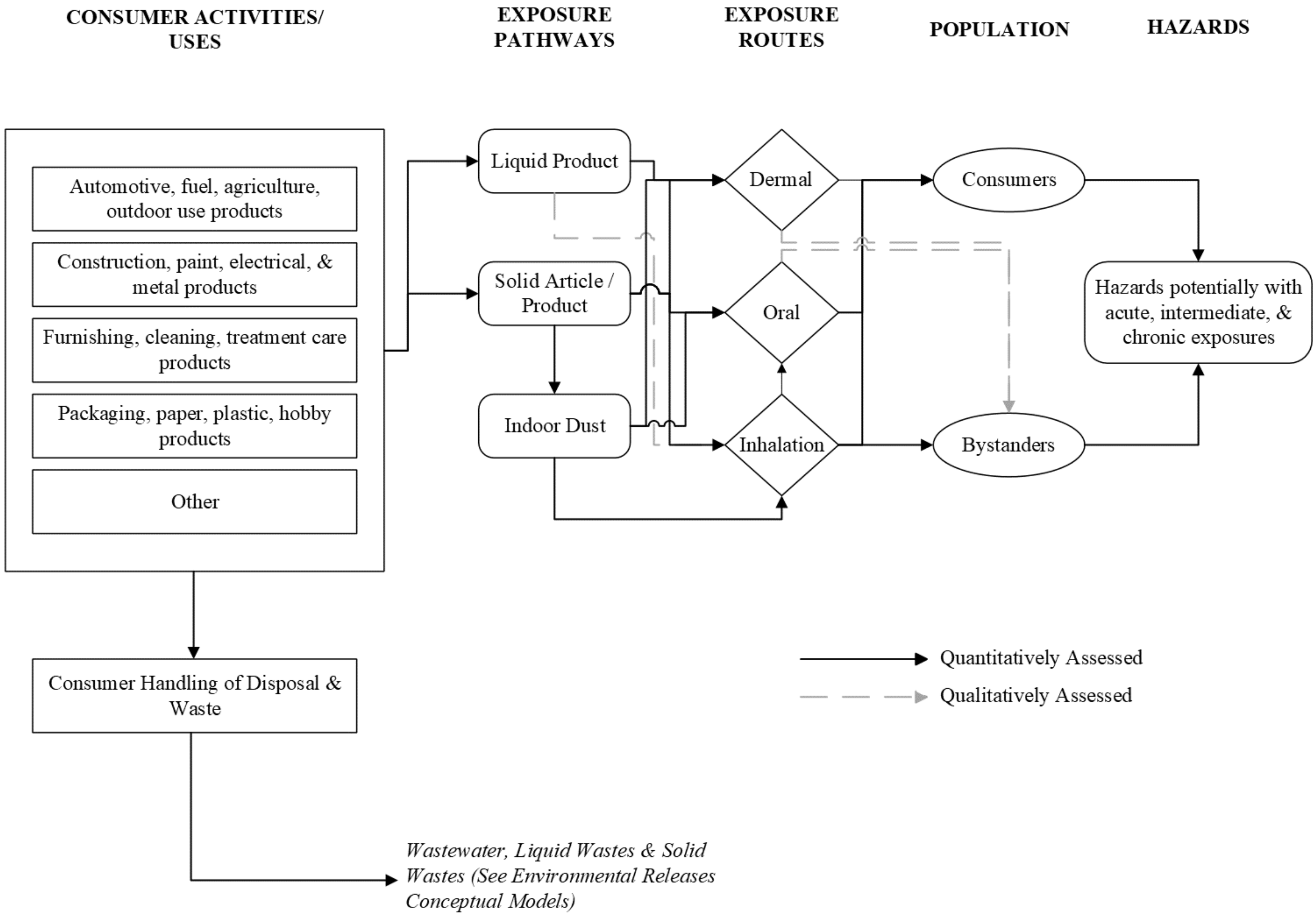

Figure 1-5. DEHP Conceptual Model for Consumer Activities and Uses: Potential Exposures and Hazards

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

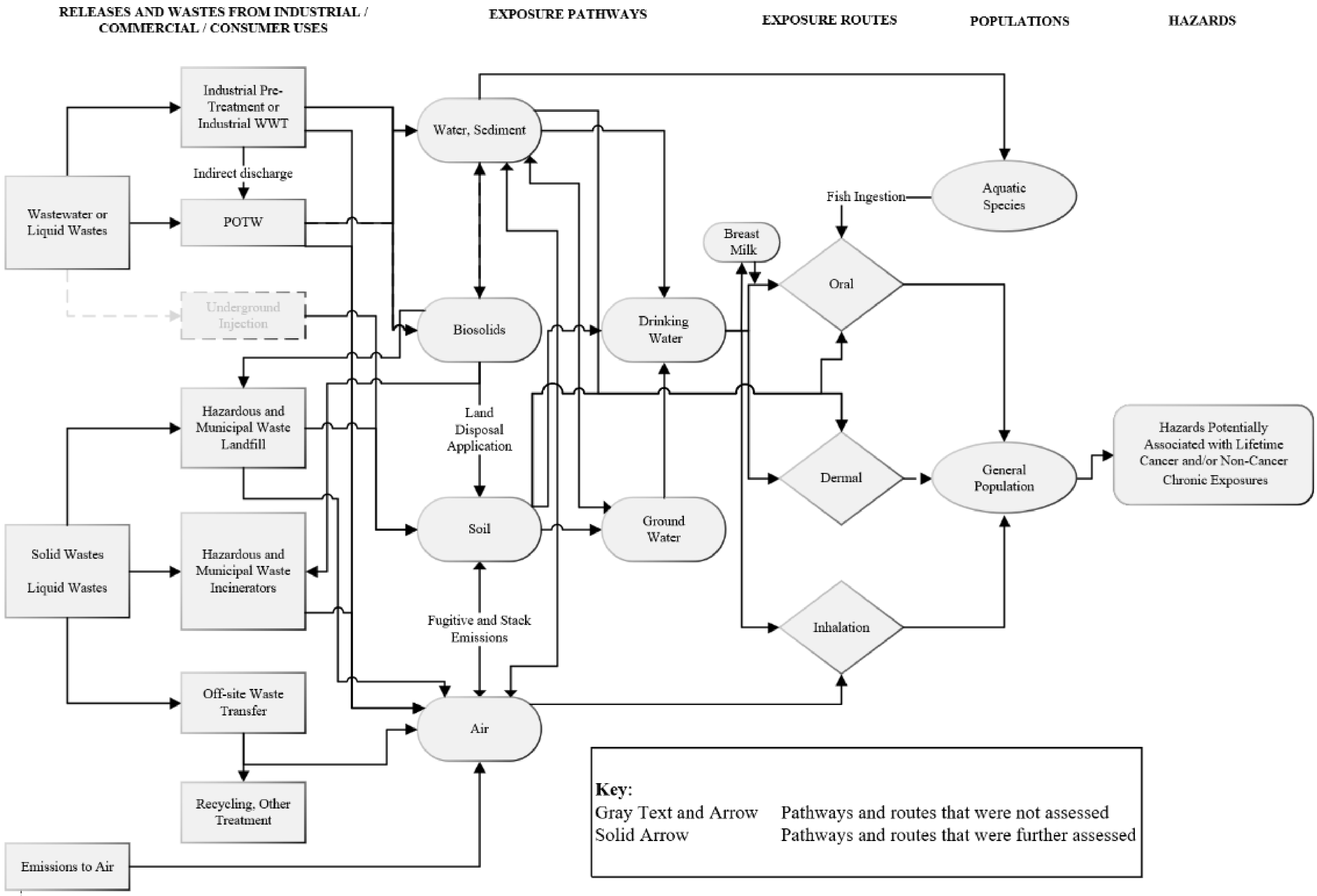

Figure 1-6. DEHP Conceptual Model for Environmental Releases and Wastes: General Population Hazards
The conceptual model presents the exposure pathways, exposure routes, and hazards to human populations from releases and wastes from industrial, commercial, and/or consumer uses of DEHP.

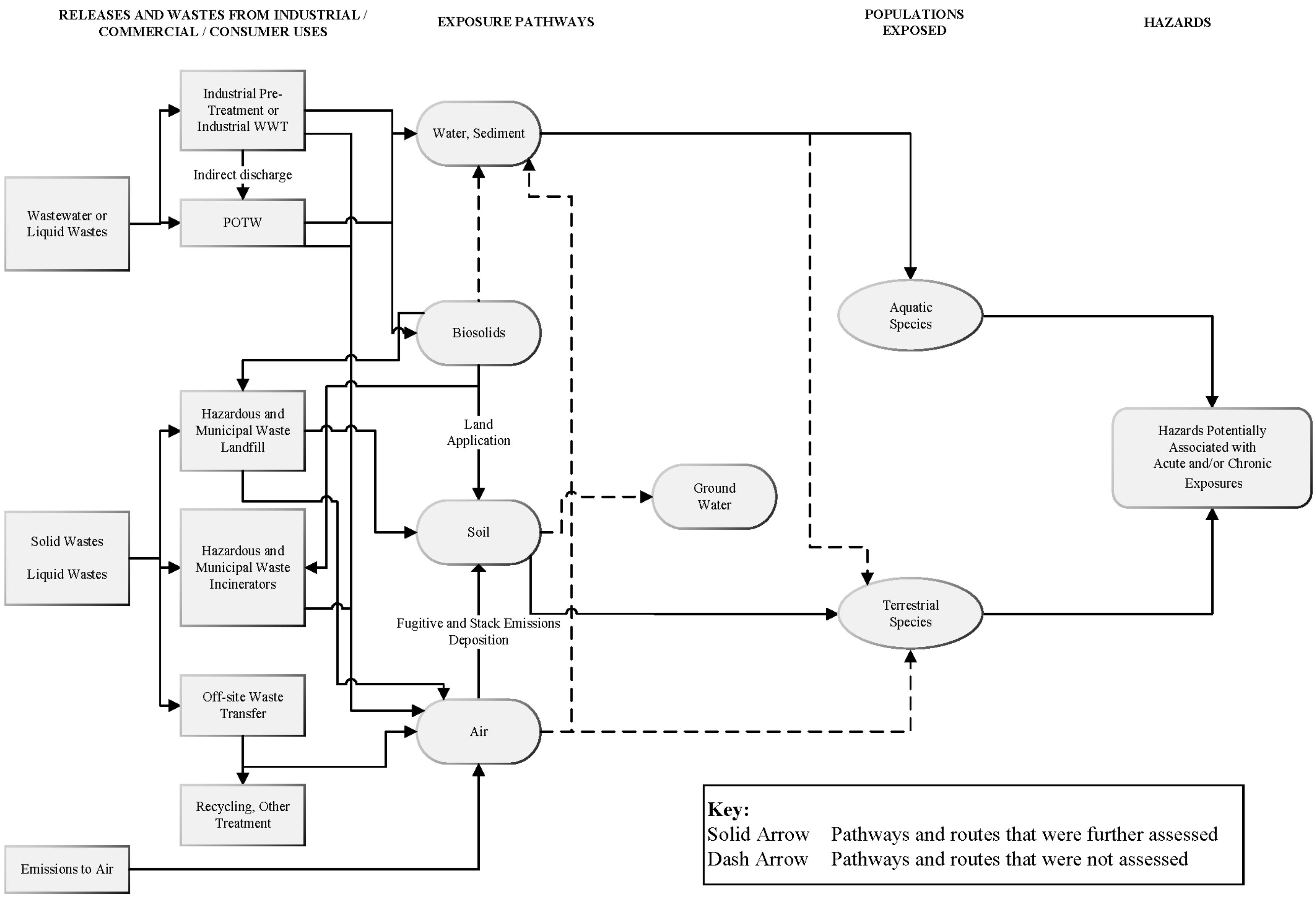

Figure 1-7. DEHP Conceptual Model for Environmental Releases and Wastes: Ecological Exposures and Hazards
The conceptual model presents the exposure pathways, exposure routes, and hazards to human populations from releases and wastes from industrial, commercial, and/or consumer uses of DEHP.

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 environmental and human populations. Environmental risks were evaluated for acute and chronic exposure scenarios for aquatic and terrestrial species, as appropriate. Human health risks 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 females 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 and above);
- Bystanders, 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); and
- 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 evaluated have unique exposure pathways and 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). In general, factors such as exposure duration and frequency and product and article use patterns have a greater impact on exposure or dose compared to sex-specific differences in body weight and body surface area. Therefore, with the exception of workers, EPA characterized risk to average adults, and considered all populations, including females of reproductive age, pregnant women, and other PESS to be included in the resulting distribution of exposures examined.

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, 2023d), EPA is focusing its phthalate CRA on populations most relevant to the common hazard endpoint (*i.e.*, reduced fetal testicular testosterone)—specifically females 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 DEHP (U.S. EPA, 2025aa), DIBP (U.S. EPA, 2025ab), DCHP (U.S. EPA, 2025z), DBP (U.S. EPA, 2025y), BBP (U.S. EPA, 2025x), and DINP (U.S. EPA, 2025ac). Additionally, EPA is focusing its CRA on acute duration exposures. This is because—as described further in the *Technical Support Document for the Cumulative Risk Analysis of DEHP, DBP, BBP, DIBP, DCHP, and DINP Under TSCA* (U.S. EPA, 2025al)—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 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: females of reproductive age, pregnant women, infants, children and adolescents, people who frequently use consumer products and/or articles containing high concentrations of DEHP, people exposed to DEHP in the workplace, people in close 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 DEHP per body weight (*e.g.,* infants, children, adolescents) or due to age-specific behaviors (*e.g.*, mouthing of toys, insulated cords, and erasers by infants and children, assessed in the consumer exposure scenarios), while some experience aggregate or sentinel exposures. EPA also evaluated non-attributable exposures and cumulative risk to other phthalates (*i.e.*, BBP, DEHP, DCHP[2], DIBP, and DINP) using biomonitoring data from the Center for Disease Control and Prevention's (CDC) National Health and Nutrition Examination Survey (NHANES; accessed December 23, 2025). 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 DEHP, presented below in Sections 4.4.4 and 4.4.5 and around exposures to DEHP from both occupational and consumer COUs/OES.

Section 4.3.5 summarizes how PESS were incorporated into the risk evaluation through consideration of potentially higher 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 risk evaluation for DEHP includes five additional major sections, and several appendices, including:

- Section 2 summarizes basic physical and chemical characteristics as well as the fate and transport of DEHP.
- Section 3 includes an overview of releases and concentrations of DEHP in the environment.
- Section 4 presents the human health risk assessment, including the exposure, hazard, and risk characterization based on the 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 discusses assumptions and uncertainties and how they potentially impact the strength of the evidence of the risk evaluation. Finally, Section 4 presents cumulative risk estimates from exposure to BBP, DEHP, DBP, DIBP, DCHP, and DINP (Section 4.4), as well as a comparison of the individual DEHP risk assessment and the CRA (Section 4.5).
- 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 DEHP. It also discusses assumptions and uncertainties and how they impact EPA's overall confidence in risk estimates.
- Section 6 presents EPA's determination of whether the chemical presents an unreasonable risk to human health or the environment under the assessed COUs.
- Appendix A provides a list of key abbreviations and acronyms used throughout this risk evaluation.

[2] Note that DCHP metabolites are no longer measured in the NHANES urinary biomonitoring dataset.

- Appendix B provides a brief summary of the federal, state, and international regulatory history of DEHP.
- Appendix C incudes a list and citations for all TSDs and supplemental files included in the risk evaluation for DEHP.
- Appendix D provides a summary of updates made to COUs for DEHP from the final scope document to this risk evaluation.
- Appendix E provides descriptions of the DEHP COUs evaluated by EPA.
- Appendix F provides the occupational exposure value for DEHP that was derived by EPA.

This risk evaluation describes analyses considering DEHP exposure under the COUs as the "individual assessment" or "single chemical assessment" and analysis also considering background exposure to other phthalates[3] (*i.e.*, NHANES) as the "cumulative assessment." The risk evaluation includes each of the steps described below.

- The risk evaluation involves two sets of calculations for the single chemical analysis:
  Step 1. Single chemical, single route evaluation by COU.
    - Routes include dermal and inhalation for workers, and dermal, inhalation, and oral for consumers.
    - For example, evaluation of inhalation exposure to workers for the manufacturing COU.

  Step 2. Aggregate exposure and risk: Single chemical, multi-route evaluation by COU
    - Aggregate assessment is only conducted when the hazard assessment shows that the same hazard is observed from different routes (*i.e.*, dermal, inhalation and oral).
    - Aggregate risk for workers combines MOEs from dermal and inhalation routes by COU from Step 1.
    - Aggregate risk for consumers combines MOEs from dermal, inhalation, and oral routes by COU from Step 1.
- The risk evaluation also involves a third set of calculations:
  Step 3. "Cumulative" risk: Single chemical, multi-route evaluation by COU from Step 2 combined with NHANES background evaluation of BBP, DBP, DEHP, DIBP, and DINP.
    - For phthalates, the multi-chemical aspect of the evaluation is derived from the addition of *background phthalate exposure* as estimated from NHANES biomonitoring data.
        - A detailed description of how this is done can found in the CRA TSD (U.S. EPA, 2025al). Summary information is found in Section 4.4.2 of this risk evaluation.
    - The "cumulative" calculations start with the aggregate risk estimates from Step 2 for each phthalate by COU.
    - The NHANES background risk is combined with the aggregate risk estimates.
    - As such, the cumulative MOEs from each phthalate-COU scenario are 6.2 to 15.5 percent smaller than the aggregate MOE depending on the life stage. This is because the NHANES background risk was added.

[3] The six phthalates in the cumulative assessment are BBP, DBP, DCHP, DEHP, DIBP, and DINP.

2 CHEMISTRY AND FATE AND TRANSPORT OF DEHP

Physical and chemical properties determine the behavior and characteristics of a chemical that inform its conditions of use, 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 DEHP informs the specific exposure pathways, and potential human and environmental exposed populations that EPA considered in this risk evaluation.

In general, under normal environmental conditions DEHP is a hydrophobic liquid that (1) is not expected to volatilize from water, (2) has low bioaccumulation potential in aquatic and terrestrial organisms, (3) has no apparent biomagnification across trophic levels in aquatic food webs, and (4) is considered readily biodegradable under most aquatic and terrestrial environmental conditions. Sections 2.1and 2.2 summarize the physical and chemical properties, and environmental fate and transport of DEHP, respectively. See the *Physical and Chemical Property Assessment and Fate and Transport Assessment for DEHP* (U.S. EPA, 2025af) for 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 *Systematic Review Protocol for DEHP* (U.S. EPA, 2025ak). The Agency considered both measured and estimated physical and chemical property data/information as described in the *Physical Chemistry, Fate, and Transport Assessment for DEHP* (U.S. EPA, 2025af). The selected values are summarized in Table 2-1, as applicable. Information on the full, extracted dataset is available in the *Data Quality Evaluation and Data Extraction Information for Environmental Fate and Transport for DEHP* (U.S. EPA, 2025i).

Table 2-1. Physical and Chemical Properties of DEHP

Property	Selected Value(s)	Reference(s)	Data Quality Rating
Molecular formula	$C_{24} H_{38} O_4$	–	–
Molecular weight	390.56 g/mol	–	–
Physical form	Liquid	Rumble (2018)	High
Melting point	−55 °C	Rumble (2018)	High
Boiling point	384 °C	Rumble (2018)	High
Density	0.981 g/cm^3	Rumble (2018)	High
Vapor pressure	1.42E−07 mmHg	NLM (2015)	High
Vapor density	16	NLM (2015)	High
Water solubility	0.003 mg/L	EC/HC (2017)	High
Octanol:water partition coefficient (log K_{OW})	7.60	NLM (2015)	High
Octanol:air partition coefficient (log K_{OA})	10.76 (EPI Suite™)	NLM (2015)	High
Henry's Law constant	9.87E−06 atm·m^3/mol at 25 °C	Cousins and Mackay (2000)	High
Flash point	206 °C	O'Neil (2013)	High

Property	Selected Value(s)	Reference(s)	Data Quality Rating
Autoflammability	390 °C	NIOSH (1988)	High
Viscosity	57.94 cP at 25 °C	Mylona et al. (2013)	High

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 water sources, and organic carbon:water partition coefficient (log K_{OC})—are parameters used in the current risk evaluation. In assessing the environmental fate and transport of DEHP, EPA considered the full range of results from the available high quality data sources obtained during the Agency's systematic review of the relevant literature. Information on the full extracted dataset is available in the *Data Quality Evaluation and Data Extraction Information for Environmental Fate and Transport for DEHP* (U.S. EPA, 2025i). Other fate estimates were based on modeling results from EPI Suite™ (U.S. EPA, 2012a), a predictive tool for physical and chemical properties and environmental fate estimation. Information regarding the model inputs is available in the *Physical and Chemical Property Assessment and Fate and Transport Assessment for DEHP* (U.S. EPA, 2025af).

EPA evaluated the reasonably available information to characterize the environmental fate and transport of DEHP. The key points of the fate assessment for DEHP (U.S. EPA, 2025af) are summarized below and listed in Table 2-2.

Given the consistent results from numerous high-quality studies, there is a robust confidence of the following:

- DEHP is expected to undergo significant direct photolysis.
- DEHP will partition to organic carbon and particulate matter in air.
- DEHP will biodegrade in aerobic surface water, soil, and wastewater treatment processes;
- DEHP does not biodegrade in anaerobic environments.
- DEHP will be removed after undergoing wastewater treatment primarily via sorption to sludge at high fractions, with a small fraction being present in effluent.
- DEHP is not bioaccumulative.
- DEHP is not expected to biodegrade under anoxic conditions and may have high persistence in anaerobic soils and sediments.
- DEHP may show persistence in surface water and sediment proximal to continuous points of release.

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

- Showed no significant degradation via hydrolysis under standard environmental conditions, but hydrolysis rate was seen to increase with increasing pH and temperature in deep-landfill environments.
- Is expected to be removed in conventional drinking water treatment systems by standard treatment processes, and via reduction by chlorination and chlorination byproducts in post-treatment storage and drinking water conveyance.

Findings with a robust weight of evidence had one or more high-quality studies that were largely in agreement with each other. Findings that were said to have a moderate weight of evidence were based on a mix of high- and medium-quality studies that were largely in agreement but varied in sample size and consistency of findings.

Table 2-2. Summary of Environmental Fate Information for DEHP[a]

Parameter	Value	Source(s)	Overall Quality Determination
Octanol:water (Log K_{OW})	7.60	NLM (2015)	High
Organic carbon:water (Log K_{OC})	5.41–5.95	Williams et al. (1995)	High
Octanol:air (Log K_{OA})	10.76 (EPI Suite estimate)	U.S. EPA (2017)	High
Air:water (Log K_{AW})	−2.12 (estimated)	Riederer (1990)	Medium
Aerobic primary biodegradation in water	70–78% in 24 hours (AS) >99%/28 days $t_{1/2}$ = <5 days (AS) $t_{1/2}$ = <7 days (river water)	Saeger and Tucker (1976) SRC (1983) Fujita et al. (2005)	High
Aerobic ready biodegradation in water	58.7–81% in 28 days $t_{1/2}$ = 6.9 days (AS)	NCBI (2020) Stasinakis et al. (2008) Scholz et al. (1997)	High
Aerobic primary biodegradation in sediment	5.9–19.79% in 28 days $t_{1/2}$ = 7.3–27.5 days	Johnson et al. (1984) Yuan et al. (2002)	High
Anaerobic primary biodegradation in sediment	13% in 30 days $t_{1/2}$ = 22.8–39.1 days	Kao et al. (2005) Yuan et al. (2002)	High
Aerobic biodegradation in soil	8.2% in 7 days	Schmitzer et al. (1988)	Medium
	10% in 10 days	Cartwright et al. (2000)	High
	7–43% in 35 days	Zhu et al. (2018)	High
	31–38% in 42 days	Zhu et al. (2019)	High
	98.8% in 49 days	Carrara et al. (2011)	High
	8.5–21.8% in 60 days	Gejlsbjerg et al. (2001)	High
	55.5–90.47% in 112 days	He et al. (2018)	High
Hydrolysis	$t_{1/2}$ at pH 7: 5.36 years at 25 °C (estimated); $t_{1/2}$ at pH 8: 195 days at 25 °C (estimated)	U.S. EPA (2017)	High
Photolysis	Direct: expected to be susceptible to direct photolysis by sunlight; contains chromophores that absorb at wavelengths >290 nm Indirect: $t_{1/2}$ = 5.58 hours (estimated; based on a 12-hour day with 21.96E−12 ·OH/cm^3 and ·OH rate constant of 2.39E−11 ·OH/cm^3 and ·OH cm^3/molecule-sec)	U.S. EPA (2017)	High
Wastewater treatment plant (WWTP) removal	>64% (median)	U.S. EPA (1982)	High

Parameter	Value	Source(s)	Overall Quality Determination
Aquatic bioconcentration factor (BCF)	Tilapia: 0.17–15.18 Catfish: 0.09–4.31 Rainbow trout: 1.6–51.5	Adeogun et al. (2015a) Adeogun et al. (2015b) Hayton et al. (1990)	High
Aquatic bioaccumulation factor (BAF)	Bluegill: 63.1 Bass: 316.2 Carp: 1,259	Lee et al. (2019)	High
Aquatic food web magnification factor (FWMF)	0.34–0.4	Burkhard et al. (2012) Mackintosh et al. (2004)	High
Terrestrial bioconcentration factor (BCF)	Earthworm: 0.2	ECJRC (2003)	High
Terrestrial biota-soil accumulation factor (BSAF)	Earthworms: 0.073–0.244	Hu et al. (2005)	High

AS = activated sludge
[a] Additional information on value selection can be found in the *Physical Chemistry, Fate, and Transport Assessment for DEHP* (U.S. EPA, 2025af).

3 RELEASES AND CONCENTRATIONS OF DEHP IN THE ENVIRONMENT

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

3.1 Approach and Methodology

This section provides an overview of the approach and methodology for assessing releases to the environment from industrial, commercial, and consumer uses. Specifically, Section 3.1.1 through Section 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

This subsection describes the grouping of manufacturing, processing, industrial and commercial COUs into OESs as well as the use of DEHP 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 DEHP 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 whereas Table 3-2 provides the reverse: a crosswalk of OESs to COUs. 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 EPA 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 *Environmental Release and Occupational Exposure Assessment for DEHP* (U.S. EPA, 2025u) provides further information on specific OESs.

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

COU			OES [d]
Life Cycle Stage [a]	**Category [b]**	**Subcategory [c]**	
Manufacturing	Domestic manufacturing	Domestic manufacturing	Manufacturing
Processing	Incorporation into article	Plasticizer in basic organic chemical manufacturing; plastics product manufacturing; rubber product manufacturing; miscellaneous manufacturing; PVC extruding	Rubber manufacturing
	Incorporation into formulation, mixture, or reaction product	Plasticizer in basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint and coating manufacturing; adhesive manufacturing; plastic material and resin manufacturing; synthetic rubber manufacturing; all other basic inorganic chemical manufacturing; wholesale and retail trade; services; ink, toner and colorant manufacturing	Plastic converting
	Incorporation into article	Plasticizer in basic organic chemical manufacturing; plastics product manufacturing; rubber product manufacturing; miscellaneous manufacturing; PVC extruding	
Industrial Use	Other uses	Solid Rocket Motor Insulation and other aerospace applications Automotive articles	
Processing	Incorporation into formulation, mixture, or reaction product	Plasticizer in basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint and coating manufacturing; adhesive manufacturing; plastic material and resin manufacturing; synthetic rubber manufacturing; all other basic inorganic chemical manufacturing; wholesale and retail trade; services; ink, toner and colorant manufacturing	Plastic compounding
	Incorporation into formulation, mixture, or reaction product	Plasticizer in basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint and coating manufacturing; adhesive manufacturing; plastic material and resin manufacturing; synthetic rubber manufacturing; all other basic inorganic chemical manufacturing; wholesale and retail trade; services; ink, toner and colorant manufacturing	Incorporation into formulation, mixture, or reaction product
	Other uses	Miscellaneous processing (cyclic crude and intermediate manufacturing; processing aid specific to hydraulic fracturing)	

COU			OES [d]
Life Cycle Stage [a]	**Category [b]**	**Subcategory [c]**	
Manufacture	Importing	Importing	Import and repackaging
Processing	Repackaging	Repackaging in wholesale and retail trade and in paint and coating manufacturing	
Industrial Use	Construction, paint, electrical, and metal products	Paints and coatings	Application of paints, coatings, adhesives, and sealants
Commercial Use	Construction, paint, electrical, and metal products	Adhesives and sealants	
		Paints and coatings	
	Furnishing, cleaning, and treatment care products	All-purpose waxes and polishes	
Commercial Use	Furnishing, cleaning, and treatment care products	Fabric, textile, and leather products; furniture and furnishings	Textile finishing
	Furnishing, cleaning, and treatment care products	Fabric enhancer	
Commercial Use	Construction, paint, electrical, and metal products	Batteries and capacitors	Fabrication or use of final product or articles
		Construction and building materials covering large surface areas, including paper articles; metal articles; stone, plaster, cement, glass and ceramic articles	
		Machinery, mechanical appliances, electrical/electronic articles	
	Automotive, fuel, agriculture, and outdoor use products	Lawn and garden care products	
	Packaging, paper, plastic, toys, hobby products	Packaging (excluding food packaging) and other articles with routine direct contact during normal use, including paper articles; rubber articles; plastic articles (hard); plastic articles (soft)	
		Packaging (excluding food packaging), including paper articles	
		Toys, playground, and sporting equipment	
	Furnishing, cleaning, and treatment care products	Floor coverings; Construction and building materials covering large surface areas including stone, plaster, cement, glass and ceramic articles fabrics, textiles, and apparel	
	Other uses	Automotive articles and products	

COU			OES [d]
Life Cycle Stage [a]	**Category [b]**	**Subcategory [c]**	
Commercial Use	Packaging, paper, plastic, toys, hobby products	Ink, toner and colorants	Use of dyes and pigments, and fixing agents
Industrial Use	Construction, paint, electrical, and metal products	Adhesives and Sealants	Application of paints, coatings, adhesives, and sealants (formulations for diffusion bonding)
Commercial Use	Other uses	Laboratory chemicals	Use of laboratory chemicals
Commercial Use	Other uses	Automotive articles and products	Use of automotive care products
Industrial Use	Other uses	Hydraulic fracturing	Use in hydraulic fracturing
Processing	Recycling	Recycling	Recycling
Disposal	Disposal	Disposal	Waste handling, treatment, and disposal
Distribution in Commerce	Distribution in Commerce	–	Distribution in Commerce

[a] Life Cycle Stage Use Definitions (40 CFR 711.3)

- "Industrial use" means use at a site at which 1 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 COU appear in the life cycle diagram, reflect CDR codes, and broadly represent COUs of DEHP in industrial and/or commercial settings.

[c] These subcategories represent more specific activities within the life cycle stage and category of the COU of DEHP.

[d] An OES is based on a set of facts, assumptions, and inferences that describe how releases and exposures take place within an occupational COU. The occurrence of releases/exposures may be similar across multiple conditions of use (multiple COUs mapped to single OES), or there may be several ways in which releases/exposures take place for a given condition of use (single COU mapped to multiple OESs).

Table 3-2. Crosswalk of Assessed Occupational Exposure Scenarios to Conditions of Use

OES [a]	COU		
	Life Cycle Stage [b]	**Category [c]**	**Subcategory [d]**
Manufacturing	Manufacturing	Domestic manufacturing	Domestic manufacturing
Import and repackaging	Manufacture	Importing	Importing
	Processing	Repackaging	Repackaging in wholesale and retail trade and in paint and coating manufacturing
Plastic converting	Processing	Incorporation into article	Plasticizer in basic organic chemical manufacturing; plastics product manufacturing; rubber product manufacturing; miscellaneous manufacturing; PVC extruding
	Industrial Use	Other uses	Solid Rocket Motor Insulation and other aerospace applications

OES [a]	COU		
	Life Cycle Stage [b]	**Category [c]**	**Subcategory [d]**
			Automotive articles
Rubber manufacturing	Processing	Incorporation into article	Plasticizer in basic organic chemical manufacturing; plastics product manufacturing; rubber product manufacturing; miscellaneous manufacturing; PVC extruding
		Incorporation into formulation, mixture, or reaction product	Plasticizer in basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint and coating manufacturing; adhesive manufacturing; plastic material and resin manufacturing; synthetic rubber manufacturing; all other basic inorganic chemical manufacturing; wholesale and retail trade; services; ink, toner and colorant manufacturing
Plastic compounding	Processing	Incorporation into formulation, mixture, or reaction product	Plasticizer in basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint and coating manufacturing; adhesive manufacturing; plastic material and resin manufacturing; synthetic rubber manufacturing; all other basic inorganic chemical manufacturing; wholesale and retail trade; services; ink, toner and colorant manufacturing
Incorporation into formulation, mixture, or reaction product	Processing	Incorporation into formulation, mixture, or reaction product	Plasticizer in basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint and coating manufacturing; adhesive manufacturing; plastic material and resin manufacturing; synthetic rubber manufacturing; all other basic inorganic chemical manufacturing; wholesale and retail trade; services; ink, toner and colorant manufacturing
		Other uses	Miscellaneous processing (cyclic crude and intermediate manufacturing; processing aid specific to hydraulic fracturing)
Recycling	Processing	Recycling	Recycling
Use in hydraulic fracturing	Industrial Use	Other uses	Hydraulic fracturing
Application of paints, coatings, adhesives, and sealants	Industrial Use	Construction, paint, electrical, and metal products	Paints and coatings
	Commercial Use	Construction, paint, electrical, and metal products	Adhesives and sealants
			Paints and coatings
		Furnishing, cleaning, and treatment care products	All-purpose waxes and polishes
Use of automotive care products	Commercial Use	Other uses	Automotive articles
Fabrication or use of final product or articles	Commercial Use	Construction, paint, electrical, and metal products	Batteries and capacitors
			Construction and building materials covering large surface areas, including paper articles; metal articles; stone, plaster, cement, glass and ceramic articles

OES [a]	COU		
	Life Cycle Stage [b]	Category [c]	Subcategory [d]
			Machinery, mechanical appliances, electrical/electronic articles
		Automotive, fuel, agriculture, and outdoor use products	Lawn and garden care products
		Packaging, paper, plastic, toys, hobby products	Packaging (excluding food packaging) and other articles with routine direct contact during normal use, including paper articles; rubber articles; plastic articles (hard); plastic articles (soft)
			Packaging (excluding food packaging), including paper articles
			Toys, playground, and sporting equipment
		Furnishing, cleaning, and treatment care products	Floor coverings; Construction and building materials covering large surface areas including stone, plaster, cement, glass and ceramic articles fabrics, textiles, and apparel
Use of dyes and pigments, and fixing agents	Commercial Use	Packaging, paper, plastic, toys, hobby products	Ink, toner and colorants
Textile finishing	Commercial Use	Furnishing, cleaning, and treatment care products	Fabric, textile, and leather products; furniture and furnishings
		Furnishing, cleaning, and treatment care products	Fabric enhancer
Formulations for diffusion bonding	Industrial Use	Construction, paint, electrical, and metal products	Adhesives and Sealants
Use of laboratory chemicals	Commercial Use	Other uses	Laboratory chemicals
Waste handling, treatment, and disposal	Disposal	Disposal	Disposal

[a] An OES is based on a set of facts, assumptions, and inferences that describe how releases and exposures take place within an occupational COU. The occurrence of releases/exposures may be similar across multiple conditions of use (multiple COUs mapped to single OES), or there may be several ways in which releases/exposures take place for a given condition of use (single COU mapped to multiple OESs).

[b] Life Cycle Stage Use Definitions (40 CFR 711.3)

- "Industrial use" means use at a site at which 1 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.

OES [a]	COU		
	Life Cycle Stage [b]	Category [c]	Subcategory [d]

[c] These categories of COU appear in the life cycle diagram, reflect CDR codes, and broadly represent COUs of DEHP in industrial and/or commercial settings.
[d] These subcategories represent more specific activities within the life cycle stage and category of the COU of DEHP.

3.1.1.2 Description of DEHP Use for Each OES

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

Table 3-3. Description of the Function of DEHP for Each OES

OES	Role/Function of DEHP
Manufacturing	DEHP is typically produced through the reaction of phthalic anhydride with 2-ethylhexanol using either an acid or metal catalyst or at a high temperature.
Import and repackaging	DEHP is imported domestically for use and/or may be repackaged before shipment to formulation sites.
Plastic converting	DEHP is used in PVC plastics to increase flexibility.
Rubber manufacturing	DEHP is used as a plasticizer in non-PVC polymers, such as resins, rubber tires, and synthetic rubbers.
Plastic compounding	DEHP is used in PVC plastics to increase flexibility.
Incorporation into formulation, mixture, or reaction product	DEHP is incorporated into products, such as paint, adhesives, synthetic dyes, and solid rocket motor insulation.
Recycling	Some PVC plastics that contain DEHP are recycled either in-house or at PVC recycling facilities for continuous compounding of new PVC material.
Use in hydraulic fracturing	DEHP is used as an additive in hydraulic fracturing fluids and has been identified in flowback water from hydraulic fracturing operations.
Application of paints, coatings, adhesives, and sealants	DEHP is a plasticizer in adhesives and sealants and in paint and coating products for industrial and commercial use.
Use of automotive care products	DEHP is used as a plasticizer in liquid automotive care products such as glass cleaners, fabric water proofing products, and rust converters.
Fabrication or use of final product or articles	DEHP is found in a wide array of different final articles not found in other OES including asphalt, banners, cork soundproofing, electrical tape, putty, pipe wrap, and rollers.
Use of dyes and pigments, and fixing agents	DEHP may be found in coloring agents, inks, or dyes as an additive or as a contaminant from plastic.
Textile finishing	DEHP is used in textile finishing as a fabric coating to impart fluidity to the coating formulation.
Formulations for diffusion bonding	DEHP is found in formulations for diffusion bonding, which are applied to metal surfaces to protect against the equipment and extreme temperatures of diffusion bonding equipment.

OES	Role/Function of DEHP
Use of laboratory chemicals	DEHP is a laboratory chemical used for laboratory analyses in liquid and solid forms.
Waste handling, treatment, and disposal	Upon fabrication or use of DEHP-containing products, residual chemical is disposed and released to air, wastewater, or disposal facilities.

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

For many scenarios, EPA has limited data on the number of release days. Additionally, EPA may develop generic estimates of the number of operating days (days/year) for facilities in each OES (Table 3-4) through generic scenarios (GSs) or emission scenario documents (ESDs). Subsequently, EPA estimated the average daily releases for facilities by using the operating assumption that the number of release days is equal to the number of operating days. For OES where there is no corresponding GS or ESD, the basis for the operating days, unless otherwise stated, may be limited facility data from sites within that OES. The operating assumptions for this approach are discussed in Section 2.3.3 and 3.0 of the *Environmental Release and Occupational Exposure Assessment for DEHP* (U.S. EPA, 2025u).

Table 3-4. Generic Estimates of Number of Operating Days per Year for Each OES

Occupational Exposure Scenario (OES)	Operating Days (days/yr)	Basis
Manufacturing	180–350	EPA assumed 7 days/week, year-round site operation, considering a 2-week downtime, totaling 350 days/year. Through public comment (Eastman Chemical Company, EPA-HQ-OPPT-2018-0433-0137, 2025) an estimate of 180 days of operation was provided which is used as the lower end of the range.
Import and repackaging	260	EPA assumed 260 days/year as per the Revised Draft GS on Chemical Repackaging (U.S. EPA, 2022a).
Plastic converting	253	EPA assumed 253 days/year of operation according to the Revised Draft GS on Plastic Converting (U.S. EPA, 2014b).
Rubber manufacturing	250	EPA assumed 5 days/week, year-round site operation, considering a 2-week downtime, totaling 250 days/year.
Plastic compounding	246	EPA assumed 246 days/year of operation per the Revised Draft GS on the Use of Additives in Plastic Compounding (U.S. EPA, 2021e)
Incorporation into formulation, mixtures and reaction product	300	EPA assumed 300 days/year operation based on the assumption that DEHP is a commodity chemical with a large production volume.
Recycling	246	EPA assumed 246 release days per year per the Revised Draft GS on the Use of Additives in Plastic Compounding (U.S. EPA, 2021e).
Use in hydraulic fracturing	1–3	EPA modeled releases using a triangular distribution with a range of 1–3 days/year and mode of 1 day/year based on 2022 data from FracFocus (2022).
Application of paints, coatings, adhesives, and sealants	250	EPA assumed 250 days/year of operation per the ESD on Radiation Curable Coatings, Inks, and Adhesives (OECD, 2010). The ESD on the Use of Adhesives (OECD, 2015) provides an average of 171 working days for general assembly but provides 250 days for use in specific industries such as motor and non-motor vehicle, vehicle parts, and tire

Occupational Exposure Scenario (OES)	Operating Days (days/yr)	Basis
		manufacturing (except retreading), and labels and tapes manufacturing.
Use of automotive care products	235–258	EPA modeled releases using a range of 235–258 days/year based on the Methodology Review Draft on Use of Automotive Detailing Products (U.S. EPA, 2022b).
Fabrication or use of final product or articles	131–350	EPA identified operating days ranging from 131–350 with an average of 238 days, based on National Emissions Inventory (NEI) air release data.
Use of dyes and pigments, and fixing agents	157	EPA assumes 157 days/year of operation per the ESD on Use of Textile Dyes (OECD, 2017).
Textile finishing	225	EPA assumed 225 days/year of operation per the ESD on Textile Finishing (OECD, 2004).
Formulations for diffusion bonding	250	EPA assumed 5 days/week, year-round site operation, considering a 2-week downtime, totaling 250 days/year.
Use of laboratory chemicals	235–258	The 2023 Use of Laboratory Chemicals GS estimated the total number of operating days based on the shift lengths of operators over the course of a full year as 174–260 days/year (U.S. EPA, 2023g). Shift lengths include 8, 10, or 12 hour/day shifts. Release estimates that EPA assessed using Monte Carlo modeling (*Environmental Release and Occupational Exposure Assessment for DEHP* (U.S. EPA, 2025u)) used a 50th to 95th percentile range of 235 to 258 days/year.
Waste handling, treatment, and disposal	365	EPA assumed 365 days/year based on NEI air release data and the assumption that waste management sites continuously operate 365 days/year.

3.1.3 Daily Release Estimation

For each OES, EPA estimated releases to each media of release using Toxics Release Inventory (TRI) Program data (years 2017–2022), Discharge Monitoring Report (DMR) data (years 2017–2022), and National Emissions Inventory (NEI) data (years 2017 and 2020) or modeling as shown in Figure 3-1. Where available, EPA used NEI, GSs, or ESDs to estimate number of release days, which the Agency used to convert between annual release estimates and daily release estimates. EPA used 2020 CDR, TRI, DMR, NEI, and Monte Carlo modeling data to estimate the number of sites using DEHP within an OES. The *Environmental Release and Occupational Exposure Assessment for DEHP* (U.S. EPA, 2025u) describes EPA's approach and methodology for estimating daily releases and provides detailed facility level results for each OES.

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

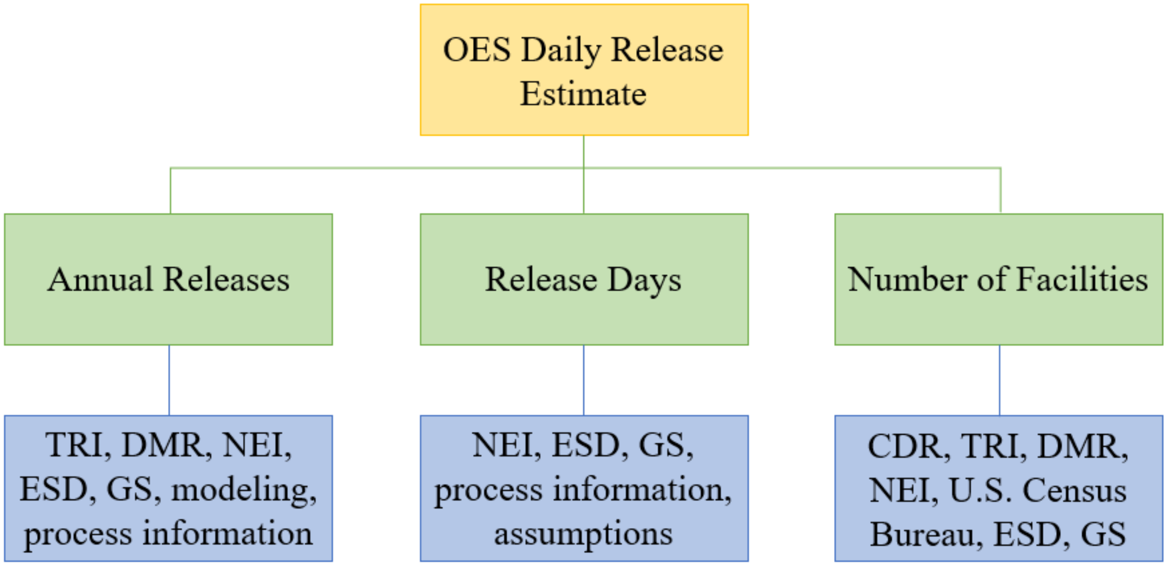

Figure 3-1. Overview of EPA's Approach to Estimate Daily Releases for Each OES
TRI = Toxics Release Inventory; DMR = Discharge Monitoring Report; NEI =National Emissions Inventory; CDR = Chemical Data Reporting; ESD = Emission Scenario Document; GS = Generic Scenario

3.1.4 Consumer Disposal Down-the-Drain and Landfills

Environmental releases may occur from consumer products and articles containing DEHP via the end-of-life disposal and demolition of consumer products and articles in the built environment, as well as from the associated down-the-drain release of DEHP. EPA did not quantify these end-of-life and down-the-drain exposures due to limited information on source attribution of the consumer COUs. In previous assessments, EPA has considered down-the-drain analysis for consumer product scenarios where it can be reasonably foreseen that at least a portion of some consumer product (*e.g.*, paints, sealants, oils) may be discarded directly down-the-drain. Adhesives, sealants, paints, lacquers, and coatings can be disposed down-the-drain while users wash their hands, brushes, sponges, and other product applying tools. Although EPA acknowledges that there may be DEHP releases to the environment via the cleaning and disposal of adhesives, sealants, paints, lacquers, and coatings, the Agency did not quantitatively assess these scenarios due to limited information, monitoring data, or modeling tools. In addition, these products can be disposed when they are no longer used, or they have reached the product shelf life and are taken to landfills.

All other solid products and articles included in Table 4-7 can be removed and disposed in landfills or other waste handling locations that properly manage the disposal of products like adhesives, sealants, paints, lacquers, and coatings.

EPA identified two sources that reported DEHP concentrations in drinking water in the United States (see Section 6.2 in U.S. EPA (2025s)). In summary, for the available monitoring data in the United States for finished drinking water, DEHP was only detectable in 0.45 percent of samples, confirming the expectation of high treatment removal efficiencies. Based on the low water solubility and log K_{OW}, DEHP 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 DEHP during drinking water treatment by sorption into suspended organic matter, settling, and physical removal. Although there is limited measured data on DEHP in landfill leachates, these data suggest that

DEHP is unlikely to be present in landfill leachates. Further, the small amounts of DEHP that could potentially be in landfill leachates will have limited mobility and are unlikely to infiltrate groundwater due to high affinity of DEHP for organic compounds that would be present in receiving soil and sediment (U.S. EPA, 2025s).

3.2 Summary of Environmental Releases

3.2.1 Manufacturing, Processing, Industrial and Commercial

EPA combined its estimates for annual releases, release days, number of facilities, and hours of release per day to estimate a range of daily releases for each OES. Table 3-5 presents a summary of these ranges across facilities, and Table 3-6 provides a summary of the weight of scientific evidence supporting the overall confidence in environmental release estimates by OES. The complete data (from TRI, DMR, and/or NEI) for each facility, including zero releases, are presented in Section 3 of the *Environmental Release and Occupational Exposure Assessment for DEHP* (U.S. EPA, 2025u). Additional detail on deriving the overall confidence score for each OES is also presented in this technical support document. EPA was not able to estimate site-specific releases for the final use of products or articles OES. Disposal sites handling post-consumer end-use DEHP were not quantifiable due to the wide and dispersed use of DEHP in PVC and other products. Pre-consumer waste handling, treatment, and disposal are assumed to be captured in upstream OES.

Table 3-5. Summary of EPA's Release Estimates for Each OES and EPA's Overall Confidence in these Estimates

OES	Estimated Annual Release Across Sites [a] (kg/site-year)		Type of Discharge, [b] Air Emission, [c] or Transfer for Disposal [d]	Estimated Release Frequency Across Sites (days) [e, i]	Number of Facilities [f]		Weight of Scientific Evidence Rating [g]	Source(s) [j]
	Central Tendency	High-End			Central Tendency	High-End		
Manufacturing	26	149	Fugitive Air	364	3		Moderate	TRI, NEI, DMR
	28	141	Stack Air					
	38	204	Land	350				
	150	442	Water					
Rubber manufacturing	0.22	145	Fugitive Air	120–365	85		Moderate to Robust	TRI, NEI, DMR
	5.7	145	Stack Air					
	862	6,060	Land	364				
	227	227	Water	250				
Plastic compounding	2.3	285	Fugitive Air	365	62		Moderate to Robust	TRI, NEI, DMR
	9.7	1,342	Stack Air					
	919	6,678	Land					
	13.5	227	Water	246				
Plastic converting	3.2	335	Fugitive Air	172–365	71		Moderate to Robust	TRI, NEI, DMR
	2.7	915	Stack Air					
	767	1.2E04	Land	296				
	15	227	Water	253				
Incorporation into mixture, formulation, or reaction product	0.19	227	Fugitive Air	309–365	127		Moderate to Robust	TRI, NEI, DMR
	1.0	227	Stack Air					
	113	1,406	Land	300				
	4.2	227	Water	300				

OES	Estimated Annual Release Across Sites [a] (kg/site-year)		Type of Discharge, [b] Air Emission, [c] or Transfer for Disposal [d]	Estimated Release Frequency Across Sites (days) [e, i]	Number of Facilities [f]		Weight of Scientific Evidence Rating [g]	Source(s) [j]
	Central Tendency	High-End			Central Tendency	High-End		
Import and repackaging	72	227	Fugitive Air	350–365	47		Moderate to Robust	TRI, NEI, DMR
	227	227	Stack Air					
	325	325	Land	364				
	227	227	Water	260				
Application of paints, coatings, adhesives, and sealants	0	13	Fugitive Air	153–365	140		Moderate to Robust	TRI, NEI, DMR
	0.27	491	Stack Air					
	274	274	Land	364				
	1.2	1,057	Water	250				
Textile finishing	0.23	0.43	Fugitive Air	15–364	11		Slight	TRI, NEI, DMR
	0.45	80	Stack Air					
	Not reported		Land	No land release	–		–	
	390	738	Water	215				
Fabrication of final products from articles	0.65	194	Fugitive Air	131–350	16		Slight	TRI, NEI
	0	3.8	Stack Air					
	Not reported		Land	No land release				
	Not reported		Water	No water release				
Use of dyes, pigments, and fixing agents	Not reported		Fugitive Air	157	5		Slight	DMR
	Not reported		Stack Air					
	1.1	22	Water					
	Not reported		Land					
Formulations for diffusion bonding	4.2E−02	31	Fugitive Air		14		Slight	TRI, NEI, DMR
	9.2	399	Stack Air					
	Not reported		Land					
	9.2E−02 [h]		Surface Water					

OES	Estimated Annual Release Across Sites [a] (kg/site-year)		Type of Discharge, [b] Air Emission, [c] or Transfer for Disposal [d]	Estimated Release Frequency Across Sites (days) [e, i]	Number of Facilities [f]		Weight of Scientific Evidence Rating [g]	Source(s) [j]
	Central Tendency	High-End			Central Tendency	High-End		
Use of laboratory chemicals (liquid)	6.3E−09	2.1E−08	Fugitive or Stack Air	235 as central tendency and 258 as high-end	1,996	36,873	Slight to Moderate	Model, peer-reviewed literature (GS/ESD)
	26	96	Wastewater, Incineration, or Landfill					
Use of laboratory chemicals (solid)	3.5	3.5	Water, Incineration, or Landfill		36,873			
	1.8E−02	1.8E−02	Air, Water, Incineration, or Landfill					
	1.7E−02	1.8E−02	Stack Air					
	1.7E−02	1.8E−02	Incineration or Landfill					
Use of automotive care products	4.6E−11	3.4E−10	Fugitive Air	235 as Central Tendency and 258 as high-end	25,170	147,152	Slight to Moderate	Model, peer-reviewed literature (GS/ESD)
	5.2	23	POTW or Landfill					
Use in hydraulic fracturing	1.7E−11	1.8E−10	Fugitive Air	1 as central tendency and 3 as high-end	44		Slight to Moderate	Model, peer-reviewed literature (GS/ESD)
	9.7E−02	2	Water, Incineration, or Landfill					
	0.37	6.5	Surface Water					
	0.12	2.1	Soil					
	0	6.6E−04	Incineration or Landfill					
	2.9	45	Deep Well Injection					
	9.6E−02	1.7	Recycle					
	3.6	56	Total					

OES	Estimated Annual Release Across Sites [a] (kg/site-year)		Type of Discharge, [b] Air Emission, [c] or Transfer for Disposal [d]	Estimated Release Frequency Across Sites (days) [e, i]	Number of Facilities [f]		Weight of Scientific Evidence Rating [g]	Source(s) [j]
	Central Tendency	High-End			Central Tendency	High-End		
Recycling	3.3E−02 [h]		Fugitive Air	248	1		Slight	TRI
	1.2E−02 [h]		Stack Air					
	Not reported		Land	No land release				
	Not reported		Water	No water release				
Waste handling, treatment, and disposal	4.2E−02	224	Fugitive Air	15–365	477		Moderate to Robust	TRI, NEI, DMR
	13	224	Stack Air					
	2.3	6,481	Land	365				
	7.9	1,451	Water	250				

[a] For programmatic data (TRI, NEI, DMR), central tendency and high-end values represent the 50th and 95th percentiles, respectively, of the available maximum values reported for all sites mapped to each OES. The specific central tendency and high-end values presented depends on the number of sites with programmatic data. For databases with six or more reporting facilities, EPA estimated central tendency and high-end releases using the 50th and 95th percentile values, respectively. For 3–5 facilities, EPA estimated the central tendency and high-end releases using the 50th percentile and maximum values, respectively. For 2 sites, EPA presented the midpoint and the maximum value. Finally, EPA presented sites with only 1 data point as-is from the programmatic database. It is important to note that when the reported maximum value for a given facility indicates zero releases, these values are included in the calculation of 50th and 95th percentile for each OES. For data from DMR: in instances where a facility reports a period's monitoring results as below the limit of detection (LOD), also referred to as a non-detect or ND for a pollutant, the Loading Tool applies a hybrid method to estimate the wastewater discharge for the period. The hybrid method sets the ND values to half of the LOD if there was at least 1 detected value in the facility's DMRs in a calendar year. If all values are less than the LOD in a calendar year, the annual load is set to 0.
[b] Direct discharge to surface water; indirect discharge to non-POTW; indirect discharge to POTW.
[c] Emissions via fugitive air or stack air, or treatment via incineration.
[d] Transfer to surface impoundment, land application, or landfills.
[e] Where available, EPA used industry provided information, ESDs, or GSs to estimate the number of release days for each condition of use.
[f] 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 DEHP for each condition of use. Some modeled OES calculated the number of facilities/sites, presented as 50th and 95th percentiles. Other modeled OES set the number of facilities deterministically, presented as one value.
[g] See Section 3.2.2 for details on EPA's determination of the weight of scientific evidence rating.
[h] Insufficient data to calculate central tendency and high-end values.
[i] There are different release days for the different media for some OES, and they have been listed separately.
[j] Data Quality Score – Release Sources: TRI (medium), DMR (medium), NEI (high).

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 3-6 provides the Agency's weight of scientific evidence rating for each OES.

EPA integrated numerous evidence streams across systematic review sources to develop environmental releases for DEHP. The Agency made judgments on the weight of scientific evidence supporting the release estimates based on the strengths, limitations, and uncertainties associated with the release estimates. These judgements are characterized through the statement of weight of scientific evidence conclusions which express the plausibility of the estimate(s). Plausibility is determined through sufficient consideration of the representativeness of integrated underlying sources and assessment methods. EPA described these conclusions using the following 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 the "Draft Systematic Review Protocol") (U.S. EPA, 2021a) for additional information on weight of scientific evidence conclusions.

Table 3-6 summarizes EPA's overall weight of scientific evidence conclusions for its release estimates for each OES. TRI and DMR databases had data quality ratings of medium, whereas NEI had a high data quality rating. In general, modeled data had data quality ratings of medium. As a result, for releases that used GSs/ESDs, the weight of scientific conclusion was slight to moderate when used in conjunction with Monte Carlo modeling. In general, there is inherent uncertainty in the accuracy of any programmatic database with respect to the self-reported data elements. Additionally, representativeness of the releases for any COU with respect to the full distribution of releasing sites is unknown. However, the number of facilities reporting and the variability of facilities within a COU may address some of the uncertainty.

Table 3-6. Summary of Overall Confidence in Environmental Release Estimates by OES

OES[a]	Weight of Scientific Evidence Conclusion in Release Estimates
Manufacturing	Air releases are assessed using reported releases from 2017–2022 TRI (U.S. EPA, 2022g), and 2017 and 2020 NEI (U.S. EPA, 2023a). A strength of NEI data is that NEI captures additional sources that are not included in TRI due to reporting thresholds. An additional strength is that the data set includes 2 reporting sites under TRI and 2 reporting sites under NEI, which adds variability to the assessment. Factors that decrease the overall confidence for this OES include the uncertainty in the accuracy of reported releases, and the limitations in representativeness to all sites because TRI and NEI may not capture all relevant sites. Based on other reporting databases (CDR), there is 1 additional manufacturing site that is not accounted for in this assessment. Land releases are assessed using reported releases from 2017–2022 TRI. The primary limitation is that the land releases assessment is based on 1 reporting site, with the other TRI site reporting no land releases. EPA did not have additional sources to estimate land releases from this OES. Based on other reporting databases (CDR, DMR, NEI, etc.), there are 2 additional manufacturing sites that are not accounted for in this assessment. Water releases are assessed using reported releases from 2017–2022 TRI and DMR (U.S. EPA, 2014a). The primary strength of TRI data is that TRI compiles the best readily available release data for all reporting facilities. The primary limitation is that the water release assessment is based on 2 reporting sites for this OES, with 1 site reporting releases from which the maximum was used for the high-end, and the other TRI site reporting no water releases; therefore, EPA used the midpoint between the 0 release and the maximum (high-end) as an estimate for central tendency. EPA did not have additional sources to estimate water releases from this OES. Based on other reporting databases (CDR, NEI, etc.), there are 2 additional manufacturing sites that are not accounted for in this assessment. The release information sources are EPA programmatic data from the last 10 years and cover all media of primary concern. Although there are limited reporting sites, significant variability in the manufacture of DEHP and the associated releases from the manufacture are not expected. Based on this information, EPA has concluded that the weight of scientific evidence for this assessment provides moderate confidence in the estimate of releases in consideration of the strengths and limitations of reasonably available data. Note that facilities that do not report any data because releases were below the reporting threshold do not inform the concentrations calculated in these media (air, land, water) determined from the range of reported releases.
Rubber manufacturing	Air releases are assessed using reported releases from 2017–2022 TRI (U.S. EPA, 2022g) and 2017 and 2020 NEI (U.S. EPA, 2023a). A strength of NEI data is that NEI captures additional sources that are not included in TRI due to reporting thresholds. An additional strength is that the data set includes 58 NEI reporting sites and 29 TRI reporting sites which adds variability to the assessment. Factors that decrease the overall confidence for this OES include the uncertainty in the accuracy of reported releases and the limitations in representativeness to all sites because TRI and NEI may not capture all relevant sites. Land releases are assessed using reported releases from 2017–2022 TRI. The land release assessment is based on 19 reporting sites under TRI, which are used to estimate releases, with the remainder of TRI sites mapped to this OES reporting no land releases. Factors that decrease the overall confidence for this OES include the uncertainty in the accuracy of reported releases, the limitations

OES[a]	Weight of Scientific Evidence Conclusion in Release Estimates
	in representativeness to all sites because TRI may not capture all relevant sites, and EPA did not have additional sources to estimate land releases from this OES. Water releases are assessed using reported releases from 2017–2022 TRI. The primary strength of TRI data is that TRI compiles the best readily available release data for all reporting facilities. The primary limitation is that the water release assessment is based on 8 reporting sites, and EPA did not have additional sources to estimate water releases from this OES. Other factors that decrease the overall confidence for this OES include the uncertainty in the accuracy of reported releases, and the limitations in representativeness to all sites because TRI may not capture all relevant sites, and EPA did not have additional sources to estimate water releases from this OES. Based on the availability of programmatic data from multiple sites across all media of primary concern, EPA has concluded that the weight of scientific evidence for this assessment provides moderate to robust confidence in the estimate of releases in consideration of the strengths and limitations of reasonably available data.
Plastics compounding	Air releases are assessed using reported releases from 2017–2022 TRI (U.S. EPA, 2022g) and 2017 and 2020 NEI (U.S. EPA, 2023a). A strength of NEI data is that NEI captures additional sources that are not included in TRI due to reporting thresholds. An additional strength is that the data includes 14 NEI reporting sites and 22 TRI reporting sites, and this variability in data sources with different levels of granularity in reporting generally increases the representativeness of the assessment. Factors that decrease the overall confidence for this OES include the uncertainty in the accuracy of reported releases, and the limitations in representativeness to all sites because TRI and NEI may not capture all relevant sites. Land releases are assessed using reported releases from 2017–2022 TRI. The primary limitation is that the land releases assessment is based on 9 reporting sites, which inform the release estimate to land for this OES, with the remainder of TRI sites mapped to this OES reporting 0 land releases which are not included in the release statistics. Other factors that decrease the overall confidence for this OES include the uncertainty in the accuracy of reported releases, the limitations in representativeness to all sites because TRI may not capture all relevant sites, and EPA did not have additional sources to estimate land releases from this OES. Water releases are assessed using reported releases from 2017–2022 TRI and DMR (U.S. EPA, 2014a). The primary strength of TRI data is that TRI compiles the best readily available release data for all reporting facilities. An additional strength is that the data set includes 28 DMR reporting sites and 13 TRI reporting sites that inform the release estimate to water for this OES, and the extensive reporting across these databases adds variability to the assessment. The remaining TRI sites mapped within this OES reported no water releases and are not included in the release statistics. Factors that decrease the overall confidence for this OES include the uncertainty in the accuracy of reported releases and the limitations in representativeness to all sites because TRI and DMR may not capture all relevant sites. Based on this information, EPA has concluded that the weight of scientific evidence for this assessment provides moderate to robust confidence in the estimate of releases in consideration of the strengths and limitations of reasonably available data.

OES[a]	Weight of Scientific Evidence Conclusion in Release Estimates
Plastics converting	Air releases are assessed using reported releases from 2017–2022 TRI (U.S. EPA, 2022g) and 2017 and 2020 NEI (U.S. EPA, 2023a). A strength of NEI data is that NEI captures additional sources that are not included in TRI due to reporting thresholds. An additional strength is that the data includes 23 NEI reporting sites and 48 TRI reporting sites which adds variability to the assessment. Factors that decrease the overall confidence for this OES include the uncertainty in the accuracy of reported releases and the limitations in representativeness to all sites because TRI and NEI may not capture all relevant sites. Land releases are assessed using reported releases from 2017–2022 TRI. The land release assessment is based on 30 reporting sites under TRI with the remainder of TRI sites mapped to this OES reporting no land releases. Factors that decrease the overall confidence for this OES include the uncertainty in the accuracy of reported releases, the limitations in representativeness to all sites because TRI may not capture all relevant sites, and EPA did not have additional sources to estimate land releases from this OES. Water releases are assessed using reported releases from 2017–2022 TRI and DMR (U.S. EPA, 2014a). The primary strength of TRI data is that TRI compiles the best readily available release data for all reporting facilities. An additional strength is that the data set includes 2 DMR reporting sites and 13 TRI reporting sites which adds variability to the assessment. The remaining TRI sites mapped within this OES reported no water releases. Factors that decrease the overall confidence for this OES include the uncertainty in the accuracy of reported releases and the limitations in representativeness to all sites because TRI and DMR may not capture all relevant sites. Based on this information, EPA has concluded that the weight of scientific evidence for this assessment provides moderate to robust confidence in the estimate of releases in consideration of the strengths and limitations of reasonably available data.
Incorporation into formulation, mixture, or reaction product	Air releases are assessed using reported releases from 2017–2022 TRI (U.S. EPA, 2022g), and 2017 and 2020 NEI (U.S. EPA, 2023a). A strength of NEI data is that NEI captures additional sources that are not included in TRI due to reporting thresholds. An additional strength is that the data includes 71 NEI reporting sites and 19 TRI reporting sites which adds variability to the assessment. Factors that decrease the overall confidence for this OES include the uncertainty in the accuracy of reported releases and the limitations in representativeness to all sites because TRI and NEI may not capture all relevant sites. Land releases are assessed using reported releases from 2017–2022 TRI. The primary limitation is that the land releases assessment is based on 3 reporting sites, with the remainder of TRI sites mapped to this OES reporting no land releases. Other factors that decrease the overall confidence for this OES include the uncertainty in the accuracy of reported releases, the limitations in representativeness to all sites because TRI may not capture all relevant sites, and EPA did not have additional sources to estimate land releases from this OES. Water releases are assessed using reported releases from 2017–2022 TRI and DMR (U.S. EPA, 2014a). The primary strength of TRI data is that TRI compiles the best readily available release data for all reporting facilities. An additional strength is that the data set includes 38 DMR reporting sites and 8 TRI reporting sites which adds variability to the assessment. The remaining TRI sites mapped within this OES reported no water releases. Factors that decrease the overall confidence for this OES include the uncertainty in the

OES[a]	Weight of Scientific Evidence Conclusion in Release Estimates
	accuracy of reported releases and the limitations in representativeness to all sites because TRI and DMR may not capture all relevant sites. Based on this information, EPA has concluded that the weight of scientific evidence for this assessment provides moderate to robust confidence in the estimate of releases in consideration of the strengths and limitations of reasonably available data.
Import and repackaging	Air releases are assessed using reported releases from 2017–2022 TRI (U.S. EPA, 2022g), and 2017 and 2020 NEI (U.S. EPA, 2023a). A strength of NEI data is that NEI captures additional sources that are not included in TRI due to reporting thresholds. An additional strength is that the data includes 16 NEI reporting sites and 24 TRI reporting sites which adds variability to the assessment. Factors that decrease the overall confidence for this OES include the uncertainty in the accuracy of reported releases and the limitations in representativeness to all sites because TRI and NEI may not capture all relevant sites. Land releases are assessed using reported releases from 2017–2022 TRI. The primary limitation is that the land release assessment is based on 1 reporting site, with the remainder of TRI sites mapped to this OES reporting no land releases. Other factors that decrease the overall confidence for this OES include the uncertainty in the accuracy of reported releases, the limitations in representativeness to all sites because TRI may not capture all relevant sites, and EPA did not have additional sources to estimate land releases from this OES. Water releases are assessed using reported releases from 2017–2022 TRI and DMR (U.S. EPA, 2014a). The primary strength of TRI data is that TRI compiles the best readily available release data for all reporting facilities. An additional strength is that the data set includes 8 DMR reporting sites and 19 TRI reporting sites which adds variability to the assessment. The remaining TRI sites mapped within this OES reported no water releases. Factors that decrease the overall confidence for this OES include the uncertainty in the accuracy of reported releases and the limitations in representativeness to all sites because TRI and DMR may not capture all relevant sites. In summary, some media (land) had few reporting sites, while for others (air, water), there are a significantly more reporting sites. The release weight of scientific evidence is an integration across media that must consider the number of sites for each medium along with other factors. The only limiting medium is land, the others have release information from multiple sources (TRI/DMR, TRI/NEI). The fact that the release estimates were based on an integration of actual release data from programmatic databases with a data quality score of medium for TRI and DMR and a data quality score of high for NEI increase EPA's confidence in the release estimates. Based on this information, EPA has concluded that the weight of scientific evidence for this assessment provides moderate to robust confidence in the estimate of releases in consideration of the strengths and limitations of reasonably available data.
Application of paints, coatings, adhesives and sealants	Air releases are assessed using reported releases from 2017–2022 TRI (U.S. EPA, 2022g) and 2017 and 2020 NEI (U.S. EPA, 2023a). A strength of NEI data is that NEI captures additional sources that are not included in TRI due to reporting thresholds. An additional strength is that the data includes 117 NEI reporting sites and 2 TRI reporting sites which adds variability to the assessment. Factors that decrease the overall confidence for this OES include the uncertainty in the accuracy of reported releases and the limitations in representativeness to all sites because TRI and NEI may not capture all relevant sites.

OES[a]	Weight of Scientific Evidence Conclusion in Release Estimates
	Land releases are assessed using reported releases from 2017–2022 TRI. The primary limitation is that the land releases assessment is based on 1 reporting site, with the remainder of TRI sites mapped to this OES reporting no land releases. Other factors that decrease the overall confidence for this OES include the uncertainty in the accuracy of reported releases, the limitations in representativeness to all sites because TRI may not capture all relevant sites, and EPA did not have additional sources to estimate land releases from this OES. Water releases are assessed using reported releases from 2017–2022 TRI and DMR (U.S. EPA, 2014a). The primary strength of TRI data is that TRI compiles the best readily available release data for all reporting facilities. An additional strength is that the data set includes 21 DMR reporting sites and 1 TRI reporting site which adds variability to the assessment. The remaining TRI sites mapped within this OES reported no water releases. Factors that decrease the overall confidence for this OES include the uncertainty in the accuracy of reported releases and the limitations in representativeness to all sites because TRI and DMR may not capture all relevant sites. Based on this information, EPA has concluded that the weight of scientific evidence for this assessment provides moderate to robust confidence in the estimate of releases in consideration of the strengths and limitations of reasonably available data.
Textile finishing	Air releases are assessed using reported releases from 2017–2022 TRI (U.S. EPA, 2022g) and 2017 and 2020 NEI (U.S. EPA, 2023a). A strength of NEI data is that NEI captures additional sources that are not included in TRI due to reporting thresholds. An additional strength is that the data includes 9 NEI reporting sites and 2 TRI reporting sites which adds variability to the assessment. Factors that decrease the overall confidence for this OES include the uncertainty in the accuracy of reported releases and the limitations in representativeness to all sites because TRI and NEI may not capture all relevant sites. All TRI sites within this OES reported no land releases. EPA did not have additional sources to estimate land releases from this OES. There is uncertainty if all sites within this OES that are not captured by TRI have no land releases. While some facilities report no releases, others do not report if below the reporting threshold. EPA's procedure for calculating central tendency and high-end release estimates, including the treatment of reporting of no releases, are described in the note below this table. Water releases are assessed using reported releases from 2017–2022 TRI and DMR (U.S. EPA, 2014a). The primary strength of TRI data is that TRI compiles the best readily available release data for all reporting facilities. The primary limitation is that the water release assessment is based on 1 reporting site under DMR and 1 reporting site under TRI. The remaining TRI sites mapped within this OES reported no water releases. Other factors that decrease the overall confidence for this OES include the uncertainty in the accuracy of reported releases and the limitations in representativeness to all sites because TRI and DMR may not capture all relevant sites. Due to the low number of reporting facilities across all media, EPA has concluded that the weight of scientific evidence for this assessment provides slight confidence in the estimate of releases in consideration of the strengths and limitations of reasonably available data.

OES[a]	Weight of Scientific Evidence Conclusion in Release Estimates
Fabrication and final use of products or articles	Air releases are assessed using reported releases from 2017–2022 TRI (U.S. EPA, 2022g) and 2017 and 2020 NEI (U.S. EPA, 2023a). A strength of NEI data is that NEI captures additional sources that are not included in TRI due to reporting thresholds. An additional strength is that the data includes 13 NEI reporting sites and 3 TRI reporting sites which adds variability to the assessment. Factors that decrease the overall confidence for this OES include the uncertainty in the accuracy of reported releases and the limitations in representativeness to all sites because TRI and NEI may not capture all relevant sites. All TRI sites within this OES reported 0 land releases. EPA did not have additional sources to estimate land releases from this OES. There is uncertainty if all sites within this OES that are not captured by TRI have no land releases. All TRI sites reported 0 water releases, and no DMR facilities were mapped to this OES. EPA did not have additional sources to estimate water releases from this OES. There is uncertainty if all sites within this OES that are not captured by TRI have 0 water releases. Based on the limited release information for 1 medium (land) combined with the inherent uncertainty that the programmatic data for land and water releases is sufficiently representative of all facilities covered by this COU, EPA has concluded that the weight of scientific evidence for this assessment is slight.
Use of dyes, pigments, and fixing agents	No TRI and NEI facilities were mapped within this OES. EPA did not have additional sources to estimate air or land releases from this OES. Water releases are assessed using reported releases from 2017–2022 DMR (U.S. EPA, 2022c). The primary strength of DMR data is that DMR compiles the best readily available water release data for all reporting facilities. The primary limitation is that the water release assessment is based on 5 reporting sites under DMR. Other factors that decrease the overall confidence for this OES include the uncertainty in the accuracy of reported releases, the limitations in representativeness to all sites because DMR may not capture all relevant sites, and EPA did not have additional sources to estimate water releases from this OES. Based on the limited programmatic release information for 1 medium (DMR data for water releases) combined with the lack of programmatic release data for land and air (*i.e.*, no TRI or NEI facilities were mapped within this OES), EPA has concluded that the weight of scientific evidence provides slight confidence in the estimate of releases for this OES.
Formulations for diffusion bonding	Air releases are assessed using reported releases from 2017 and 2020 NEI (U.S. EPA, 2023a). A strength of NEI data is that NEI captures additional sources that are not included in other databases due to reporting thresholds. The primary limitation is that the air release assessment is based on 13 reporting sites under NEI. Other factors that decrease the overall confidence for this OES include the uncertainty in the accuracy of reported releases, the limitations in representativeness to all sites because NEI may not capture all relevant sites, and EPA did not have additional sources to estimate air releases from this OES. All TRI sites within this OES reported 0 land releases. EPA did not have additional sources to estimate land releases from this OES. There is uncertainty if all sites within this OES that are not captured by TRI have no land releases.

OES[a]	Weight of Scientific Evidence Conclusion in Release Estimates
	Water releases are assessed using reported releases from 2017–2022 DMR (U.S. EPA, 2022c). The primary strength of DMR data is that DMR compiles the best readily available water release data for all reporting facilities. The primary limitation is that the water release assessment is based on 1 reporting site under DMR. Other factors that decrease the overall confidence for this OES include the uncertainty in the accuracy of reported releases, the limitations in representativeness to all sites because DMR may not capture all relevant sites, and EPA did not have additional sources to estimate water releases from this OES. Based on a limited number of reporting sites for water (1 DMR site reporting) and the lack of reporting sites for land, EPA has concluded that the weight of scientific evidence provides slight confidence in the estimate of releases for this OES.
Use of laboratory chemicals	EPA identified 2 DMR facilities reporting water releases and 4 NEI facilities reporting air releases of DEHP; however, EPA determined this data is not sufficient to capture the entirety of environmental releases for this scenario. Therefore, EPA assessed releases to the environment using the Draft GS on the Use of Laboratory Chemicals, which has a high data quality rating based on systematic review (U.S. EPA, 2023g). 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 DEHP lab materials. 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 used SDSs from identified laboratory DEHP products to inform product concentration and material states. 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 DEHP laboratory chemical throughput and number of laboratories; therefore, EPA based the number of laboratories and throughput estimates on stock solution throughputs from the Draft GS on the Use of Laboratory Chemicals and on CDR reporting thresholds. Additionally, because no entries in CDR indicate a laboratory use case and there were no other sources to estimate the volume of DEHP used in this OES, EPA developed a high-end bounding estimate based on the CDR reporting threshold, which is expected to result in a release estimate that likely exceeds highest release in the full distribution of facilities covered by this OES. Due to the high-end bounding estimate, EPA concludes that the weight of scientific evidence provides slight to moderate confidence in the accuracy of the release estimate for this OES. However, EPA has confidence that the estimates encompass the entire OES due to the high-end bounding release estimates.
Use of automotive care products	EPA identified 1 DMR facility reporting water releases of DEHP; however, EPA determined this data is not sufficient to capture the entirety of environmental releases for this scenario. Therefore, EPA assessed releases to the environment using the Automotive Detailing Methodology Review Draft (MRD), which has a high data quality rating based on systematic review (U.S. EPA, 2022b). EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment, and media of release using assumptions from the MRD and EPA/OPPT models for paste/liquid DEHP automotive care product materials. 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

OES[a]	Weight of Scientific Evidence Conclusion in Release Estimates
	(simulation runs) and the full distributions of input parameters. EPA used SDSs from identified automotive detailing products to inform product concentration and material states. 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 DEHP automotive detailing throughput and number of sites; therefore, EPA based the number of sites and throughput estimates on total number of automotive detailing sites known to operate and use rate of product used per car provided by the Automotive Detailing MRD. Additionally, because no entries in CDR indicate an automotive detailing case and there were no other sources to estimate the volume of DEHP used in this OES, EPA developed a high-end bounding estimate based on the CDR reporting threshold, which is expected to result in a release estimate that likely exceeds highest release in the full distribution of facilities covered by this OES. Due to the high-end bounding estimate, EPA concludes that the weight of scientific evidence provides slight to moderate confidence in the accuracy of the release estimate for this OES. The accuracy is based on EPA's incorporation of the number of use sites, product use rate, and SDS for automotive detailing products from the Automotive Detailing MRD, which was rated high quality, and EPA used these empirical data as inputs for Monte Carlo modeling to generate a full distribution of release estimates. No data were available in CDR to estimate the volume of DEHP used in this OES, so we used the CDR reporting threshold for this parameter, which is the only factor that contributes to the estimate representing an upper bound. However, EPA has confidence that the estimates encompass the entire OES due to the high-end bounding release estimates.
Use in hydraulic fracturing	EPA found limited chemical specific data for the use in hydraulic fracturing OES and assessed releases to the environment using the Draft ESD on Chemicals Used in Hydraulic Fracturing and FracFocus 3.0, which has a high data quality rating based on systematic review (U.S. EPA, 2023g; FracFocus, 2022). 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 for liquid DEHP formulations. 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 used FracFocus distributions from identified DEHP products to inform product concentration and material states. EPA believes the primary limitation to be the uncertainty in the representativeness of values toward the true distribution of potential releases. Additionally, the Agency lacks data on DEHP hydraulic fracturing throughput and number of sites; therefore, EPA based the number of sites and throughput estimates on FracFocus Data. Based on this information, EPA concluded that the weight of scientific evidence for this assessment provides slight to moderate confidence in the estimate of releases, considering the strengths and limitations of reasonably available data.
Recycling	Air releases are assessed using reported releases from 2017–2022 TRI (U.S. EPA, 2022g). The primary strength of TRI data is that TRI compiles the best readily available release data for all reporting facilities. The primary limitation is that the air release assessment is based on 1 reporting site under TRI. Other factors that decrease the overall confidence for this OES include the

OES[a]	Weight of Scientific Evidence Conclusion in Release Estimates
	uncertainty in the accuracy of reported releases, the limitations in representativeness to all sites because TRI may not capture all relevant sites, and EPA did not have additional sources to estimate air releases from this OES. The singular TRI site within this OES reported 0 land and water releases. No DMR and NEI facilities were mapped within this OES. EPA did not have additional sources to estimate water or land releases from this OES. Based on this information, EPA has concluded that the weight of scientific evidence for this assessment is slight yet provides a plausible estimate of releases in consideration of the strengths and limitations of reasonably available data.
Waste handling, treatment, and disposal	***General Waste Handling, Treatment, and Disposal*** Air releases for non-POTW sites are assessed using reported releases from 2017–2022 TRI (U.S. EPA, 2022g), and 2017 and 2020 NEI (U.S. EPA, 2023a). A strength of NEI data is that NEI captures additional sources that are not included in TRI due to reporting thresholds. An additional strength is that the data includes 514 NEI reporting sites and 21 TRI reporting sites which adds variability to the assessment. Factors that decrease the confidence for this OES include the uncertainty in the accuracy of reported releases, and the limitations in representativeness to all sites because TRI and NEI may not capture all relevant sites. Land releases for non-POTW are assessed using reported releases from 2017–2022 TRI. The primary limitation is that the land releases assessment is based on 7 reporting sites, with the remainder of TRI sites mapped to this OES reporting 0 land releases. Other factors that decrease the overall confidence for this OES include the uncertainty in the accuracy of reported releases, the limitations in representativeness to all sites because TRI may not capture all relevant sites, and EPA did not have additional sources to estimate land releases from this OES. Water releases for non-POTW sites are assessed using reported releases from 2017–2022 TRI and DMR (U.S. EPA, 2014a). The primary strength of TRI data is that TRI compiles the best readily available release data for all reporting facilities. For non-POTW sites, the primary limitation is that the water release assessment is based on 1 reporting site under TRI and 1 reporting site under DMR. The remaining TRI sites mapped within this OES reported no water releases. Other factors that decrease the overall confidence for this OES include the uncertainty in the accuracy of reported releases, and the limitations in representativeness to all sites because TRI and DMR may not capture all relevant sites. Based on this information, EPA has concluded that the weight of scientific evidence for this assessment provides moderate to robust confidence in the estimate of releases in consideration of the strengths and limitations of reasonably available data. ***Waste Handling, Treatment, and Disposal (POTW and Remediation)*** Water releases for POTW and remediation sites are assessed using reported releases from 2017–2022 DMR (U.S. EPA, 2022c), which has a medium overall data quality determination from the systematic review process. A strength of using DMR data and the Pollutant Loading Tool used to pull the DMR data is that the tool calculates an annual pollutant load by integrating monitoring period release reports provided to the EPA and extrapolating over the course of the year. However, this approach assumes average quantities, concentrations, and hydrologic flows for a given period are representative of other times of the year. Based on this

OES[a]	Weight of Scientific Evidence Conclusion in Release Estimates
	information, for POTW releases, EPA has concluded that the weight of scientific evidence provides moderate confidence in the estimate of releases in consideration of the strengths and limitations of reasonably available data.

[a] Table 3-2 provides a crosswalk of assessed OES to COUs.
For programmatic data (TRI, NEI, DMR), central tendency and high-end values represent the 50th and 95th percentiles, respectively, of the available maximum values reported for all sites mapped to each OES. The specific central tendency and high-end values presented depends on the number of sites with programmatic data. For databases with 6 or more reporting facilities, EPA estimated central tendency and high-end releases using the 50th and 95th percentile values, respectively. For 3–5 facilities, EPA estimated the central tendency and high-end releases using the 50th percentile and maximum values, respectively. For 2 sites, EPA presented the midpoint and the maximum value. Finally, EPA presented sites with only 1 data point as-is from the programmatic database. It is important to note that when the reported maximum value for a given facility indicates no releases, these values are included in the calculation of 50th and 95th percentile for each OES.

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

Strengths

EPA compiled release information using reported releases from the 2017 through 2022 TRI (U.S. EPA, 2022g), 2017 through 2022 DMR (U.S. EPA, 2022c), and 2017 through 2020 NEI (U.S. EPA, 2022e). TRI, DMR, and NEI data were determined to have a high data quality rating through EPA's systematic review process. Furthermore, TRI-reporting facilities are required to submit their "best available data" to EPA for TRI reporting purposes. Some facilities are required to measure or monitor emission or other waste management quantities due to regulations unrelated to the TRI Program (*e.g.*, permitting requirements), or due to company policies. These existing, reasonably available data are often used by facilities for TRI reporting purposes, as they represent the best available data (*e.g.*, stack releases can be directly measured by stack testing using EPA reference methods, providing a directly measured emission rate which can then be used to calculate annual emissions). NEI does not require stack testing or continuous emissions monitoring, and reporting agencies may use different emission estimation methods. These reasonable estimates may be obtained through various release estimation techniques, including continuous emissions monitoring, stack testing, mass-balance calculations, the use of emission factors, and engineering calculations.

Limitations

When monitoring or direct measurement data are not reasonably available or are known to be non-representative for TRI reporting purposes, the TRI regulations require that facilities determine release and other waste management quantities of TRI-listed chemicals by making reasonable estimates. For each release quantity reported, TRI facilities select a "Basis of estimate" code indicating the principal method used to determine the amount of the release. TRI provides six basis of estimate codes to choose from: continuous monitoring, periodic monitoring, mass balance, published emissions factors, site-specific emissions factors, or engineering calculations/best engineering judgment. In facilities where a chemical is used in multiple operations, the facility may use a combination of methods to calculate the release reported. In such cases, TRI instructs the facility to enter the basis of estimate code of the method that applies to the largest portion of the release quantity. Additional details on the basis of estimate, such as any calculations and underlying assumptions, are not reported.

Facilities are only required to report to TRI if the facility has 10 or more full-time employees, is included in an applicable NAICS code, and manufactures, processes, or uses the chemical in quantities greater than a certain threshold (25,000 lb for manufacturers and processors and 10,000 lb for users). For NEI, the Air Emissions Reporting Requirements (AERR) only requires Criteria Air Pollutants and Precursors (CAP) data reporting, Hazardous Air Pollutant (HAP) data reporting is voluntary. As a result, EPA augments State/Local/Tribal (SLT)-provided HAP data with other information to better estimate point, nonpoint, and mobile source HAP emissions. For point sources, HAP augmentation is performed on each emissions source using the Web Factor Information Retrieval (FIRE) Data System (WebFIRE database) or data from TRI. DMR data are submitted by National Pollutant Discharge Elimination System (NPDES) permit holders to states or directly to the EPA according to the monitoring requirements of the facility's permit. States are only required to load major discharger data into DMR and may or may not load minor discharger data. The definition of major vs. minor discharger is set by each state and could be based on discharge volume or facility size. Due to these limitations across programs, some sites may release DEHP but are not included in TRI, NEI, or DMR. It is uncertain the extent to which sites not captured in these databases release DEHP into the environment, or whether releases are to water, air, or landfill.

Manufacturers and importers of DEHP 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 DEHP may not be included in the CDR dataset and the total production volume for a given OES may be under or overestimated due to the absence of these sites in the universe of CDR reporters. The extent to which sites that are not captured in the CDR report releases of DEHP into the environment is unknown. The media of release for these sites is also unknown.

Assumptions and Uncertainties

There is some uncertainty in the DMR data pulled using the ECHO Pollutant Loading Tool Advanced Search option. The average measurements may be reported as a quantity (kg/day) or a concentration (mg/L). Calculating annual loads from concentrations requires adding wastewater flow to the equation, which increases the uncertainty of the calculated annual load. In addition, for facilities that reported having zero pollutant loads to DMR, the EZ Search Load Module uses a combination of setting non-detects equal to zero and as one-half the detection limit to calculate the annual pollutant loadings: if all values reported for a facility are non-detects, the loading tool sets the value to zero; and for facilities reporting some values above zero, the non-detects are set to one-half the detection limit . A strength of using DMR data and the Pollutant Loading Tool is that the tool calculates an annual pollutant load by integrating monitoring period release reports provided to the EPA and extrapolating over the course of the year. However, this approach assumes average quantities, concentrations, and hydrologic flows for a given period are representative of other times of the year.

There is additional uncertainty in daily release estimates for air emissions. Facilities reporting to TRI and NEI report annual air emissions; to assess daily air emissions, EPA assumed a continuous value of 365 release days, 24/7 and averaged the annual releases over these days. Some sites do not operate year-round; therefore, the actual average daily releases may be higher if sites operate for fewer days than 365.

For the characterization of releases per COU, EPA developed an approach to streamline analysis using the facility's primary NAICS code. The primary NAICS code corresponds to the primary economic activity at that facility. This approach does not rely on the TRI use codes or NEI SCC codes, which EPA views as a higher tier characterization. For TRI, a facility can also provide additional NAICS codes. Some sites are multi-use complexes where the activity of DEHP may not be best represented by the primary NAICS code. There is some uncertainty if a site's primary NAICS code will assign it to the appropriate COU.

CDR information on the downstream use of DEHP 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 volumes given reported CDR data and known reporting thresholds for DEHP in 2020. To handle an OES without programmatic data, EPA 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. DEHP 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 for Number of Facilities:** In some cases, EPA estimated the maximum number of facilities for a given OES using data from the U.S. Census. In such cases, EPA determined the maximum number of sites for use in Monte Carlo modeling from industry data from the U.S. Census Bureau, County and Business Patterns dataset (U.S. Census Bureau, 2022).
- **Uncertainties Associated with Facility Throughputs:** EPA estimated facility throughputs of DEHP or DEHP-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 DEHP 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 Estimate:** For most OES, EPA estimated the number of release days using programmatic data where available, or from GSs, ESDs, or SpERC factsheets when no programmatic data are found. 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 DEHP-specific facility operations, release days may be under or overestimated.
- **Uncertainties Associated with DEHP-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 DEHP concentrations for products in the OES. However, the extent to which these products represent all DEHP-containing products within the OES is uncertain. For OES with little-to-no product data, EPA estimated DEHP concentrations from GSs or ESDs. Due to these uncertainties, the average product concentrations may be under or overestimated.

3.3 Summary of Concentrations of DEHP in the Environment

Based off the environmental release assessment summarized in Section 3.2 and detailed in EPA's *Environmental Release and Occupational Exposure Assessment for DEHP* (U.S. EPA, 2025u), DEHP is expected to be released to the environment via air, water, biosolids, and disposal to landfills. Environmental media concentrations were quantified in ambient air, soil from ambient air deposition, sediment, and surface water. Additional analysis of surface water used as drinking water was conducted for the Human Health Risk Assessment (Section 4). Given limited available information on DEHP in soil and groundwater from releases to biosolids and landfills, along with the availability of high-quality physical and chemical and fate data (Section 2), concentrations of DEHP in soil and groundwater from releases to biosolids and landfills were not quantified (discussed further below).

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 *Physical Chemistry Assessment and Fate and Transport for DEHP* (U.S. EPA, 2025af). Briefly, based on DEHP's fate parameters (*e.g.,* Henry's Law constant, log K_{OC}, water solubility, fugacity modeling), EPA anticipated DEHP to be predominantly in water, soil, and sediment though DEHP may also exist in air since it is released to air. Therefore, the Agency quantitatively assessed concentrations of DEHP in surface water, sediment, ambient air, and soil from air to soil deposition. Soil concentrations of DEHP from land applications were not quantitatively assessed in the screening level analysis as DEHP was expected to have limited persistence potential and mobility in soils receiving biosolids. To contrast, EPA has greater confidence in quantifying DEHP concentrations in soil resulting from air to soil deposition because it is direct deposition onto soil. Therefore, EPA quantified air to soil deposition with a screening level approach for the purpose of the environmental exposure assessment.

Further detail on the screening-level assessment of each environmental pathway can be found in EPA's *Environmental Media and General Population and Environmental Exposure for DEHP* (U.S. EPA, 2025s). EPA began its environmental and general population exposure assessment with a screening-level approach using high-end environmental media concentrations for the environmental pathways expected to be of greatest concern. The high-end environmental media concentrations were estimated using the release estimates for an OES that, when combined with conservative assumptions of environmental conditions, resulted in the greatest modeled concentration of DEHP in a given environmental media. Therefore, EPA did not estimate environmental concentrations of DEHP resulting from all OES presented in Table 3-1. The OESs resulting in the highest environmental concentration of DEHP varied by environmental media as shown in Table 3-7.

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, 2019c). The summary table (Table 3-7) also indicates whether the highest estimate was used for environmental exposure assessment or general population exposure assessment.

For the water pathway, different hydrological flow rates were used for the different screening level exposure scenarios. The 30Q5[4] flows (lowest 30-day average flow that occurs in a 5-year period) are used to estimate acute, incidental human exposure through swimming or recreational contact. The harmonic mean[5] flows provide a more long-term average estimate that is preferred for assessing potential chronic human exposure via drinking water and is more protective than an arithmetic mean flow. The harmonic mean is also used for estimating human exposure through fish ingestion because it takes time for chemical concentrations to accumulate in fish. Lastly, for aquatic or ecological exposure, a 7Q10[6] flow (lowest 7-day average flow that occurs in a 10-year period) is used to estimate exceedances of concentrations of concern for aquatic life (U.S. EPA, 2007b). When OES had reported releases, EPA was able to determine facility-specific receiving water body information to pair with reported releases to model surface water concentrations. However, there were no reported releases for some OES. For those OES, in lieu of facility-specific receiving water body information for DEHP, flow statistics were drawn from a generic distribution of receiving water body flow rates derived from receiving water bodies listed on NPDES permits for facilities with relevant NAICS codes. The modeled distribution of hydrological flow data is specific to an industry sector rather than a single facility but provides a reasonable estimate of the distribution of location-specific values. The complete methods for retrieving and processing flow data by NAICS code are detailed in Appendix B of the *Environmental Media and General Population and Environmental Exposure for DEHP* (U.S. EPA, 2025s). Briefly, EPA selected a median flow (P50) from the distribution of resulting receiving water body flow rates across the pooled flow data of all relevant NAICS codes as a conservative low flow condition across modeled releases. Additional refined analyses were conducted for the scenarios resulting in the greatest environmental concentrations by applying the 75th and 90th percentile (P75 and P90, respectively) flow metrics from the distribution to represent a more complete range of potential flow rates. When comparing generic scenario releases and flow percentiles to known releases from facilities within relevant phthalate COUs and their respective receiving waterbodies, EPA was unable to constrain the analysis to a single flow percentile, as the P50, P75, and P90 flows are derived from relevant facilities, and each condition is plausible.

[4] 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 and incidental surface water exposure via swimming (Versar, 2014).
[5] 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.
[6] 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).

For the screening level assessment, EPA identified the Plastic compounding OES as yielding the highest water concentrations for a TRI reported release, and the Use of automotive care products OES as yielding the highest water concentrations for a generic scenario (Table 3-7). As described in further detail in the *Environmental Media and General Population and Environmental Exposure for DEHP* (U.S. EPA, 2025s) and in Section 3.3.1.1, EPA estimated the surface water concentration for Plastic compounding OES using TRI annual release reports. EPA selected a single facility reporting the highest release value for the Plastic compounding OES for the purpose of screening. The Use of automotive care products OES relied on modeled release estimates (generic scenarios) due to a lack of reporting of releases to the TRI and DMR systems. The highest end of the estimated release concentrations from the generic scenario distribution were used for the purpose of screening. However, releases associated with the Use of automotive care products OES were categorized to multiple release categories and the proportion discharged only to surface water was indeterminable. Therefore, EPA conservatively assumed that all releases associated with Use of automotive care products OES went directly to surface water. EPA has slight confidence in this assumption, as described in Section 3.3.1.1, but robust confidence that Use of automotive care products OES represents a conservative estimate of surface water concentrations that is appropriate for use in a screening level assessment. If using a screening level approach yielded MOEs below the benchmark, then other assumptions or data were incorporated into the assessment. Details on the input assumptions and the confidence of the surface water concentrations can be found in *Environmental Media and General Population and Environmental Exposure for DEHP* (U.S. EPA, 2025s) and partly in Section 3.3.1.1.

Surface water concentrations presented in Table 3-7 exceed the water solubility of DEHP which EPA estimates at 0.003 mg/L as detailed in Section 2. However, DEHP has been monitored in the environment at concentrations above the water solubility as presented in Table 4-5 in the *Environmental Media and General Population and Environmental Exposure for DEHP* (U.S. EPA, 2025s). Phthalate esters commonly exhibit a tendency to form colloidal suspensions in aquatic environments due to their hydrophobic nature and slight water solubility. Many phthalate esters exhibit large, nonpolar alkyl chains that resist dissolution in water, promoting aggregation into small droplets or particles. These colloidal formations can remain suspended in water, allowing phthalates to be present at concentrations exceeding their nominal solubility limits.

The maximum daily release value for fugitive releases for DEHP used to model ambient air concentrations was 8.85 kg/site-day. This value was reported to the 2020 NEI dataset and categorized under the Plastic converting OES as fugitive releases. The maximum daily release value for stack releases for DEHP used to model ambient concentrations was 36.23 kg/site-day. This value was reported to the 2017 NEI dataset and categorized under the Application of paints, coatings, adhesives, and sealants OES as stack releases. Although the maximum releases for each release type are from different facilities in different locations and different OES, for this assessment EPA assumes the releases occurred from the same location at the same time under the same OES to determine a "total exposure" to DEHP from both release types. This approach may overestimate ambient concentrations of DEHP at the distances evaluated since exposures to each release type at the distances evaluated cannot occur at a single location at the same time.

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 environmental and human health risk assessment (*i.e.*, plastic compounding and use of automotive care products for water and application of paints, coatings, adhesives, and sealants for ambient air). For the screening level analysis, if the highest environmental media concentrations did not result in potential environmental or human health risk, no further OESs were assessed, and no further refinements were pursued. Section 4.1.3 and Section 5.1 discusses the use of the various environmental media concentration presented in Table 3-7 for general population exposure and environmental exposure, respectively. No refinements were needed for general population risk as described in Section 4.1.3, but additional refinements were needed for environmental risk that are discussed in Section 5.3.

Table 3-7. Summary of Highest DEHP Concentrations in Various Environmental Media from Environmental Releases

OES [a]	Release Media	Environmental Media	DEHP Concentration [b]	Environmental or General Population
Plastic compounding, High-end from TRI releases	Water	Total water column (7Q10) [c]	16 µg/L [f]	Environmental
		Benthic pore water (7Q10) [c]	7.98 µg/L [f]	Environmental
		Benthic sediment (7Q10) [c]	83,800 µg/kg	Environmental
Use of automotive care products, High-end from Generic Scenario Modeling (P50 flow)	Water	Total water column (7Q10) [c]	217 µg/L [f]	Environmental
		Benthic pore water (7Q10) [c]	112 µg/L [f]	Environmental
		Benthic sediment (7Q10) [c]	1,180,000 µg/kg	Environmental
Plastic compounding, High-end from TRI releases	Water	Surface water (30Q5) [d]	10.3 µg/L [f]	General Population
		Surface water (harmonic mean) [e]	4 µg/L [f]	General Population
Use of automotive care products, High-end from Generic Scenario Modeling (P50 flow)	Water	Surface water (30Q5) [d]	140 µg/L [f]	General Population
		Surface water (harmonic mean) [e]	92.90 µg/L [f]	General Population
Plastic converting (fugitive)	Ambient air	Total daily-average concentration (Sum: fugitive and stack, 100 m)	23.23 µg/m^3	General Population
Application of paints, coatings, adhesives, and sealants (stack)		Total annual-average concentration (Sum: fugitive and stack, 100 m)	18.50 µg/m^3	
Plastic Converting (fugitive)	Ambient air	Total annual deposition rate (Sum: fugitive and stack, 100 m)	478 µg/m^2	Environmental and General Population
Application of Paints, coatings, adhesives, and sealants (stack)				

[a] Table 3-1 provides the crosswalk of OES to COUs.
[b] DEHP concentrations in environmental media were modeled using data on actual releases determined from programmatic databases (TRI, DMR, and NEI) when available.
[c] 7Q10 is the 7 consecutive days of lowest flow over a 10-year period.
[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.
[f] This value is exceeds the water solubility limit for DEHP, which EPA estimates at 0.003 mg/L.

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 *Environmental Media and General Population and Environmental Exposure for DEHP* (U.S. EPA, 2025s). However, the weight of scientific evidence conclusion is summarized below for the modeled concentrations for surface water and ambient air.

For the screening level assessment, EPA used the release estimates presented in Table 3-5 to model DEHP concentrations in different environmental media. The Agency considers additional variables when considering the weight of scientific evidence for its estimation of environmental media concentrations. Some additional considerations include the use of an additional model using the release as an input, the applicability of the release data to the environmental media being considered, likelihood of an occurrence of a release to the specific environmental compartment, and available monitoring data. These considerations are largely discussed for surface water and ambient air within the proceeding Sections 3.3.1.1 and 3.3.1.2, respectively. Additional information is provided within the EPA's *Environmental Media and General Population and Environmental Exposure for DEHP* (U.S. EPA, 2025s).

3.3.1.1 Surface Water

As mentioned in the *Environmental Media and General Population and Environmental Exposure for DEHP* (U.S. EPA, 2025s), DEHP has both federal effluent limitation guidelines (ELGs) and ambient water quality criteria (AWQC). The ELGs regulate the maximum allowable levels of concentrations economically achievable based on best available technology for certain chemicals across various industry sectors and processes. ELGs established in 40 CFR 414 and 40 CFR 437 for the point source category of Organic Chemicals, Plastics and Synthetic Fibers, and Centralized Waste Treatment limit effluent releases of DEHP to: 215 to 279 µg/L daily maximum concentration; and 95 to 158 µg/L maximum monthly average concentration. DEHP is also included in a Total Toxic Organics (TTO) ELG, which is a limit of the sum of multiple chemicals. Some of the processes included in OES evaluated in this assessment are subject to established ELGs, including: Waste handling, treatment, and disposal; Rubber manufacturing; Application of paints and coatings; Manufacturing; Incorporation into formulation, mixture or reaction product. EPA also has established AWQC for DEHP, which protect the designated uses of waters. EPA's AWQC are not national regulatory limits but inform limits that States, and authorized Tribes set for point source discharges regulated under the National Pollutant Discharge Elimination System (NPDES) program. For noncarcinogenic toxicological effects for consumption of water and organisms it is 50 µg/L while for consumptions of organisms only it is 60 µg/L (U.S. EPA, 2015). The human health AWQC for carcinogenic effects of DEHP is 0.32 µg/L for consumption of water and organisms and 0.37 µg/L for consumption of organisms only. EPA recommends the lower AWQC of 0.32 µg/L for consumption of water and organisms and 0.37 µg/L for consumption of organisms only for DEHP. Although the ELGs and AWQC may not represent releases associated with all OES, they provide helpful context to EPA's modeled results.

For the screening level assessment, EPA utilized releases associated with the Plastic compounding OES and the Use of automotive care products OES, as these resulted in the highest modeled surface water concentrations. EPA determined the surface water concentration associated with these OESs represented conservative high-end exposure scenarios and were appropriate to use in its screening level assessment to assess all other OESs and their associated COUs.

EPA utilized annual release information to estimate surface water concentrations for use in general population and environmental exposure assessment. As mentioned in Section 3.2, EPA estimated a range for annual and daily releases for each OES when possible. The Agency was not able to estimate site-specific releases for the final use of products or articles OES. Disposal sites handling post-consumer end-use DEHP were not quantifiable due to the wide and dispersed use of DEHP in PVC and other products. Pre-consumer waste handling, treatment, and disposal are assumed to be captured in upstream OES. Many OES had releases estimated using programmatic data. EPA compiled programmatic release information using reported releases from TRI, DMR, and NEI, which were determined to have a high data quality rating through EPA's systematic review process and a weight of scientific evidence conclusion of moderate to robust across releases for the various OESs as shown in Table 3-6. One limitation noted was that it is uncertain the extent to which sites not captured in these databases release DEHP into the environment. Additionally, not all OESs are represented in these databases.

Table 3-8 below identifies the data available for use in modeling surface water concentrations for each OES and EPA's confidence in the estimated surface water concentrations used for exposure assessment. For the screening level assessment, EPA identified the Use of automotive care products OES as the OES that resulted in the highest surface water concentrations. As Table 3-5 shows, releases for Use of automotive care products were modeled based on a generic scenario and were reported as releasing to "POTW or landfill," which is not water specific. EPA identified the Plastic compounding OES as resulting in the highest surface water concentration for releases reported to TRI. EPA prioritized use of programmatic data with actual release data from reporting facilities, where overall confidence in the estimates would be higher. For estimating concentrations from releases, EPA also prioritized the use of TRI annual release reports over DMR monitoring data, reviewing DMR period data as supporting information for the releases reported to TRI. Releases from facilities reporting via TRI Form A, which represents undefined releases to unspecified media types, less than 500 lb per year, were not directly modeled. For the purpose of the tiered approach taken for the general population analysis, environmental concentrations from potential releases to surface water from facilities reporting via TRI Form A were expected to be lower than the high-end concentrations applied for screening.

For facilities reporting releases to TRI, relevant flow data from the associated receiving waterbody were collected by querying multiple EPA databases and permit IDs under the NPDES. The flow data include self-reported hydrologic reach codes on NPDES permits and the best available flow estimates from EPA and USGS databases. 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.

For OESs that did not have reported release data, releases were estimated using GSs/ESDs. For releases that use GSs/ESDs, EPA concluded the weight of scientific evidence conclusion was slight to moderate (Table 3-5). Three OESs (Use of laboratory chemicals, Use of automotive care products, and Use in hydraulic fracturing) had modeled releases from generic scenarios for the following types of discharge: surface water; water, incineration, or landfill; and POTW or landfill. For the releases categorized as releasing to multiple media types, EPA could not differentiate the proportion of DEHP released only to surface water. For these generic scenario OESs, EPA lacked reasonably available data to quantify what portion of a release may be discharged specifically to surface water. Therefore, EPA performed a conservative analysis in which the total estimated multimedia release amount was assumed to be discharged to surface water starting with an assumption of no removal from wastewater treatment but adjusting if necessary. Due to the low confidence and high uncertainty inherent in assuming what portion of a release may be discharged to surface water, EPA has slight confidence in risks identified through this method, but greater confidence in a finding that these conservative estimates did not show risk in excess of a benchmark and the Agency is confident that the screening analysis overestimates risk.

Based on the weight of scientific evidence conclusions regarding confidence in the release estimates from facilities and the associated receiving waterbody and hydrologic flow information described in the preceding paragraphs, EPA proceeded with the use of TRI data for modeling surface water concentrations with greater confidence. In considering the various OESs for use in a screening assessment, EPA identified Use of automotive care product as appropriate for use as it resulted in a high-end surface water concentration. However, EPA also utilized the Plastic compounding OES as it resulted in the highest surface water concentration based on reporting data for actual facilities. Additionally, release concentrations were estimated at the point of release in the receiving waterbody, as a conservative assumption to evaluate the upper end of potential exposure concentrations for a given release. Overall, EPA has robust confidence that the highest estimated surface water concentration modeled using the Use of automotive care products and Plastic compounding OES are both appropriate to use in its screening level assessment of the general population surface water exposure pathway, as the releases from all other OESs and their associated COUs (including OESs and COUs with releases that could not be quantified and those with releases modeled from generic scenarios) are expected to result in lower environmental concentrations in surface water. General population and environmental risk from surface water can be found in Sections 4.3.4 and 5.3.2, respectively.

Table 3-8. Summary of Weight of Scientific Evidence Associated with Each OES

OES [a]	Water Release Data Type(s)	Weight of Scientific Evidence
Manufacture	TRI	EPA conducted modeling using the PSC tool to estimate surface water and sediment concentrations of DEHP. PSC inputs include physical and chemical properties of DEHP which received a high confidence rating and a reported DEHP release from TRI which received a moderate to robust rating. Based on this information, EPA concluded that the weight of scientific evidence for this assessment is moderate to robust.
Rubber manufacturing	TRI	EPA conducted modeling using the PSC tool to estimate surface water and sediment concentrations of DEHP. PSC inputs include physical and chemical properties of DEHP which received a high confidence rating and a reported DEHP release from TRI which received a moderate to robust rating. Based on this information, EPA concluded that the weight of scientific evidence for this assessment is moderate to robust.
Plastic converting	TRI	EPA conducted modeling using the PSC tool to estimate surface water and sediment concentrations of DEHP. PSC inputs include physical and chemical properties of DEHP which received a high confidence rating and a reported DEHP release from TRI which received a moderate to robust rating. Based on this information, EPA concluded that the weight of scientific evidence for this assessment is moderate to robust.
Plastic compounding [b]	TRI	EPA conducted modeling using the PSC tool to estimate surface water and sediment concentrations of DEHP. PSC inputs include physical and chemical properties of DEHP which received a high confidence rating and reported DEHP releases from TRI which received a moderate to robust rating. Based on this information, EPA concluded that the weight of scientific evidence for this assessment is moderate to robust. This OES resulted in the highest surface water concentration based on TRI releases used for screening purposes.

OES [a]	Water Release Data Type(s)	Weight of Scientific Evidence
Incorporation into formulation, mixture, or reaction product	TRI	All reported releases to TRI within this OES were via Form A. Due to EPA's high confidence that such releases to surface water, if present, would not exceed the highest releases applied for screening, no quantitative estimate of surface water release concentrations was calculated for this OES.
Import and repackaging	TRI	All reported releases to TRI within this OES were via Form A. Due to EPA's high confidence that such releases to surface water, if present, would not exceed the highest releases applied for screening, no quantitative estimate of surface water release concentrations was calculated for this OES.
Application of paints, coatings, adhesives, and sealants	DMR	No reported releases to TRI, and review of DMR period data demonstrated lower release concentrations than highest releases applied for screening. Due to limited annual data and low reported concentrations in effluent, no quantitative estimate of surface water release concentrations was calculated for this OES.
Textile finishing	TRI/DMR	One TRI facility reported no surface water discharge, and review of DMR period data demonstrated lower release concentrations than highest releases applied for screening. Due to limited annual data and low reported concentrations in effluent, no quantitative estimate of surface water release concentrations was calculated for this OES.
Use of dyes and pigments, and fixing agents	DMR	No reported releases to TRI, and review of DMR period data demonstrated lower release concentrations than highest releases applied for screening. Due to limited annual data and low reported concentrations in effluent, no quantitative estimate of surface water release concentrations was calculated for this OES.
Application of paints, coatings, adhesives, and sealants (formulations for diffusion bonding)	DMR	No reported releases to TRI, and review of DMR period data demonstrated lower release concentrations than highest releases applied for screening. Due to limited annual data and low reported concentrations in effluent, no quantitative estimate of surface water release concentrations was calculated for this OES.
Use of laboratory chemicals	Generic Scenario (multimedia)	No facilities reported releases for this OES, so EPA modeled releases using generic scenarios. Because EPA was unable to model releases to just surface water, EPA performed a conservative analysis in which the total estimated multimedia release amount was assumed to be discharged to surface water. For this scenario, the modeled release concentrations were less than the highest releases applied for screening.
Use of automotive care products [c]	Generic Scenario (multimedia)	No facilities reported releases for this OES, so EPA modeled releases using generic scenarios. Because EPA was unable to model releases to just surface water, EPA performed a conservative analysis in which the total estimated multimedia release amount was assumed to be discharged to surface water. For this scenario, EPA included the resulting concentrations in the high-end screening analysis, with slight confidence in any subsequent risk identified, but robust confidence in the value being representative of an upper bound of potential exposure from these releases.
Use in hydraulic fracturing	Generic Scenario	No facilities reported releases for this OES, so EPA modeled releases using generic scenarios. Sufficient release data were

OES [a]	Water Release Data Type(s)	Weight of Scientific Evidence
	(water-specific)	available to model a surface water-specific release, and the resulting range of estimated concentrations were below the highest releases applied for screening.
Recycling	TRI	Within this OES, only one facility reported to TRI, claiming no releases to surface water. No quantitative estimate of surface water release concentrations was calculated for this OES.
Waste handling, treatment, and disposal	DMR	No reported releases to TRI, and review of DMR period data demonstrated lower release concentrations than highest releases applied for screening. Due to limited annual data and low reported concentrations in effluent, no quantitative estimate of surface water release concentrations was calculated for this OES.

DMR = Discharge Monitoring Report; OES = occupational exposure scenario; PSC = point source calculator (tool); TRI = Toxics Release Inventory
[a] Table 3-1 provides a crosswalk of industrial and commercial COUs to OES.
[b] Plastic compounding OES chosen as OES most appropriate for screening level assessment based on high surface water concentrations resulting from facility release
[c] Use of Automotive care products OES was chosen as OES most appropriate for screening level assessment for exposure scenarios.

3.3.1.2 Ambient Air

EPA used the Integrated Indoor-/Outdoor Air Calculator (IIOAC) Model, previously peer-reviewed methodology for fenceline communities (U.S. EPA, 2022d) and integrated recommendations from that and other peer reviews to evaluate exposures and deposition rates via the ambient air pathway for this assessment. The IIOAC Model was developed based on a series of pre-run scenarios within AERMOD (the Agency's regulatory model) which gives EPA greater confidence in the IIOAC results. However, since results from IIOAC are based on the pre-run AERMOD scenarios, IIOAC modeling is limited to the parameters s (*e.g.*, stack parameters, meteorological data, and other factors) used as inputs to those pre-run AERMOD scenarios, thus limiting the flexibility of the IIOAC results for highly site-specific, or date specific modeling needs (*e.g.*, if refined analyses are needed). The screening level analyses presented in this assessment, IIOAC provides reliable and reproduceable results which can be used to characterize upper-bound exposures and derive screening level risk estimates, giving EPA moderate confidence in the results and findings.

The Agency considered three different datasets for DEHP releases for this assessment. Those datasets include EPA estimated releases based on production volumes of DEHP from facilities that manufacture, process, repackage, or dispose of DEHP (U.S. EPA, 2025u), releases reported to TRI by industry (2017–2022 reporting years), and releases reported to NEI (U.S. EPA, 2025u) (2017 and 2020 reporting years). This gives the Agency moderate confidence that release data utilized is representative and high-end releases are not missed. EPA uses the maximum daily releases of DEHP across all OES/COUs as direct inputs to the IIOAC Model, giving EPA high confidence that the releases used are health protective for a screening level analysis. However, the use of estimated or reported annual release data and number of operating days to calculate daily average releases assumes operations are continuous and releases are the same for each day of operation. This can underestimate short-term or daily exposure and deposition rates because results may miss actual peak releases (and associated exposures) if higher and lower releases occur on different days. The uncertainties associated with the release data are detailed in the *Environmental Release and Occupational Exposure Assessment for DEHP* (U.S. EPA, 2025u).

The maximum daily fugitive and stack release values used for this ambient air assessment are from NEI reported datasets (fugitive from 2020 and stack from 2017). Additionally, these releases were reported by two different facilities in two different locations. Therefore, these two releases do not align either spatially or temporally. For this screening level ambient air assessment EPA modeled these two releases assuming they occurred from the same location, at the same time, during the same reporting year, and under the same OES to determine a "total exposure" to DEHP from both release types. These assumptions provide a conservative estimate of "total exposure," ensures possible exposure from either release type are not missed and retains health protective estimates of exposure and associated risk estimates. The lack of spatial or temporal alignment gives the Agency low confidence in the exposure scenario modeled (cannot occur at same time under assumptions modeled) and overestimates ambient concentrations and deposition rates at the evaluated distances. Due to the conservative assumptions made along with the use of the highest release estimates, EPA has robust confidence the modeled ambient air concentrations and deposition rates are highly conservative estimates appropriate for a screening level analysis for all OES and associated COUs. Based on the risk findings described in Section 4.1.3.1, even with the conservative assumptions and exposure scenario modeled, results indicate the total exposure or deposition rate under this scenario still does not indicate an exposure or risk concern. Therefore, EPA has robust confidence that exposure to and deposition rates of DEHP via the ambient air pathway do not pose an exposure or risk concern, and no further refined analysis is pursued. If new information becomes available and after the Agency's consideration of such information and results, under the same scenario and assumptions, indicate an exposure or risk concern, then EPA would have low confidence in the results and refine the analysis to be more representative of a real exposure scenario (*e.g.,* only determine exposures and derive risk estimates based on a single facility reporting both release types).

4 HUMAN HEALTH RISK ASSESSMENT

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

EPA evaluated all reasonably available information to support the human health risk characterization of DEHP for workers, ONUs, consumers, bystanders, and the general population, exposures to these groups 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. The following bullets summarize the key points.

Exposure Key Points

- EPA assessed inhalation and dermal exposures for workers and ONUs, as appropriate, for each OES (Section 4.1.1). Both dermal and inhalation were primary routes of exposure, depending on the OES.
- EPA assessed inhalation, dermal, and oral exposures for consumers and bystanders, as appropriate, for each COU (Section 4.1.2) in scenarios that represent a range of use patterns and behaviors. The primary routes of exposure were ingestion and inhalation for most products, followed by dermal.
- EPA assessed inhalation, oral, and dermal exposures for the general population via ambient air, surface water, drinking water, and fish ingestion for Tribal populations (Sections 4.1.3).
- 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 as the most sensitive and robust non-cancer hazard associated with oral exposure to DEHP in experimental animal models (Section 4.2).
- A non-cancer point of departure (POD) of 1.1 mg/kg-day was selected to characterize non-cancer risks for acute, intermediate, and chronic durations of exposure. A total uncertainty factor (UF) of 30 was selected for use as the benchmark margin of exposure (MOE).
- Under the *Guidelines for Carcinogen Risk Assessment* (U.S. EPA, 2005), EPA has determined that DEHP is *Not Likely to be Carcinogenic to Humans.* Consistent with the guidelines, the Agency did not quantitatively evaluate DEHP for cancer risk.
- EPA derived relative potency factors (RPFs) based on a common hazard endpoint (*i.e.*, reduced fetal testicular testosterone). RPFs were derived via meta-analysis and benchmark dose (BMD) modeling (Section 4.4.1).

Risk Assessment Key Points

- Inhalation exposures drive acute non-cancer risks to workers in occupational settings (Section 4.3.2).
- Ingestion and inhalation exposures drive acute non-cancer risks to consumers (Section 4.3.3).
- No potential non-cancer risk was identified for the general population for the land, surface water, fish ingestion, and ambient air pathways (Section 4.3.4).
- EPA considered PESS throughout the exposure assessment, hazard identification, and dose-response analysis supporting this risk evaluation (Section 4.3.5).
- EPA considered cumulative risk to workers and consumers through exposure to DEHP 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).

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, 2020c), EPA evaluated exposures to workers and ONUs via the inhalation route, including incidental ingestion of inhaled dust, and exposures to workers via the dermal route associated with the manufacturing, processing, use, and disposal of DEHP. Also, EPA assessed dermal exposure to workers and ONUs in scenarios where there is potential exposure to mist and dust on deposited surfaces. Determinants of exposure such as, but not limited to, worker activities, physical form, conditions of an application, and type of operation may be considered when determining whether the potential for ONU exposure exists. The *Environmental Release and Occupational Exposure Assessment for DEHP* (U.S. EPA, 2025u) 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 (U.S. EPA, 2020c), 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 DEHP and have direct contact with the DEHP, while ONUs work in the general vicinity of DEHP but do not handle DEHP. Where possible, for each condition of use, 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 more specifically within each COU, and Table 3-1 provides a crosswalk between COUs and OESs. EPA identified relevant inhalation exposure monitoring data for some of the OESs. EPA evaluated the quality of this monitoring data using the data quality review evaluation metrics and the rating criteria described in the 2021 Draft Systematic Review Protocol (U.S. EPA, 2021a). EPA assigned an overall quality level of high, medium, or low to the relevant data. In addition, the Agency established an overall confidence level for the data when integrated into the occupational exposure assessment. EPA considered the assessment approach, the quality of the data and models, as well as uncertainties in assessment results to assign an overall confidence level of robust, moderate, or slight.

Where monitoring data were reasonably available, the Agency used these data to characterize central tendency and high-end inhalation exposures (see also Table 4-1). EPA may also use monitoring data from a similar condition of use as a surrogate. Where no inhalation monitoring data were available, but inhalation exposure models were reasonably available, the Agency estimated central tendency and high-end exposures using only modeling approaches. If both inhalation monitoring data and exposure models were reasonably available, EPA presented central tendency and high-end exposures using both. For inhalation exposure to dust in occupational settings, EPA used the Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR) (also called the "PNOR Model") (U.S. EPA, 2021d). In all cases of occupational dermal exposure to DEHP, EPA used flux-limited dermal absorption to estimate both high-end and central tendency dermal exposures for workers in each OES, as described in the *Environmental Release and Occupational Exposure Assessment for DEHP* (U.S. EPA, 2025u).

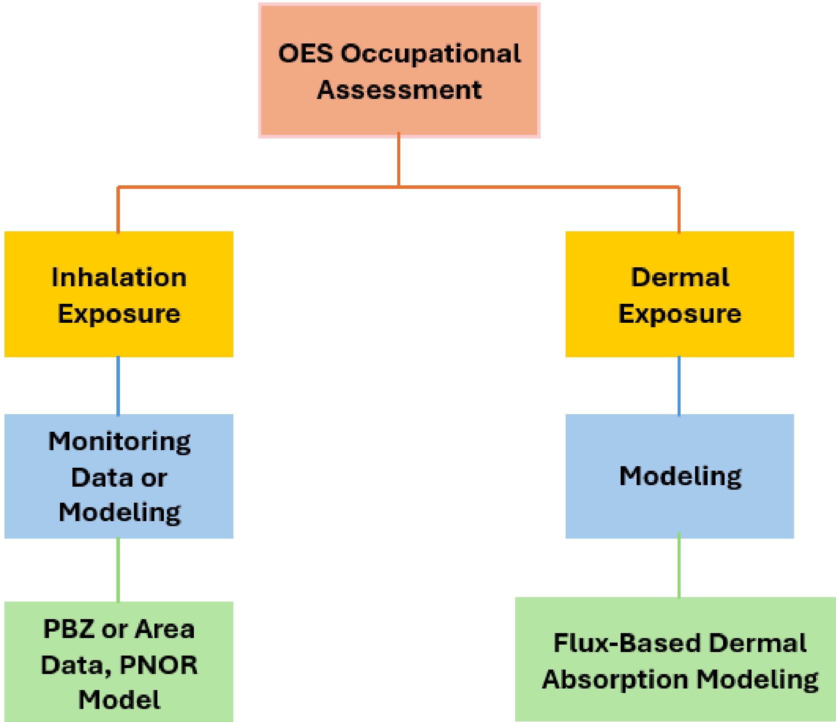

Figure 4-1. Approaches Used for Each Component of the Occupational Assessment for Each OES
PBZ = personal breathing zone; PNOR = particulates not otherwise regulated

For inhalation and dermal exposure routes, EPA provided occupational exposure results representative of 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 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 depending on the available data. EPA preferred to provide the 50th percentile of the distribution. However, if the full distribution was unknown, the Agency 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, 1992a). For risk evaluation, EPA provided 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 statistics available for the distribution. If the full distribution is not known and the preferred statistics are not reasonably available, EPA estimated a maximum or bounding estimate in lieu of the high-end. Table 4-1 provides a summary of whether monitoring data were reasonably available for each OES, and if data were available, the number of data points and quality of that data. Table 4-1 also provides EPA's overall confidence rating and whether EPA used modeling to estimate inhalation and dermal exposures for workers.

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

OES	Inhalation Exposure												Dermal Exposure [c]		
	DEHP Monitoring					Surrogate Monitoring					Modeling		Empirical		Modeling
	Worker	# Data Points	ONU[a]	# Data Points	Data Quality Rating[b]	Worker	# Data Points	ONU[a]	# Data Points	Data Quality Rating[b]	Worker	ONU[a]	Worker	Data Quality Rating[b]	Worker
Manufacturing	✓	45	×	N/A	M/H	×	N/A	×	N/A	H	×	×	×	N/A	✓
Rubber manufacturing	✓	7	×	N/A	H	×	N/A	×	N/A	N/A	×	×	×	N/A	✓
Plastic compounding	✓	6	✓	1	H	×	N/A	×	N/A	N/A	×	×	×	N/A	✓
Plastic converting	✓	13	×	N/A	H	×	N/A	×	N/A	N/A	×	×	×	N/A	✓
Incorporation into formulation, mixture, or reaction product	×	N/A	×	N/A	N/A	✓	45	×	N/A	N/A	×	×	×	N/A	✓
Import and repackaging	✓	1	×	N/A	H	×	N/A	×	N/A	M	×	×	×	N/A	✓
Application of paints, coatings, adhesives, and sealants	✓	1	×	N/A	H	×	N/A	×	N/A	N/A	✓	×	×	N/A	✓
Textile finishing	×	N/A	×	N/A	N/A	×	N/A	×	N/A	N/A	✓	×	×	N/A	✓
Fabrication or use of final product or articles	✓	7	✓	1	H	×	N/A	×	N/A	N/A	×	×	×	N/A	✓
Use of dyes, pigments, and fixing agents	×	N/A	×	N/A	N/A	✓	1	×	N/A	H	×	×	×	N/A	✓
Formulations for diffusion bonding	×	N/A	×	N/A	N/A	×	N/A	×	N/A	N/A	✓	×	×	N/A	✓
Use of laboratory chemicals	✓	1	×	N/A	M/H	×	N/A	×	N/A	N/A	×	×	×	N/A	✓
Use of automotive care products	✓	1	✓	1	H	×	N/A	×	N/A	N/A	×	×	×	N/A	✓
Use in hydraulic fracturing	×	N/A	×	N/A	N/A	✓	45	×	N/A	M/H		×	×	N/A	✓
Recycling	×	N/A	×	N/A	N/A	✓	13	×	N/A	H	×	×	×	N/A	✓
Waste handling, treatment, and disposal	×	N/A	×	N/A	N/A	×	N/A	×	N/A	N/A	✓	×	×	N/A	✓

[a] Where EPA was not able to estimate occupational non-user (ONU) inhalation exposure from monitoring data or models (indicated by an "x"), this was assumed equivalent to the central tendency experienced by workers for the corresponding OES.
[b] Data quality ratings for reported data are based on EPA systematic review and include ratings Low (L), Medium (M), and High (H). Data quality evaluation criteria are described in the Draft Systematic Review Protocol (U.S. EPA, 2021a) and include evaluation of the representativeness or applicability of the data to the OES.

OES	Inhalation Exposure												Dermal Exposure [c]		
	DEHP Monitoring					Surrogate Monitoring					Modeling		Empirical		Modeling
	Worker	# Data Points	ONU[a]	# Data Points	Data Quality Rating[b]	Worker	# Data Points	ONU[a]	# Data Points	Data Quality Rating[b]	Worker	ONU[a]	Worker	Data Quality Rating[b]	Worker

[c] Dermal modeling incorporated experimental dermal loading data for liquid DEHP from (U.S. EPA, 1992b) and solid DEHP from (Lansink et al., 1996). These data were determined to have a data quality rating of medium.
× No data available
✓ Data available

4.1.1.2 Number of 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 lower 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. For some OESs, the estimated number of facilities is based on the number of reporting sites to the 2020 CDR (U.S. EPA, 2020b), NEI (U.S. EPA, 2023a), DMR (U.S. EPA, 2024a), and TRI databases (U.S. EPA, 2024c).

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

Occupational Exposure Scenario (OES)[a]	Total Exposed Workers	Total Exposed ONUs[b]	Number of Facilities	Notes
Manufacturing	99	45	3	Number of workers and ONU estimates based on the 2021 BLS and 2015 U.S. Census Bureau data (U.S. BLS, 2023; U.S. Census Bureau, 2015). Number of facilities estimate based on identified sites from NEI, DMR, TRI, and CDR.
Import and repackaging	517	235	47	Number of workers and ONU estimates based on the 2021 BLS and 2015 U.S. Census Bureau data (U.S. BLS, 2023; U.S. Census Bureau, 2015). Number of facilities estimate based on identified sites from NEI, DMR, TRI, and CDR.
Incorporation into Formulation, Mixture, or Reaction Product	3,048	1,270	127	Number of workers and ONU estimates based on the 2021 BLS and 2015 U.S. Census Bureau data (U.S. BLS, 2023; U.S. Census Bureau, 2015). Number of facilities estimate based on identified sites from NEI, DMR, and TRI.
Use in Hydraulic Fracturing	396	88	44	Number of workers and ONU estimates based on the 2021 BLS and 2015 U.S. Census Bureau data (U.S. BLS, 2023; U.S. Census Bureau, 2015). Number of facilities estimate based on FracFocus (FracFocus, 2022).
Application of Paints, Coatings, Adhesives, and Sealants	5,600	1,820	140	Number of workers and ONU estimates based on the 2021 BLS and 2015 U.S. Census Bureau data (U.S. BLS, 2023; U.S. Census Bureau, 2015). Number of facilities estimate based on identified sites from NEI, DMR, and TRI.
Use of Laboratory Chemicals - Liquid	1,996 (central tendency); 36,873 (high-end)	19,960 (central tendency); 368,730 (high-end)	1,996 (central tendency); 36,873 (high-end)	Number of workers and ONU estimates based on the 2021 BLS and 2015 U.S. Census Bureau data (U.S. BLS, 2023; U.S. Census Bureau, 2015). Number of facilities

Occupational Exposure Scenario (OES)[a]	Total Exposed Workers	Total Exposed ONUs[b]	Number of Facilities	Notes
				estimate based on results from Monte Carlo modeling.
Use of Laboratory Chemicals - Solid	36,873	368,730	36,873	Number of workers and ONU estimates based on the 2021 BLS and 2015 U.S. Census Bureau data (U.S. BLS, 2023; U.S. Census Bureau, 2015). Number of facilities estimate based on results from Monte Carlo modeling.
Plastics Compounding	2,170	1,178	62	Number of workers and ONU estimates based on the 2021 BLS and 2015 U.S. Census Bureau data (U.S. BLS, 2023; U.S. Census Bureau, 2015). Number of facilities estimate based on identified sites from NEI, DMR, and TRI.
Plastics Converting	2,414	1,491	71	Number of workers and ONU estimates based on the 2021 BLS and 2015 U.S. Census Bureau data (U.S. BLS, 2023; U.S. Census Bureau, 2015). Number of facilities estimate based on identified sites from NEI, DMR, and TRI.
Recycling	6	4	1	Number of workers and ONU estimates based on the 2021 BLS and 2015 U.S. Census Bureau data (U.S. BLS, 2023; U.S. Census Bureau, 2015). Number of facilities estimate based on identified sites from TRI.
Rubber Manufacturing	2,805	765	85	Number of workers and ONU estimates based on the 2021 BLS and 2015 U.S. Census Bureau data (U.S. BLS, 2023; U.S. Census Bureau, 2015). Number of facilities estimate based on identified sites from NEI, DMR, and TRI.
Formulations for Diffusion Bonding	406	308	14	Number of workers and ONU estimates based on the 2021 BLS and 2015 U.S. Census Bureau data (U.S. BLS, 2023; U.S. Census Bureau, 2015). Number of facilities estimate based on identified sites from NEI and DMR.
Use of Dyes and Pigments, and Fixing Agents	10	5	5	Number of workers and ONU estimates based on the 2021 BLS and 2015 U.S. Census Bureau data (U.S. BLS, 2023; U.S. Census Bureau, 2015). Number of facilities estimate based on identified sites from DMR.
Textile Finishing	77	33	11	Number of workers and ONU estimates based on the 2021 BLS

Occupational Exposure Scenario (OES)[a]	Total Exposed Workers	Total Exposed ONUs[b]	Number of Facilities	Notes
				and 2015 U.S. Census Bureau data (U.S. BLS, 2023; U.S. Census Bureau, 2015). Number of facilities estimate based on identified sites from NEI, DMR, and TRI.
Fabrication of Final Product from Articles	224	80	16	Number of workers and ONU estimates based on the 2021 BLS and 2015 U.S. Census Bureau data (U.S. BLS, 2023; U.S. Census Bureau, 2015). Number of facilities estimate based on identified sites from NEI, DMR, and TRI.
Use of Automotive Care Products	75,510 (central tendency); 441,456 (high-end)	0	25,170 (central tendency); 147,152 (high-end)	Number of workers and ONU estimates based on the 2021 BLS and 2015 U.S. Census Bureau data (U.S. BLS, 2023; U.S. Census Bureau, 2015). Number of facilities estimate based on results from Monte Carlo modeling.
Disposal	2,862	1,908	477	Number of workers and ONU estimates based on the 2021 BLS and 2015 U.S. Census Bureau data (U.S. BLS, 2023; U.S. Census Bureau, 2015). Number of facilities estimate based on identified sites from NEI, DMR, and TRI.

[a] An OES is based on a set of facts, assumptions, and inferences that describe how releases and exposures take place within an occupational COU. The occurrence of releases/exposures may be similar across multiple COUs (multiple COUs mapped to single OES), or there may be several ways in which releases/exposures take place for a given COU (single COU mapped to multiple OESs).
[b] ONUs do not directly handle DEHP, but may be exposed to dust, vapors. or mists that enter their personal breathing zone while working in locations near where DEHP is handled by workers.

4.1.1.3 Summary of Inhalation Exposure Assessment

Table 4-3 presents a summary of inhalation exposure results based on monitoring data and exposure modeling for each OES. This tables provides a summary of the 8-hour time weighted average air concentration (TWA) used to estimate inhalation exposure, as well as the calculated acute dose (AD), the intermediate average daily dose (IADD), and the chronic average daily dose (ADD). The *Environmental Release and Occupational Exposure Assessment for DEHP* (U.S. EPA, 2025u) provides exposure results for females of reproductive age and ONUs. The *Environmental Release and Occupational Exposure Assessment for DEHP* (U.S. EPA, 2025u) also provides additional details regarding AD, IADD, and ADD calculations along with EPA's approach and methodology for estimating inhalation exposures. EPA applied the following hierarchy in selecting data and approaches for assessing occupational exposures:

1. Monitoring data:
    a. Personal and directly applicable to the OES
    b. Area and directly applicable to the OES
    c. Personal and potentially applicable or similar to the OES
    d. Area and potentially applicable or similar to the OES

2. Modeling approaches:
    a. Surrogate monitoring data
    b. Fundamental modeling approaches
    c. Statistical regression modeling approaches
3. Occupational exposure limits:
    a. Company-specific occupational exposure limits (OELs) (for site-specific exposure assessments, *e.g.*, there is only one manufacturer who provides their internal OEL to EPA, but the manufacturer does not provide monitoring data)
    b. Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PEL)
    c. Voluntary limits (*i.e.*, American Conference of Governmental Industrial Hygienists [ACGIH] Threshold Limit Values [TLV], National Institute for Occupational Safety and Health [NIOSH] Recommended Exposure Limits [REL], Occupational Alliance for Risk Science (OARS) workplace environmental exposure level (WEEL) [formerly by AIHA])

Due to the lack of reasonably available exposure data for some OESs, surrogate assessment approaches were used for the following:

- Incorporation into formulation, mixture, or reaction product (Manufacturing as surrogate: OES is expected to have comparable exposure potential based on the similarity of worker activities (*e.g.*, unloading transport containers, packaging final products, cleaning transport containers, product sampling, cleaning reaction vessels or other equipment, and during filter media change out) and physical form).
- Non-spray application of paints, coatings, adhesives, and sealants (rubber product manufacturing as surrogate: OES is expected to have comparable exposure potential based on the similarity of worker activities (*e.g.*, product unloading into application equipment, container and application equipment cleaning, and curing or drying or applied product) and physical form.
- Use of dyes, pigments, and fixing agents (Rubber product manufacturing as surrogate: OES is expected to have comparable exposure potential based on the similarity of worker activities (*e.g.*, during unloading of liquid dyes, container cleaning, and machine operation) and physical form.
- Hydraulic fracturing (Manufacturing as surrogate: OES is expected to have comparable exposure potential based on the similarity of worker activities (*e.g.*, during unloading transport containers, transport container cleaning, and during equipment/storage tank cleaning) and physical form.
- Recycling (Plastic converting as surrogate: OES is expected to have comparable exposure potential based on the similarity of worker activities (*e.g.*, unloading of baled plastics or rubber, loading of processed DEHP-containing plastics or rubber onto compounding or converting lines or into transport containers, processing of recycled plastics or rubber, and equipment cleaning).

Where available, EPA used inhalation monitoring data from the OSHA Chemical Exposure Health Data (CEHD) database. The chemical exposure information in the CEHD represents samples for airborne contaminants as collected by industrial hygienists as part of a compliance monitoring program. When the compliance officers collect these data, it is key to emphasize that they do not:

- routinely visit every business that uses chemicals known to be toxic;
- take representative samples of every employee and every activity on every day; and
- always obtain a sample for an entire 8-hour period or shift.

Additionally, it should be noted that historically slightly more than half of all inspections are unprogrammed (complaints, injuries/fatalities, and referrals). The remainder are programmed inspections as part of national, regional, or local emphasis programs monitoring for known hazards (*e.g.*, chemical processing, respirable silica, combustible dusts, ship-breaking, heat, falls in construction). The prevalence of bias in exposure monitoring across the dataset due to unprogrammed inspections is uncertain.

Table 4-3. Summary of Worker Inhalation Exposure Results for Each OES[a]

OES	Population	8-Hour TWA Exposures – Total Exposure (mg/m³)		8-Hour TWA Exposures – Particulate Exposure Only (mg/m³)		AD (mg/kg/day)		IADD (mg/kg/day)		ADD (mg/kg/day)	
		CT	HE	CT	HE	CT	HE	CT	HE	CT	HE
Manufacturing	Average Worker	1.20E−02	2.20E−02	–	–	1.50E−03	2.75E−03	1.10E−03	2.02E−03	1.03E−03	1.88E−03
	Females of Reproductive Age	1.20E−02	2.20E−02	–	–	1.66E−03	3.04E−03	1.22E−03	2.23E−03	1.13E−03	2.08E−03
	ONU[g]	1.20E−02	1.20E−02	–	–	1.50E−03	1.50E−03	1.10E−03	1.10E−03	1.03E−03	1.03E−03
Import and repackaging	Average Worker	1.40E−01	5.20E−01	–	–	1.75E−02	6.50E−02	1.28E−02	4.77E−02	1.20E−02	4.45E−02
	Females of Reproductive Age	1.40E−01	5.20E−01	–	–	1.93E−02	7.18E−02	1.42E−02	5.27E−02	1.32E−02	4.92E−02
	ONU[g]	1.40E−01	1.40E−01	–	–	1.75E−02	1.75E−02	1.28E−02	1.28E−02	1.20E−02	1.20E−02
Incorporation into formulation, mixture, or reaction product[b]	Average Worker	1.20E−02	2.20E−02	–	–	1.50E−03	2.75E−03	1.10E−03	2.02E−03	1.03E−03	1.88E−03
	Females of Reproductive Age	1.20E−02	2.20E−02	–	–	1.66E−03	3.04E−03	1.22E−03	2.23E−03	1.13E−03	2.08E−03
	ONU[g]	1.20E−02	1.20E−02	–	–	1.50E−03	1.50E−03	1.10E−03	1.10E−03	1.03E−03	1.03E−03
Plastic compounding	Average Worker	0.085	0.085	–	–	1.1E-02	1.1E-02	7.8E-03	7.8E-03	7.3E-03	7.3E-03
	Females of Reproductive Age	0.085	0.085	–	–	1.2E-02	1.2E-02	8.6E-03	8.6E-03	8.0E-03	8.0E-03
	ONU[g]	0.085	0.085	–	–	1.1E-02	1.1E-02	7.8E-03	7.8E-03	7.3E-03	7.3E-03
Plastic converting	Average Worker	0.051	0.051	–	–	6.4E-03	6.4E-03	4.7E-03	4.7E-03	4.4E-03	4.4E-03
	Females of Reproductive Age	0.051	0.051	–	–	7.0E-03	7.0E-03	5.2E-03	5.2E-03	4.8E-03	4.8E-03
	ONU[g]	0.051	0.051	–	–	6.4E-03	6.4E-03	4.7E-03	4.7E-03	4.8E-03	4.8E-03
Rubber product manufacturing	Average Worker	1.67	8.13	–	–	2.09E−01	1.02	1.53E−01	7.45E−01	1.43E−01	6.96E−01
	Females of Reproductive Age	1.67	8.13	–	–	2.31E−01	1.12	1.69E−01	8.23E−01	1.58E−01	7.69E−01
	ONU[g]	1.67	1.67	–	–	2.09E−01	2.09E−01	1.53E−01	1.53E−01	1.43E−01	1.43E−01

OES	Population	8-Hour TWA Exposures – Total Exposure (mg/m³)		8-Hour TWA Exposures – Particulate Exposure Only (mg/m³)		AD (mg/kg/day)		IADD (mg/kg/day)		ADD (mg/kg/day)	
		CT	HE	CT	HE	CT	HE	CT	HE	CT	HE
Spray application of paints, coatings, adhesives, and sealants	Average Worker	3.0E−01	2.2E01	–	–	3.80E−02	2.76	2.78E−02	2.03	2.60E−02	1.89
	Females of Reproductive Age	3.0E−01	2.2E01	–	–	4.19E−02	3.05	3.08E−02	2.24	2.87E−02	2.09
	ONU [g]	3.0E−01	3.0E−01	–	–	3.80E−02	3.80E−02	2.78E−02	2.78E−02	2.60E−02	2.60E−02
Non-spray application of paints, coatings, adhesives, and sealants [c]	Average Worker	1.67	8.13	–	–	2.09E−01	1.02	1.53E−01	7.45E−01	1.43E−01	6.96E−01
	Females of Reproductive Age	1.67	8.13	–	–	2.31E−01	1.12	1.69E−01	8.23E−01	1.58E−01	7.69E−01
	ONU [g]	1.67	1.67	–	–	2.09E−01	2.09E−01	1.53E−01	1.53E−01	1.43E−01	1.43E−01
Use of dyes, pigments, and fixing agents [d]	Average Worker	1.67	8.13	–	–	2.09E−01	1.02	1.53E−01	7.45E−01	1.43E−01	6.96E−01
	Females of Reproductive Age	1.67	8.13	–	–	2.31E−01	1.12	1.69E−01	8.23E−01	1.58E−01	7.69E−01
	ONU [g]	1.67	1.67	–	–	2.09E−01	2.09E−01	1.53E−01	1.53E−01	1.43E−01	1.43E−01
Use of automotive care products	Average Worker	5.50E−02	1.10E−01	–	–	6.88E−03	1.38E−02	5.04E−03	1.01E−02	4.43E−03	9.42E−03
	Females of Reproductive Age	5.50E−02	1.10E−01	–	–	7.59E−03	1.52E−02	5.57E−03	1.11E−02	4.89E−03	1.04E−02
	ONU	5.00E−02	6.00E−02	–	–	6.25E−03	7.50E−03	4.58E−03	5.50E−03	4.02E−03	5.14E−03
Textile finishing	Average Worker	0	0	3.10E−06	4.30E−05	3.88E−07	5.38E−06	2.84E−07	3.94E−06	2.28E−07	3.17E−06
	Females of Reproductive Age	0	0	3.10E−06	4.30E−05	4.28E−07	5.94E−06	3.14E−07	4.35E−06	2.52E−07	3.50E−06
	ONU [g]	0	0	3.10E−06	3.10E−06	3.88E−07	3.88E−07	2.84E−07	2.84E−07	2.28E−07	2.28E−07
Formulation for diffusion bonding	Average Worker	0.34	7.96	–	–	4.25E−02	9.95E−01	3.12E−02	7.30E−01	2.91E−02	6.82E−01
	Females of Reproductive Age	0.34	7.96	–	–	4.69E−02	1.10	3.44E−02	8.06E−01	3.22E−02	7.53E−01
	ONU [g]	0.34	0.34	–	–	4.25E−02	4.25E−02	3.12E−02	3.12E−02	2.91E−02	2.91E−02
	Average Worker	1.20E−02	2.20E−02	–	–	1.50E−03	2.75E−03	5.00E−05	2.75E−04	4.11E−06	2.26E−05

OES	Population	8-Hour TWA Exposures – Total Exposure (mg/m³)		8-Hour TWA Exposures – Particulate Exposure Only (mg/m³)		AD (mg/kg/day)		IADD (mg/kg/day)		ADD (mg/kg/day)	
		CT	HE	CT	HE	CT	HE	CT	HE	CT	HE
Use in hydraulic fracturing [e]	Females of Reproductive Age	1.20E−02	2.20E−02	–	–	1.66E−03	3.04E−03	5.52E−05	3.04E−04	4.54E−06	2.50E−05
	ONU	1.20E−02	1.20E−02	–	–	1.50E−03	1.50E−03	5.00E−05	1.50E−04	4.11E−06	1.23E−05
Use of laboratory chemicals	Average Worker	1.00E−02	1.00E−01	–	–	1.25E−03	1.25E−02	9.17E−04	9.17E−03	8.05E−04	8.56E−03
	Females of Reproductive Age	1.00E−02	1.00E−01	–	–	1.38E−03	1.38E−02	1.01E−03	1.01E−02	8.89E−04	9.46E−03
	ONU	1.00E−02	1.00E−02	–	–	1.25E−03	1.25E−03	9.17E−04	9.17E−04	8.05E−04	8.56E−04
Recycling [f]	Average Worker	0.051	0.051	–	–	6.4E–03	6.4E–03	4.7E–03	4.7E–03	4.4E–03	4.4E–03
	Females of Reproductive Age	0.051	0.051	–	–	7.0E–03	7.0E–03	5.2E–03	5.2E–03	4.8E–03	4.8E–03
	ONU [g]	0.051	0.051	–	–	6.4E–03	6.4E–03	4.7E–03	4.7E–03	4.4E–03	4.4E–03
Fabrication or use of final products and articles	Average Worker	4.00E−02	1.10E−01	–	–	5.00E−03	1.38E−02	3.67E−03	1.01E−02	3.26E−03	8.97E−03
	Females of Reproductive Age	4.00E−02	1.10E−01	–	–	5.52E−03	1.52E−02	4.05E−03	1.11E−02	3.60E−03	9.90E−03
	ONU [g]	4.00E−02	4.00E−02	–	–	5.00E−03	5.00E−03	3.67E−03	3.67E−03	3.26E−03	3.26E−03
Waste handling, treatment, and disposal	Average Worker	0	0	1.06E−01	1.54	1.33E−02	1.93E−01	9.72E−03	1.41E−01	9.08E−03	1.32E−01
	Females of Reproductive Age	0	0	1.06E−01	1.54	1.46E−02	2.13E−01	1.07E−02	1.56E−01	1.00E−02	1.46E−01
	ONU [g]	0	0	1.06E−01	1.06E−01	1.33E−02	1.33E−02	9.72E−03	9.72E−03	9.08E−03	9.08E−03

Abbreviations: '–' = not assessed; ADD = average daily dose; CT = central tendency; HE = high-end; ONU = occupational non-user; TWA = time-weighted average
Note that female workers of reproductive age have lower body weight than adult workers expressed as an average of males and females; therefore, although the exposure concentration in the air is the same, the dose (in mg per kg body weight) is higher for female workers of reproductive age compared to average adult workers.
[a] The source of the exposure data (*e.g.*, monitoring vs. modeling), number of data points used for each exposure estimate, and data quality rating are depicted in Table 4-1.
[b] Incorporation into formulation, mixture, or reaction product OES used data from Manufacturing OES as a surrogate.
[c] Non-spray application of paints, coatings, adhesives, and sealants OES used data from Rubber product manufacturing as a surrogate.
[d] Use of dyes, pigments, and fixing agents OES used data from Rubber product manufacturing as a surrogate.
[e] Hydraulic Fracturing OES used data from Manufacturing OES as a surrogate.

OES	Population	8-Hour TWA Exposures – Total Exposure (mg/m³)		8-Hour TWA Exposures – Particulate Exposure Only (mg/m³)		AD (mg/kg/day)		IADD (mg/kg/day)		ADD (mg/kg/day)	
		CT	HE	CT	HE	CT	HE	CT	HE	CT	HE

[f] Recycling OES used data from Plastic Converting OES as a surrogate.
[g] Data were not available to estimate exposure of ONUs to DEHP; therefore, EPA used the central tendency of worker exposure for this OES as a surrogate for ONU exposure specific to this OES.

4.1.1.3.1 Number of Personal Breathing Zone (PBZ) Samples and Non-Detects (ND)

For the 17 OESs evaluated for inhalation exposure to DEHP, four different methods were used, depending on data availability. For six OESs, EPA identified discrete personal breathing zone (PBZ) inhalation monitoring samples for workers specific to the OES, as indicated in Table 4-4. PBZ inhalation monitoring data from a different OES with similar exposure scenarios were used as a surrogate for five OESs. For two OESs, EPA did not identify any references with discrete, full-shift samples through systematic review, and no OES with PBZ data were deemed to be appropriate surrogates. Therefore, EPA relied on references which only reported summary statistics (*e.g.*, minimum, maximum) for time-weighted average (TWA) PBZ and/or area full-shift samples. However, these inhalation monitoring data did provide industry-specific data relevant to each OES:

- For the Rubber product manufacturing OES, the European Union Risk Assessment Report for DEHP provided concentrations based on 25 data points (area samples) from a plant performing rubber calendaring (ECB, 2008). Data were comprised of 25 area samples total, and summary statistics (range, mean, and SD) were provided for these 25 samples; however, sampling duration only provided for six values described as the highest values. EPA calculated the 8-hour TWA based on these values for which sampling duration was provided. EPA assessed high-end worker inhalation exposures using the TWA for the highest value for which sampling duration was provided and central tendency using the lowest value for which sampling duration was provided.
- For the Use of automotive care products OES, the European Union Risk Assessment Report on DEHP provided a minimum (below limit of detection) concentration and maximum concentration based on their collected full-shift samples during the application of car sealants and under-coatings (ECB, 2008). EPA assessed the high-end worker inhalation exposure using the maximum concentration and central tendency worker inhalation exposure using the midpoint between zero and the maximum concentration.

Finally, for four OESs (Spray application of adhesives, sealants, paints, and coatings; Formulations for diffusion bonding; Textile finishing; and Waste handling), PBZ inhalation monitoring data were not available and no OES with PBZ data were deemed to be appropriate surrogates. Additionally, EPA did not identify any references with discrete, full-shift samples through systematic review. For these OESs, EPA estimated inhalation exposures through empirically informed models but did not include information on these OES in Table 4-4.

Table 4-4. Summary of Inhalation Monitoring Data Used by EPA in Determining Inhalation Exposure Estimates (including Sample Number, Type, and Non-Detects)

OES	Sample Type	Sample Types		Worker Inhalation Exposure Estimates from Monitoring Data (8-hour TWA; mg/m^{3} [a])	
		Total # Samples	#ND	CT	HE
Manufacturing of DEHP	Worker PBZ	45[b]	37[c]	1.20E–02	2.2E–02
Use in hydraulic fracturing	Manufacturing used as surrogate	N/A	N/A		
Incorporation into formulation, mixture, or reaction product	Manufacturing used as surrogate	N/A	N/A		
Plastic converting	Worker PBZ	5[b]	5[d]	0.051[d]	

OES	Sample Type	Sample Types		Worker Inhalation Exposure Estimates from Monitoring Data (8-hour TWA; mg/m^3 [a])	
		Total # Samples	#ND	CT	HE
Recycling	Plastic Converting used as surrogate	N/A	N/A		
Plastic compounding	Worker PBZ	10[b]	7	0.085[e]	
Import and repackaging	Worker PBZ & Area monitoring	Unknown	Unknown	0.14[f]	0.52[g]
Use of laboratory chemicals	Worker PBZ	5	2	1.00E-02[h]	0.10[i]
Fabrication of final product from articles	Worker PBZ	7	0	6.0E-02	0.13
Rubber product manufacturing	Unknown and/or area	25 total; 6 with sampling duration[m]	Unknown	1.7[n]	10[o]
Non-spray application of adhesives, sealants, paints, and coatings	Rubber Product Manufacturing used as surrogate	N/A	N/A		
Use of dyes, pigments, and fixing agents	Rubber Product Manufacturing used as surrogate	N/A	N/A		
Use of automotive care products	Unknown if PBZ or area	Unknown[h]	Unknown	5.5E–02[j,k]	0.11[j,l]

[a] TWA = time-weighted average

[b] Number of data points were comprised of discrete samples (*i.e.*, excluding data presented as ranges, arithmetic means, blanks, etc.).

[c] For calculations involving samples below the LOD, EPA's Guidelines for Statistical Analysis of Occupational Exposure Data[1] (U.S. EPA, 1994a) recommend using the LOD/√2 if the geometric standard deviation (GSD) is less than 3.0 and LOD/2 if the GSD is 3.0 or greater. Manufacturing exposure scenario included ND as LOD/2. It is also important to note that a high number of these values (37 of 45 samples) were below the LOD, and there is uncertainty in the actual exposure value for any measurement below the LOD (*i.e.*, actual values could range from 0 to the LOD).

[d] All available samples were below the limit of detection. The limit of detection was used in a screening-level exposure estimate to determine a risk estimate (see Section 4.3.2.4.3). Note that if the resulting MOE from the screening analysis was below the benchmark, then refinement to determine more precise values would be warranted, which would be challenging given the uncertainty in the exposure value for any measurement below the LOD (*i.e.*, actual values could range from 0 to the LOD).

[e] Single highest measured exposure value above the detection limit was used as a sentinel exposure for a screening-level analysis for all worker activities within the OES.

[f] CT reported arithmetic mean comprising an unknown number of PBZ samples from a single facility from workers performing drumming operations with DINP, used as a surrogate for DEHP exposure.

[g] HE reported maximum value from an unknown number of area samples taken from a single facility from workers performing drumming operations on DEHP.

[h] CT LOD of two PBZ samples from laboratory staff working in a facility producing DEHP.

[i] HE mean of three PBZ samples from mechanics in a facility producing DEHP; maintenance may be conducted in the laboratory

[j] Source did not provide discrete sample data. Data source provided only the maximum full-shift sample concentration.

[k] CT 8-hour TWA exposure is the midpoint between 0 and the maximum concentration provided for the data set.

[l] HE 8-hour TWA exposure is the maximum concentration provided for the data set.

[m] Data comprised of 25 samples total, with range of 0.04–26.7 mg/m^3 and mean ± SD of 2.48 ± 5.98 mg/m^3; however, sampling duration only provided for 6 values described as the highest values; EPA calculated the 8-hour TWA based on

OES	Sample Type	Sample Types		Worker Inhalation Exposure Estimates from Monitoring Data (8-hour TWA; mg/m^{3} [a])	
		Total # Samples	#ND	CT	HE
these values for which sampling duration was provided. See Table 4-6 and Section 4.3.2.2.2 for additional characterization of this OES and discussion of the weight of evidence. [n] CT TWA for the lowest value for which sampling duration was provided (2.6 mg/m^3 × 309 min/480 min = 1.7 mg/m^3). [o] HE TWA for the highest value for which sampling duration was provided (26.7 mg/m^3 × 180 min/480 min = 10 mg/m^3) N/A = Not applicable; ND = Non-detect					

4.1.1.4 Summary of Dermal Exposure Assessment

Table 4-5 presents a summary of dermal exposure results, which are based on both empirical dermal absorption data and dermal absorption modeling estimation efforts, including a summary of the Acute Potential Dose Rate (APDR) for occupational dermal exposure estimates, as well as the AD, IADD, and Chronic ADD. The *Environmental Release and Occupational Exposure Assessment for DEHP* (U.S. EPA, 2025u) provides exposure results for females of reproductive age and ONUs. The *Environmental Release and Occupational Exposure Assessment for DEHP* also provides additional details regarding AD, IADD, and ADD calculations along with EPA's approach and methodology for estimating dermal exposures.

Table 4-5. Summary of Average Adult Worker Modeled Dermal Exposure Results for Each OES

OES	Dermal Estimates (Average Adult Worker)									
	Exposure Type		APDR[a] (mg/day)		AD (mg/kg/day)		IADD (mg/kg/day)		ADD (mg/kg/day)	
	Liquid	Solid	CT	HE	CT	HE	CT	HE	CT	HE
Manufacturing	✓	×	5.6E−03	1.1E−02	7.0E−05	1.4E−04	5.1E−05	1.0E−04	4.8E−05	9.5E−05
Import and repackaging	✓	×	5.6E−03	1.1E−02	7.0E−05	1.4E−04	5.1E−05	1.0E−04	4.8E−05	9.5E−05
Incorporation into formulation, mixture, or reaction product	✓	×	5.6E−03	1.1E−02	7.0E−05	1.4E−04	5.1E−05	1.0E−04	4.8E−05	9.5E−05
Plastic compounding	✓	✓	5.6E−03 (0.21)	1.1E−02[b] (0.41)	2.6E−03	5.1E−03	1.9E−03	3.8E−03	1.8E−03	3.5E−03
Plastic converting	×	✓	2.1E−01	0.41	2.6E−03	5.1E−03	1.9E−03	3.8E−03	1.8E−03	3.5E−03
Rubber product manufacturing	✓	✓	5.6E−03 (0.21)	1.1E−02 (0.41)	2.6E−03	5.1E−03	1.9E−03	3.8E−03	1.8E−03	3.5E−03
Application of paints, coatings, adhesives, and sealants	✓	×	1.1E−01	0.21	1.3E−03	2.7E−03	9.8E−04	2.0E−03	9.2E−04	1.8E−03
Use of dyes, pigments, and fixing agents	✓	×	1.1E−01	0.21	1.3E−03	2.7E−03	9.8E−04	2.0E−03	9.2E−04	1.8E−03
Use of automotive care products	✓	×	1.1E−01	0.21	1.3E−03	2.7E−03	9.8E−04	2.0E−03	8.6E−04	1.8E−03
Textile finishing	✓	✓	0.11 (0.21)	0.21 (0.41)	2.6E−03	5.1E−03	1.9E−03	3.8E−03	1.5E−03	3.0E−03
Formulation for diffusion bonding	✓	×	1.1E−01	0.21	1.3E−03	2.7E−03	9.8E−04	2.0E−03	9.2E−04	1.8E−03
Use in hydraulic fracturing	✓	×	1.1E−01	0.21	1.3E−03	2.7E−03	4.5E−05	2.7E−04	3.7E−06	2.2E−05
Use of laboratory chemicals	✓	✓	0.11 (0.21)	0.21 (0.41)	2.6E−03	5.1E−03	1.9E−03	3.8E−03	1.7E−03	3.5E−03
Recycling	×	✓	2.1E−01	0.41	2.6E−03	5.1E−03	1.9E−03	3.8E−03	1.8E−03	3.5E−03
Fabrication or use of final products and articles	×	✓	2.1E−01	0.41	2.6E−03	5.1E−03	1.9E−03	3.8E−03	1.7E−03	3.3E−03
Waste handling, treatment, and disposal	×	✓	2.1E−01	0.41	2.6E−03	5.1E−03	1.9E−03	3.8E−03	1.8E−03	3.5E−03

APDR = acute potential dose rate; acute dose = IADD = intermediate average daily dose; ADD = average daily dose; HE = high-end; CT = central tendency.
[a] APDR values are reported for either liquid or solid exposure types as indicated by the Exposure Type column.
[b] For OESs with both liquid and solid exposure, the APDR value for liquids is presented first, and the APDR value for solids is presented in parentheses below.

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 release 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 indeterminate, in accordance with the 2021 Draft Systematic Review Protocol (U.S. EPA, 2021a). For example, a conclusion of moderate weight of scientific evidence is appropriate where there is measured exposure data from a limited number of sources, such that there is a limited number of data points that may not be representative of worker activities or potential exposures. 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.

As a general matter, for all COUs there is uncertainty regarding the representativeness of supporting data with respect to the full distribution of exposures. This uncertainty is due to the variability in the full distribution for each COU and how well the exposure estimates reflect that variability. Additionally, values below the limit of detection (*i.e.*, non-detects) introduce additional uncertainty in the final exposure estimates and statistics. To what degree this uncertainty impacts representativeness is unknown. Although each exposure assessment is intended to present a set of conditions from which an understanding of occupational risks may be constructed, the variability in the determinants of exposure (*e.g.*, frequency, duration, etc.) from facility to facility within the full distribution of any COU is unknown. As a result, the worker exposure estimates uncertainties, as part of the integrated evidence streams, may impact the weight of scientific evidence conclusion for any particular COU. Unless otherwise stated, each scenario represents a worker with 8 exposure hours per day and 250 exposure days per year with continuous DEHP exposure each working day. With the exception of plastics compounding OES, no monitoring data specific to ONUs were identified; therefore, EPA used the central tendency estimates of worker exposure for each OES as a surrogate for ONU exposure. See the 2021 Draft Systematic Review Protocol (U.S. EPA, 2021a) for additional information on weight of scientific evidence conclusions. Table 4-6 provides a summary of EPA's overall confidence in its occupational exposure estimates for each of the OESs assessed.

Table 4-6. Summary of Assumptions, Uncertainty, and Overall Confidence in Exposure Estimates by OES

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
Manufacturing	EPA used PBZ air concentration data to assess inhalation exposures, with the data sources having a medium and high data quality rating from the systematic review process (Liss and Hartel, 1983; Nuodex Inc., 1983). Data from these sources were DEHP-specific from 2 separate DEHP manufacturing facilities, comprising a total of 45 PBZ samples, of which 37 were non-detects (ND). The Manufacturing exposure scenarios included ND as LOD/2 according to EPA's *Guidelines for Statistical Analysis of Occupational Exposure Data* (U.S. EPA, 1994a). The high-end and central tendency worker inhalation exposure results for this OES are based on the 95th and 50th percentile exposure values from full-shift samples. Several references were not included in the analysis as they did not provide discrete sample data (Kim, 2016; ECJRC, 2008, 2003; Modigh et al., 2002; Liss et al., 1985). The estimated central tendency from EPA's analysis generally aligns with these additional studies and is within an order of magnitude of the median presented in each study. No data with full-shift samples for ONUs was identified for this OES through systematic review. For this reason, worker central tendency exposures were used for ONU exposures. The primary strength is the use of directly applicable monitoring data, which are preferrable to other assessment approaches such as modeling or assumption of air concentrations at an OEL (occupational exposure limits). The primary limitations of these data include the uncertainty of the representativeness of these data toward the true distribution of inhalation concentrations in this scenario because: (1) the data only comprise 2 DEHP manufacturing facilities, and (2) no ONU exposure data were available; therefore, EPA used central tendency worker data as surrogate data for ONUs. It is also important to note that a high number of these exposure values (37 of 45 samples) were below the LOD. There is uncertainty in the actual exposure value for any measurement below the LOD (*i.e.*, actual values could range from 0 to the LOD). Based on the direct relevance of exposure scenario to the OES, the use of monitoring data with a high number of data points and high data quality, and in consideration of limited number sites, EPA has concluded that the weight of scientific evidence for this assessment is provides moderate confidence in the estimate of exposures in consideration of the strengths and limitations of reasonably available data. EPA has lower confidence in the exposure estimates for ONUs because there are no specific ONU monitoring data, and EPA relied on worker exposure estimates at central tendency as a surrogate for ONU exposure.
Rubber manufacturing	EPA used area monitoring data from rubber calendering operations to estimate worker inhalation exposures to vapor, which had a data quality rating of high. This source provided TWA exposures from 6 area samples which provided sample collection duration (ECJRC, 2003). The primary strength of this approach is that it uses monitoring data specific to this OES (rubber calendering operations), which includes sample collection duration, that allowed EPA to calculate an 8-hour TWA. This is preferable to other assessment approaches such as modeling. EPA calculated an 8-hour TWA on the six area samples considering any time outside of the sample collection period to be zero exposure. This is a reasonable assumption given that the longest collection times (5 hours) resulted in the lowest 8-hr TWA. The resulting calculations of 8-hr TWA agreed with the EU report (ECJRC, 2003) for what they considered a reasonable high end 8-hour TWA (10 mg/m^3). The central tendency 8-hour TWA calculated for the six area samples (1.7 mg/m^3), is lower than the mean for the 25 samples of unknown duration (2.48 mg/m^3). However, EPA has higher confidence in the calculated 8-hour TWAs, given the high variability among the 25

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
	data samples indicated by the mean and standard deviation, and the lack of concentration and duration information for the 25 measurements. The primary limitations of these data include uncertainty in the representativeness of the monitoring data in capturing the true distribution of inhalation concentrations for this OES and the lack of ONU exposure data, for which EPA used central tendency of worker data as a surrogate. Additionally, the monitoring dataset consisted of datapoints for area samples instead of PBZ. Based on the direct relevance of the exposure scenario to OES, relevant monitoring data of high quality and in consideration of the limited number of samples with accompanying sample duration, EPA has concluded that the weight of scientific evidence for this assessment provides moderate confidence in the estimate of exposures in consideration of the strengths and limitations of reasonably available data. EPA has lower confidence in the exposure estimates for ONUs because there are no specific ONU monitoring data, and EPA relied on worker exposure estimates at central tendency as a surrogate for ONU exposure.
Plastics compounding	EPA used monitoring data collected between 2014 and 2022 from three PVC compounding and processing sites to estimate worker inhalation exposures to vapor (Vinyl Institute, 2025). This data source has a high data quality rating from the systematic review process and provided 10 personal breathing zone exposure samples relevant to this OES, 7 of which were below the LOD (Vinyl Institute, 2025). A single value representing the highest 8-hour TWA provided for plastic compounding (0.085 mg/m^3) was used as a sentinel exposure for a screening-level analysis for all worker activities within the OES. Note that risk estimates from the screening level analysis are presented in Section 4.3.2.3.2, and if resulting MOEs were below the benchmark, EPA would next refine the exposure estimates. There is uncertainty in the precise exposure for any value less than the LOD (*e.g.*, actual value between no exposure and the LOD). Additionally, these data are from worker activities specific to this OES: bagging, blending, and mixing. No ONU exposure data were identified. However, the central tendency value for worker exposures was used as a surrogate for actual ONU exposure monitoring data. No summary statistics were provided for these data. The primary strength of this approach is that it uses recent monitoring data specific to this OES, which is preferrable to other assessment approaches, such as modeling or the use of OELs. The primary limitations of these data include uncertainty in the representativeness of the monitoring data in capturing the true distribution of inhalation concentrations for this OES; however, the relative recency of the data collection and the inherent heterogeneity of the data from three sites and multiple worker activities may mitigate the uncertainty in the representativeness. The data that EPA has presented is reasonably available public information, meeting the TSCA standard under section 26(k). Based on these strengths and limitations, EPA has lower confidence in the exposure estimates for ONUs because there are no specific ONU monitoring data, and EPA relied on worker exposure estimates at central tendency as a surrogate for ONU exposure. EPA has concluded that the weight of scientific evidence for this assessment is moderate to robust and provides a reasonable estimate of exposure for this OES.
Plastics converting	EPA used monitoring data collected between 2014 and 2022 from three PVC compounding and processing

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
	(converting) sites to estimate worker inhalation exposures (Vinyl Institute, 2025). This data source has a high data quality rating from the systematic review process and provided 5 personal breathing zone exposure samples relevant to this OES, all of which were below the LOD; therefore, EPA used the LOD (0.051 mg/m^3) in a screening level analysis. Note that risk estimates from the screening level analysis are presented in Section 4.3.2.4.1, and if resulting MOEs were below the benchmark, EPA would next refine the exposure estimates. There is uncertainty in the precise exposure for any value less than the LOD (*e.g.*, actual value between no exposure and the LOD). Additionally, these data are from worker activities specific to this OES: extrusion (calendering) and hose extrusion. No ONU exposure data were identified. However, the central tendency value for worker exposures was used as a surrogate for actual ONU exposure monitoring data. No summary statistics were provided for these data. The primary strength of this approach is that it uses recent monitoring data specific to this OES, which is preferrable to other assessment approaches, such as modeling or the use of OELs. The primary limitations of these data include uncertainty in the representativeness of the monitoring data in capturing the true distribution of inhalation concentrations for this OES and the lack of ONU exposure data, for which EPA used worker data as surrogate data; and that the data came from a single company. However, the relative recency of the data collection and the inherent heterogeneity of the data from three sites and multiple worker activities may mitigate the uncertainty in the representativeness. The data that EPA has presented is reasonably available public information, meeting the TSCA standard under section 26(k). Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate to robust and provides a reasonable estimate of exposures.
Incorporation into formulation, mixture, or reaction product	EPA used monitoring data from Manufacturing OES, comprised of 2 DEHP manufacturing facilities to estimate worker inhalation exposures due to limited data available for incorporation into formulation, mixture, or reaction product inhalation exposures. EPA used PBZ air concentration data to assess inhalation exposures, with the data sources having medium and high data quality ratings from the systematic review process (Liss and Hartel, 1983; Nuodex Inc., 1983). Data from these sources were DEHP-specific from 2 separate DEHP manufacturing facilities, comprising a total of 45 PBZ samples, of which 37 were non-detects (ND). As with manufacturing, this exposure scenarios included ND as LOD/2 according to EPA's *Guidelines for Statistical Analysis of Occupational Exposure Data* (U.S. EPA, 1994a). The high-end and central tendency worker inhalation exposure results for this OES are based on the 95th and 50th percentile exposure values from full-shift samples. Several references were not included in the analysis as they did not provide discrete sample data (Kim, 2016; ECJRC, 2008, 2003; Modigh et al., 2002; Liss et al., 1985). The estimated central tendency from EPA's analysis generally aligns with these additional studies and is within an order of magnitude of the median presented in each study. No data with full-shift samples for ONUs was identified for this OES through systematic review. For this reason, worker central tendency exposures were used for both the ONU high-end and central tendency exposures. The primary strength is the use of monitoring data, which are preferrable to other assessment approaches such as modeling or the assumption of air concentration at an OEL.

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
	The primary limitations of these data include the uncertainty of the representativeness of these data toward this OES and the true distribution of inhalation concentrations in this scenario; the lack of ONU exposure data, for which EPA used central tendency worker data as surrogate; and that the data come from only 2 DEHP manufacturing facilities. It is also important to note that a high number of these exposure values (37 of 45 samples) were below the LOD. There is uncertainty in the actual exposure value for any measurement below the LOD (*i.e.*, actual values could range from 0 to the LOD). Based on use of a surrogate scenario for this OES, uncertainty in the representativeness of the use patterns and practices to this OES, EPA has concluded that the weight of scientific evidence for this assessment provides moderate confidence in the estimate of exposures in consideration of the strengths and limitations of reasonably available data. EPA has lower confidence in the exposure estimates for ONUs because there are no specific ONU monitoring data, and EPA relied on worker exposure estimates at central tendency as a surrogate for ONU exposure.
Import and repackaging	EPA used monitoring data from 2 studies that sampled drumming activities to estimate worker inhalation exposures to vapor, with the data sources both having a high data quality rating from the systematic review process (ECJRC, 2008, 2003). For central tendency inhalation exposure, EPA used the reported arithmetic mean comprising an unknown number of PBZ samples from a single facility from workers performing drumming operations with DINP, used as a surrogate for DEHP exposure. For high-end inhalation exposure, EPA used the reported maximum value from an unknown number of area samples taken from a single facility from workers performing drumming operations on DEHP. The primary strength of this approach is that it uses monitoring data specific to this OES, which is preferrable to other assessment approaches, such as modeling or assuming air concentration at an OEL. The primary limitations of these data include uncertainty in the representativeness of the monitoring data in capturing the true distribution of inhalation concentrations for this OES and the lack of ONU exposure data, for which EPA used central tendency worker data as surrogate. Additionally, the vapor monitoring dataset consisted of an unknown number of datapoints with unknown sample durations. Based on the relevance of the exposure scenario to this OES, the high data quality and in consideration of the limited number of sites and exposure data (mean concentrations of area samples), EPA has concluded that the weight of scientific evidence for this assessment provides moderate confidence in the estimate of exposures in consideration of the strengths and limitations of reasonably available data. EPA has lower confidence in the exposure estimates for ONUs because there are no specific ONU monitoring data, and EPA relied on worker exposure estimates at central tendency as a surrogate for ONU exposure.
Spray application of paints, coatings, adhesives, and sealants	EPA used surrogate mist monitoring data from the ESD on Coating Applications via Spray-Painting in the Automotive Refinishing Industry, which the systematic review process rated high for data quality, to estimate inhalation exposures (OECD, 2011). The primary strength of this approach is that it uses surrogate monitoring data, which is preferable to other assessment approaches, such as the assumption of air concentrations at an OEL. EPA used SDSs and product data sheets from identified DEHP-containing products to identify product concentrations of DEHP in paints, coatings, adhesives, and sealants

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
	which could be used via spray application, which were then applied to the surrogate mist data from the ESD on Coating Applications via Spray-Painting in the Automotive Refinishing Industry to estimate DEHP-specific exposures. The primary limitation is the lack of DEHP-specific monitoring data, with the ESD serving 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. EPA only assessed mist exposures to DEHP over a full 8-hour work shift to estimate the level of exposure, though other activities may result in vapor exposures other than mist and application duration may be variable depending on the job site. Additionally, the lack of ONU exposure data requires the use of central tendency worker data as surrogate data, which may not be fully representative of ONU exposures. EPA assessed 250 days of exposure per year based on continuous DEHP exposure each working day for a typical worker schedule; however, application sites may use DEHP-containing paints, coatings, adhesives, or sealant formulations at much lower or variable frequencies. Based on the relevance of the scenario to the OES, use of monitoring data for mist concentration, and in consideration of the lack of DEHP-specific exposure data, EPA has concluded that the weight of scientific evidence for this assessment provides moderate confidence in the estimate of exposures , and this conclusion is supported by the detailed description and scientific rigor of the estimation approach, and the fact that the uncertainties/assumptions for the Exposure Scenario Factors and the estimation methodology are well documented. EPA has lower confidence in the exposure estimates for ONUs because there are no specific ONU monitoring data, and EPA relied on worker exposure estimates at central tendency as a surrogate for ONU exposure.
Non-spray application of paints, coatings, adhesives, and sealants	No references with discrete full-shift samples were identified for the non-spray application of paints, coatings, adhesives, and sealants through systematic review. However, the Rubber Manufacturing OES was selected as a surrogate as it represented the highest air concentration of DEHP across all scenarios with monitoring data relevant to non-spray applications, given that volatilization is the primary contributor to the air concentration for both OES. EPA used area monitoring data from rubber calendering operations to estimate worker inhalation exposures to vapor, which had a data quality rating of high from the systematic review process (ECJRC, 2003). The primary strength of this approach is that it uses monitoring data which is preferrable to other assessment approaches such as modeling or assuming an air concentration at an OEL, and the sample collection duration was included, allowing EPA to calculate 8-hour TWA Additionally, when calculating 8-hour TWA based on the six area samples, EPA considered any time outside of the sample collection period to be zero exposure. This is a reasonable assumption given that the longest collection times (5 hours) resulted in the lowest 8-hr TWA. The resulting calculations of 8-hr TWA agreed with the EU report (ECJRC, 2003) for what they considered a reasonable high end 8-hour TWA (10 mg/m^3). EPA compared the central tendency calculated by EPA using the lowest concentration provided by the six area samples for which sample duration was provided (1.7 mg/m^3) against the mean for the 25 samples of unknown duration (2.48 mg/m^3) and note that the mean for the 25 samples is similar to but higher than the 8-hour TWA from the lowest of the measurements for which sample duration was provided. EPA has higher confidence in the values based on 8-hour TWA, given the high variability among the data indicated by the mean and standard deviation, and the fact that the actual individual measurements (concentration and duration) were not presented for the 25 underlying measurements.

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
	The primary limitations of these data include the uncertainty regarding the relevance of the rubber calendering operation as a surrogate for non-spray application of paints, coatings, adhesives, and sealants. Although the weight fraction of DEHP in rubber calendering operations (4–8%) is relevant to products in the non-spray application of paints, coatings, adhesives, and sealants, the operating temperature of 200°C for rubber calendering likely results in a higher air concentration of DEHP and thereby overestimate exposure when used as a surrogate for non-spray application of adhesives, sealants, paints, and coatings. Therefore, EPA compared the dose from non-spray application of application of paints, coatings, adhesives, and sealants for DEHP (based on rubber calendering) to another phthalate (DBP) which had inhalation monitoring data for non-spray application of paints, coatings, adhesives, and sealants from operations at ambient temperatures. Importantly, the DEHP inhalation dose to females of reproductive age using rubber calendering data as a surrogate for non-spray applications of paints, coatings, adhesives, and sealants (0.23 mg/kg-day at central tendency and 1.12 mg/kg-day for high-end; (U.S. EPA, 2025u)) is very similar to DBP for this same OES (0.21 mg/kg-day at central tendency and 1.02 mg/kg-day for high-end (U.S. EPA, 2025t)), thereby increasing EPA's confidence in the use of rubber manufacturing inhalation monitoring data as a surrogate for non-spray application of paints, coatings, adhesives, and sealants. There is additional uncertainty in the representativeness of the monitoring data in capturing the true distribution of inhalation concentrations for this OES and the lack of ONU exposure data, for which EPA used central tendency worker data as surrogate. Based on the high data quality and in consideration of the uncertainty in the representativeness of the exposure data source to the OES, exposure data from mixed operations (worker activities), lack of knowledge in the relevance of the worker practices to the OES, EPA has concluded that the weight of scientific evidence for this assessment provides slight to moderate confidence in the estimate of exposures in consideration of the strengths and limitations of reasonably available data. EPA has lower confidence in the exposure estimates for ONUs because there are no specific ONU monitoring data, and EPA relied on worker exposure estimates at central tendency as a surrogate for ONU exposure.
Textile finishing	EPA PNOR Model (U.S. EPA, 2021d) to estimate worker inhalation exposure to solid particulate. A strength of the model is that the respirable PNOR range was refined using OSHA CEHD datasets, which EPA tailored to the textile manufacturing industry and the resulting dataset contains 71 discrete sample data points. The systematic review process rated the source high for data quality (OSHA, 2020). EPA estimated the highest expected concentration of DEHP in particulate using industry provided data on DEHP concentration in fabric finishing products. These data were also rated high for data quality in the systematic review process. The primary limitations are the uncertainty in the representativeness of values toward the true distribution of potential inhalation exposures and the lack of ONU exposure data, for which EPA used central tendency worker data as surrogate. EPA assumed 8 exposure hours per day and 215 exposure days per year based on continuous DEHP exposure each working day for a typical worker schedule; it is uncertain whether this captures actual worker schedules and exposures. The exposure days were based on the release days for the OES. Based on high data quality, the number of data points from the OSHA CEHD and in consideration of the lack of OES-specific or DEHP-specific exposure data, EPA has concluded that the weight of scientific evidence for this assessment provides

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
	moderate confidence in the estimate of exposures in consideration of the strengths and limitations of reasonably available data. EPA considers this exposure estimate for high end to represent an upper bound, given the assumption that the industry-specific dust level is comprised of DEHP at the highest concentration reflected in a SDS specific to this OES. EPA has lower confidence in the exposure estimates for ONUs because there are no specific ONU monitoring data, and EPA relied on worker exposure estimates at central tendency as a surrogate for ONU exposure.
Fabrication of final products from articles	EPA used monitoring data from OSHA CEHD to estimate worker and ONU inhalation exposures (OSHA, 2020). These data were comprised of 7 PBZ samples, all above the LOD. The systematic review process rated the source high for data quality (OSHA, 2020). The primary strength is this approach is that it uses monitoring data specific to this OES, which is preferrable to other assessment approaches such as modeling or assuming air concentration at an OEL. The primary limitations of these data include uncertainty in the representativeness of the monitoring data in capturing the true distribution of inhalation concentrations for this OES. Additionally, due to the lack of discrete TWA data, samples from the OSHA CEHD were combined by inspection number, establishment name, and sample number to calculate an 8-hour TWA in cases where the sum of sampling time was greater than 3 hours. This method represents workers that are exposed to DEHP for 3 hours during their shift, which may underestimate exposures if they were to be exposed for the full shift duration. Due to the lack of data for ONUs, EPA used central tendency worker data as a surrogate. Based on the high data quality, relevance of the monitoring data to this OES, and in consideration of the low number of data points, EPA has concluded that the weight of scientific evidence for this assessment provides moderate confidence in the estimate of exposures in consideration of the strengths and limitations of reasonably available data. EPA has lower confidence in the exposure estimates for ONUs because there are no specific ONU monitoring data, and EPA relied on worker exposure estimates at central tendency as a surrogate for ONU exposure.
Use of dyes, pigments, and fixing agents	No references with discrete full-shift samples were identified for the use of dyes, pigments, and fixing agents through systematic review. The Rubber Manufacturing OES was selected as a surrogate as it represented the highest air concentration of DEHP across all non-spray scenarios with monitoring data (ECJRC, 2003). The primary strength is the use of monitoring data, which are preferrable to other assessment approaches such as modeling or assuming air concentration at an OELs, and the sample collection duration was included, allowing EPA to calculate 8-hour TWA Additionally, when calculating 8-hour TWA based on the six area samples, EPA considered any time outside of the sample collection period to be zero exposure. This is a reasonable assumption given that the longest collection times (5 hours) resulted in the lowest 8-hr TWA. The resulting calculations of 8-hr TWA agreed with the EU report (ECJRC, 2003) for what they considered a reasonable high end 8-hour TWA (10 mg/m^3). EPA compared the central tendency calculated by EPA using the lowest concentration provided by the six area samples for which sample duration was provided (1.7 mg/m^3) against the mean for the 25 samples of unknown duration (2.48 mg/m^3) and note that the mean for the 25 samples is similar to but higher than the 8-hour TWA from the lowest of the measurements for which sample duration was provided. EPA has higher confidence in the values based on 8-hour TWA, given the high variability among the data indicated by the mean and standard deviation, and the fact that the actual individual measurements (concentration and duration) were not presented for the 25 underlying measurements.

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
	The primary limitations of these data include the uncertainty regarding the relevance of the rubber calendering operation as a surrogate for Use of dyes, pigments, and fixing agents. Although the weight fraction of DEHP in rubber calendering operations (4–8%) is relevant to products in dyes, pigments, and fixing agents, the operating temperature of 200 °C for rubber calendering likely results in a higher air concentration of DEHP and thereby overestimate exposure when used as a surrogate for Use of dyes, pigments, and fixing agents. Therefore, EPA compared the dose from Use of dyes, pigments, and fixing agents for DEHP and from non-spray application of paints, coatings, adhesives, and sealants (both based on rubber calendering) to another phthalate (DBP) which had inhalation monitoring data for non-spray application of paints, coatings, adhesives, and sealants from operations at ambient temperatures. Importantly, the DEHP inhalation dose to females of reproductive age using rubber calendering data as a surrogate for dyes, pigments and fixing agents and non-spray applications of paints, coatings, adhesives, and sealants (0.23 mg/kg-day at central tendency and 1.12 mg/kg-day for high-end; (U.S. EPA, 2025u)) is very similar to DBP for this same OES (0.21 mg/kg-day at central tendency and 1.02 mg/kg-day for high-end (U.S. EPA, 2025t)), thereby increasing EPA's confidence in the use of rubber manufacturing inhalation monitoring data as a surrogate for this OES. Based on the use of a surrogate OES, high data quality, and in consideration of the uncertainty regarding the representativeness of the surrogate OES to Use of Dyes, Pigments, and Fixing Agents, EPA has concluded that the weight of scientific evidence for this assessment provides slight to moderate confidence in the estimate of exposures in consideration of the strengths and limitations of reasonably available data. EPA has lower confidence in the exposure estimates for ONUs because there are no specific ONU monitoring data, and EPA relied on worker exposure estimates at central tendency as a surrogate for ONU exposure.
Formulations for diffusion bonding	EPA used surrogate mist 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 (OECD, 2011). The primary strength of this approach is that it uses surrogate monitoring data, which is preferrable to other assessment approaches, such the assumption of air concentrations at an OEL. EPA used SDSs and product data sheets from identified DEHP-containing products to identify product concentrations, which were then applied to the surrogate mist data to estimate DEHP-specific exposures. The primary limitation is the lack of DEHP-specific monitoring data, with the ESD serving 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. The inhalation monitoring data used were specific to the spray application of coating materials, so the estimates may not be representative of exposure during other application methods. Additionally, it is uncertain whether the substrates coated, and products used to generate the surrogate data are representative of those associated with DEHP-containing diffusion bonding formulations. EPA only assessed mist exposures to DEHP over a full 8-hour work shift to estimate the level of exposure, though other activities may result in vapor exposures other than mist, and application duration may be variable depending on the job site. Additionally, the lack of ONU exposure data requires the use of central tendency worker data as surrogate data, which may not be fully representative of ONU exposures. EPA assessed 250 days of exposure per year based

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
	on workers using diffusion bonding formulations on every working day, however, application sites may use DEHP-containing diffusion bonding formulations at much lower or variable frequencies. Based on modeling, and in consideration of the uncertainty in representativeness of the underlying monitoring data (in the model) and lack of relevant worker activity knowledge, EPA has concluded that the weight of scientific evidence for this assessment provides moderate confidence in the estimate of exposures in consideration of the strengths and limitations of reasonably available data. EPA has lower confidence in the exposure estimates for ONUs because there are no specific ONU monitoring data, and EPA relied on worker exposure estimates at central tendency as a surrogate for ONU exposure.
Use of laboratory chemicals	EPA used monitoring data from 2 studies that sampled laboratories to estimate worker inhalation exposures to vapor. These data had data quality ratings ranging from medium to high (ECJRC, 2008; Modigh et al., 2002). For central tendency exposure, EPA used the LOD of two PBZ samples from laboratory staff working in a facility producing DEHP, as both samples were below the LOD. Note that risk estimates from the screening level analysis are presented in Section 4.3.2.13.1, and if resulting MOEs were below the benchmark, EPA would next refine the exposure estimates, and there is uncertainty in the precise exposure for any value less than the LOD (*e.g.*, actual value between no exposure and the LOD).To estimate high-end worker exposure, EPA used the mean of three PBZ samples from mechanics in a facility producing DEHP, given that maintenance may be conducted in the laboratory. The primary strength of this approach is that it uses monitoring data specific to this OES, which is preferrable to other assessment approaches, such as modeling or the assumption of air concentrations at an OEL. The primary limitations of these data include uncertainty in the representativeness of the monitoring data in capturing the true distribution of inhalation concentrations for this OES and the lack of ONU exposure data, for which EPA used central tendency worker exposure data as surrogate. Finally, EPA assumed 8 exposure hours per day and the 95th percentile and 50th percentile operating days from the release assessment, 238 and 250 days respectively, as the exposure days per year based on continuous DEHP exposure each working day for a typical worker schedule; it is uncertain whether this captures actual worker schedules and exposures. Based on the relevance of the exposure scenario to the OES, directly relevant monitoring data, medium-high data quality, and in consideration of the limited characterization of the monitoring data (minimum, maximum), and limited number composite samples (3 area, 2 PBZ), EPA has concluded that the weight of scientific evidence for this assessment provides moderate confidence in the estimate of exposures. EPA has lower confidence in the exposure estimates for ONUs because there are no specific ONU monitoring data, and EPA relied on worker exposure estimates at central tendency as a surrogate for ONU exposure.
Use of automotive care products	EPA used monitoring data from one study that sampled a site which applies car sealings and under coatings to estimate worker inhalation exposures. This data had a data quality rating of high (ECJRC, 2008). EPA used the maximum full shift concentration from an unknown number of samples and unknown worker classification for the high-end worker exposures and the midpoint between the limit of detection and the maximum concentration, due to the minimum being below the limit of detection, for the central tendency worker exposure. The primary strength of this approach is that it uses monitoring data

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
	specific to this OES, which is preferrable to other assessment approaches, such as modeling or the assumption of air concentrations at an OEL. The primary limitations of these data include uncertainty in the representativeness of the vapor monitoring data in capturing the true distribution of inhalation concentrations for this OES and the lack of ONU exposure data, for which EPA used central tendency worker data as surrogate. Based on the relevance of the exposure data to the OES, high data quality, and in consideration of the uncertainty in the representativeness of the exposure data worker activities to the worker activities for this OES, and the limited number of sites, EPA has concluded that the weight of scientific evidence for this assessment provides moderate confidence in the estimate of exposures in consideration of the strengths and limitations of reasonably available data. EPA has lower confidence in the exposure estimates for ONUs because there are no specific ONU monitoring data, and EPA relied on worker exposure estimates at central tendency as a surrogate for ONU exposure.
Use in hydraulic fracturing	EPA used surrogate monitoring data from 2 DEHP manufacturing facilities to estimate worker inhalation exposures due to limited data available for use in hydraulic fracturing inhalation exposures. EPA used PBZ air concentration data to assess inhalation exposures, with the data sources having medium and high data quality ratings from the systematic review process (Liss and Hartel, 1983; Nuodex Inc., 1983). Data from these sources were DEHP-specific from 2 separate DEHP manufacturing facilities, comprising a total of 45 PBZ samples, of which 37 were non-detects (ND). As with manufacturing, this exposure scenarios included ND as LOD/2 according to EPA's *Guidelines for Statistical Analysis of Occupational Exposure Data* (U.S. EPA, 1994a). The primary strength is the use of monitoring data, which are preferrable to other assessment approaches such as modeling or the assumption of air concentrations at an OEL. The primary limitations of these data include the uncertainty of the representativeness of these data toward this OES and the true distribution of inhalation concentrations in this scenario; the lack of ONU exposure data, for which EPA used central tendency worker data as surrogate; and that the data come from only 2 DEHP manufacturing facilities. EPA also assumed 8 exposure hours per day and 1 to 3 exposure days per year based on data obtained from Frac Focus (2022); it is uncertain whether this captures actual worker schedules and exposures. It is also important to note that a high number of these exposure values (37 of 45 samples) were below the LOD, and there is uncertainty in the actual exposure value for any measurement below the LOD (*i.e.*, actual values could range from 0 to the LOD). Based on use of a surrogate OES, and in consideration of the uncertainty in the representativeness of the surrogate to this OES, EPA has concluded that the weight of scientific evidence for this assessment provides slight confidence in the estimate of exposures in consideration of the strengths and limitations of reasonably available data. EPA has lower confidence in the exposure estimates for ONUs because there are no specific ONU monitoring data, and EPA relied on worker exposure estimates at central tendency as a surrogate for ONU exposure.
Recycling	EPA used surrogate monitoring data from the plastics converting OES collected between 2014 and 2022 from three PVC compounding and processing (converting) sites to estimate worker inhalation exposures (Vinyl Institute, 2025). This data

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
	source has a high data quality rating from the systematic review process and provided 15 personal breathing zone exposure samples. Worker activities and resulting exposures for plastic converting are expected to be sufficiently comparable to those from recycling to serve as a surrogate in the absence of OES-specific exposure data. Data from these sources were DEHP-specific. There were 5 PBZ samples from workers relevant to plastics converting, and all 5 of these samples were below the LOD. Therefore, EPA used the LOD (0.051 mg/m^3) in a screening level assessment. Note that risk estimates from the screening level analysis are presented in Section 4.3.2.16.3, and if resulting MOEs were below the benchmark, EPA would next refine the exposure estimates. There is uncertainty in the precise exposure for any value less than the LOD (*e.g.*, actual value between no exposure and the LOD). The primary strength is the use of PBZ monitoring data, which are preferrable to other assessment approaches such as modeling or the use of OELs. The primary limitations of these data include the uncertainty of the representativeness of these data toward this OES and the true distribution of inhalation concentrations in this scenario; the lack of ONU exposure data, for which EPA used worker data as surrogate; and that these data come from a single company. The data that EPA has presented is reasonably available public information, meeting the TSCA standard under section 26(k). Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate to robust and provides a plausible estimate of exposures.
Waste handling, disposal, and treatment	EPA utilized the PNOR Model (U.S. EPA, 2021d) to estimate worker inhalation exposure to solid particulate. A strength of the model is that the respirable PNOR range was refined using OSHA CEHD datasets, which EPA tailored to the waste handling industry and the resulting dataset contains 130 discrete sample data points. The systematic review process rated the source high for data quality (OSHA, 2020). EPA estimated the highest expected concentration of DEHP in waste that is handled using industry provided data on DEHP concentration in plastic products. These data were also rated high for data quality in the systematic review process. The primary limitations are the uncertainty in the representativeness of values toward the true distribution of potential inhalation exposures and the lack of ONU exposure data, for which EPA used central tendency of worker data as surrogate. Additionally, the representativeness of the CEHD dataset and the identified DEHP maximum concentration in plastics for this specific OES is uncertain. EPA lacks facility and DEHP-containing waste handling, treatment, and disposal rates, methods, and operating times and EPA assumed 8 exposure hours per day and 250 exposure days per year based on continuous DEHP exposure each working day for a typical worker schedule; it is uncertain whether this captures actual worker schedules and exposures. The exposure days were based on working 5 days per week and 50 weeks per year. Based on high data quality, the number of data points from the OSHA CEHD and in consideration of the lack of OES-specific or DEHP-specific exposure data, EPA has concluded that the weight of scientific evidence for this assessment provides moderate confidence in the estimate of exposures in consideration of the strengths and limitations of reasonably available data. EPA has lower confidence in the exposure estimates for ONUs because there are no specific ONU monitoring data, and EPA relied on worker exposure estimates at central tendency as a surrogate for ONU exposure.

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
Dermal – liquids	EPA selected the study by Hopf et al. (Hopf et al., 2014) for determining dermal absorption of neat and aqueous DEHP because the study used metabolically-active human skin that was used within 2 hours of removal from patients undergoing abdominoplasty surgery, so that the skin retained esterase activity and metabolized DEHP to MEHP. Therefore, this study was considered to most closely approximate the dermal absorption of neat or aqueous DEHP in humans. A flux of 0.0013 μg/cm^2/hour was calculated for neat DEHP, and a flux of 0.025 μg/cm^2/hour was determined for aqueous DEHP. Data evaluation of this study through systematic review resulted in an overall quality determination of medium. EPA used dermal absorption data for dilute DEHP to estimate occupational dermal exposures to workers since the absorptive flux of dilute DEHP is greater than the absorptive flux of neat DEHP (Hopf et al., 2014). Because the absorptive flux of dilute DEHP is greater than the neat absorptive flux, EPA expects using the dilute absorptive flux for anything less than 90 percent DEHP to be a protective approach for assessing dermal exposures. Also, it is acknowledged that variations in chemical concentration and co-formulant components affect the rate of dermal absorption. However, it is assumed that absorption of the dilute chemical serves as a reasonable upper bound across chemical compositions, and the data received a medium rating through EPA's systematic review process. For occupational dermal exposure assessment, EPA assumed a standard 8-hour workday and that the chemical is contacted at least once per day. Because DEHP 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 DEHP from occupational dermal contact with materials containing DEHP may extend up to 8 hours per day (U.S. EPA, 1991). This is a conservative estimate since handwashing during the shift would reduce dermal exposure. For average adult workers, the surface area of contact was assumed equal to the area of 1 hand (*i.e.*, 535 cm^2), or 2 hands (*i.e.*, 1,070 cm^2), for central tendency exposures, or high-end exposures, respectively (U.S. EPA, 2011a). The standard sources for exposure duration and area of contact received high ratings through EPA's systematic review process. These estimates cover dermal contact for several potential worker activities including, but not limited to, equipment cleaning, sampling, activities related to liquid processing, etc. The representativeness of these estimates to actual worker exposure depends on the worker activity. The occupational dermal exposure assessment for contact with liquid materials containing DEHP was based on dermal absorption data for the dilute material, 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 provides moderate confidence in the upper bound estimate of occupational dermal exposures in consideration of the strengths and limitations of reasonably available data and the variable inputs for exposure duration, surface area, and concentration of the formulation.
Dermal – solids	EPA used dermal absorption data from an *in vivo* absorption study using male F344 rats and DEHP contained within PVC film (Chemical Manufacturers Association, 1991) to estimate occupational dermal exposures of workers and ONUs to solid materials as described in the *Environmental Release and Occupational Exposure Assessment for Diethylhexyl Phthalate* (U.S. EPA, 2025u). In general, rodent skin has a higher dermal absorption than human skin, therefore this model likely provides a conservative estimate of dermal absorption of DEHP in humans from solid matrices. This data had a data quality rating of

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
	medium from systematic review. It is acknowledged that variations in chemical concentration and co-formulant components affect the rate of dermal absorption. In a typical occupational exposure setting, the duration of exposure is not expected to exceed the shift time (typically, 8 to 12 hours). Therefore, EPA used the 24-hour average absorptive flux from the Chemical Manufacturers Association to estimate occupational exposures (Chemical Manufacturers Association, 1991). Because this duration exceeds the occupational exposure duration and because the Chemical Manufacturers Association show that the absorptive flux increased with longer test durations, EPA expects the use of the average absorptive flux data from Chemical Manufacturers Association to be protective of the duration of dermal exposures in occupational settings (Chemical Manufacturers Association, 1991). For occupational dermal exposure assessment, EPA assumed a standard 8-hour workday and that the chemical is contacted at least once per day. Because DEHP 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 DEHP from occupational dermal contact with materials containing DEHP may extend up to 8 hours per day (U.S. EPA, 1991). This is a conservative estimate since handwashing during the shift would reduce dermal exposure. For average adult workers, the surface area of contact was assumed equal to the area of 1 hand (*i.e.*, 535 cm^2), or 2 hands (*i.e.*, 1,070 cm^2), for central tendency exposures, or high-end exposures, respectively (U.S. EPA, 2011a). The standard sources for exposure duration and area of contact received high ratings through EPA's systematic review process. These estimates cover dermal contact for several potential worker activities including, but not limited to, equipment cleaning, sampling, activities related to solids processing, etc. The representativeness of these estimates to actual worker exposures depends on the worker activity. The occupational dermal exposure assessment for contact with solid materials containing DEHP was based on *in vivo* dermal absorption data using male F344 rats, 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 provides moderate confidence in the estimate of occupational dermal exposures in consideration of the strengths and limitations of reasonably available data.

ESD = Emission Scenario Document; OEL = occupational exposure limit; OES = occupational exposure scenario; ONU = occupational non-user; OSHA CEHD = Occupational Safety and Health Administration Chemical Exposure Health Data; PBZ = personal breathing zone; PVC = polyvinylchloride; SDS = safety data sheet; TWA = time-weighted average

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, EPA'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, EPA's overall confidence is low.

Strengths

The exposure scenarios and exposure factors underlying the inhalation and dermal assessment are supported by slight to robust evidence.

A strength of the modeling assessment includes the consideration of variable model input parameters as opposed to using a single static value. The Textile finishing; waste handling, disposal and treatment; and Spray application of paints, coatings, adhesives and sealants used modeling to estimate inhalation exposures. The textile finishing and Waste handling, disposal and treatment OESs used the PNOR model for industry-specific dust levels and the weight fraction of an article specific to that OES as the weight fraction comprising the dust. The Spray application of paints, coatings, adhesives and sealants used an empirical model of mist levels from the automotive industry ESD and the weight fraction of DEHP specific products. Parameter distributions increase the variability of modeled exposures and the likelihood that the exposure estimates are more representative of the true distribution. 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 4-6.

Limitations

The principal limitation of the inhalation monitoring data is uncertainty in the representativeness of the data, as there are limited exposure monitoring data in the literature from systematic review. Additionally, differences in work practices and engineering controls across sites can introduce variability and limit the representativeness of the monitoring data. The age of the monitoring data may introduce uncertainty, in scenarios where workplaces and equipment used when the monitoring data were collected may not reflect current practice. 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 DEHP 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.

For datasets that included exposure data reported as below the limit of detection (LOD), EPA estimated exposure concentrations following guidance in EPA's *Guidelines for Statistical Analysis of Occupational Exposure Data* (U.S. EPA, 1994a). That report recommends using the (LOD ÷ √2) if the geometric standard deviation of the data is less than 3.0 and (LOD ÷ 2) if the geometric standard deviation is 3.0 or greater. Use of this substitution method may impact the calculation of the exposure estimate statistics.

Additionally, bulk samples included in inhalation monitoring studies may be used to confirm the presence of DEHP which supports the inclusion of non-detect samples in the final statistics.

Limitations associated with dermal exposure assessment are described in Table 4-6.

Assumptions

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

EPA calculated ADD values assuming workers and ONUs are routinely exposed during their entire working lifetime, which may result in an overestimate. Individuals may change jobs during their career which could result in DEHP exposures that are lower than estimated.

Assumptions associated with dermal exposure assessment are described in Table 4-6.

Uncertainties

EPA addressed variability in inhalation models by identifying key model parameters and applying statistical distributions that mathematically represent the parameter's variability. The Agency defined statistical distributions for parameters using documented statistical sources where available. Where the statistical variability 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 DEHP. 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 true distribution of each of the model input parameters.

Surrogate approaches may be used in cases where no reasonably available exposure data exists for an OES. In these situations, EPA may use surrogate (analogous) monitoring/modeling data (same chemical but a different/similar OES). Additionally, the Agency may use surrogate monitoring/modeling where the different chemical but the same (or similar) OES.

Due to lack of ONU exposure data, EPA used the worker central tendency estimate as a surrogate for ONUs. How well the worker central tendency exposure estimate represents true ONU exposure is unknown. Therefore, EPA has lower confidence in the ONU exposure estimates compared to worker central tendency exposure estimates.

Generic Scenarios and Emission Scenario Documents are industry-specific guidance documents that provide estimation methods for occupational exposures and environmental releases. Although these documents are industry-specific, they are generally not chemical-specific.

These approaches are used to fill data gaps but have inherent uncertainty in how well they represent the populations and activities they are used to assess.

Uncertainties associated with dermal exposure assessment are described in Table 4-6.

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 *Consumer and Indoor Dust Exposure Assessment for DEHP* (U.S. EPA, 2025c) 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 4-7), 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; and
- Parameterization of selected modeling tools.

Consumer products or articles containing DEHP were matched with the identified consumer COUs. Table 4-7 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 product and article information for selected items with the goal of recreating the indoor environment. The subset of consumer products and articles that are 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.

When a quantitative analysis of reasonably available information 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, 2023c), see Section 4.1.2.1.1 for description of approaches and methodology. Dermal exposures were calculated using a flux-limited dermal absorption approach for liquid and solid products, see Section 4.1.2.1.2 for description of approaches and methodology. For each exposure route, EPA used the 10th percentile, average, and 95th percentile deemed to characterize a high level of uncertainty and/or variability (*e.g.,* DEHP weight fraction, article surface area, mass of product used, etc.) to characterize low, medium, and high exposure for a given condition of use. 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 the *Consumer and Indoor Dust Exposure Assessment for DEHP* (U.S. EPA, 2025c) for details about the consumer modeling approaches, sources of data, model parameterization, and assumptions.

Exposure via the inhalation route occurs from inhalation of DEHP gas-phase emissions or when DEHP partitions to suspended particulate from direct use or application of products. However, DEHP'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 article in mouth) in which the person can ingest settled dust containing DEHP or directly ingesting DEHP from migration out of the article to saliva. Additionally, ingestion of suspended dust can occur when DEHP migrates from product to dust or partitions from gas-phase to suspended dust.

EPA made some adjustments to match CEM's life stages to those listed in the U.S. Centers for Disease Control and Prevention (CDC) guidelines (CDC, 2021) and EPA's *A Framework for Assessing Health Risks of Exposures to Children* (U.S. EPA, 2006). CEM life stages are re-labeled from this point forward as follows:

- Adult (21+ years) → Adults
- Youth 2 (16–20 years) → Teenagers
- Youth 1 (11–15 years) → Young teens
- Child 2 (6–10 years) → Middle childhood
- Child 1 (3–5 years) → Preschoolers
- Infant 2 (1–2 years) → Toddlers
- Infant 1 (<1 year) → Infants

EPA assessed acute, intermediate, and chronic exposures to DEHP 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 30-second intervals during the first 24 hours and every subsequent hour for 60 days and averaged over 1 year. Intermediate dose is the exposure to continuous or intermittent (depending on product) use during a 30-day period, which is roughly 1 month. See Sections 2.2.1 and 2.2.2 and Appendix A in (U.S. EPA, 2025c) for details about acute, chronic, and intermediate dose calculations. 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 4-7. Summary of Consumer COUs, Exposure Scenarios, and Exposure Routes

Consumer COU Category	Consumer COU Subcategory	Product/Article	Exposure Scenario and Route	Evaluated Routes				
						Ingestion		
				Inhalation [a]	Dermal	Suspended Dust	Settled Dust	Mouthing
Automotive, fuel, agriculture, outdoor use products	Lawn and garden care products	Small articles with the potential for semi-routine contact: hose	Direct contact during use	*QL*	**QT**	*QL*	*QL*	*QL*
Construction, paint, electrical, and metal products	Adhesives and sealants	Adhesive/sealant for home DIY, large indoors	Use of product in DIY large-scale home repair activities; direct contact during use; inhalation of emissions during use	**QT**	**QT**	*QL*	*QL*	*QL*
Construction, paint, electrical, and metal products	Adhesives and sealants	Adhesive/sealant for home DIY, small outdoors	Direct contact during application	*QL*	**QT**	*QL*	*QL*	*QL*
Construction, paint, electrical, and metal products	Adhesives and sealants	Automotive filler/putty	Use of product in DIY small-scale auto repair. Direct contact during use; inhalation of emissions	*QL*	**QT**	*QL*	*QL*	*QL*
Construction, paint, electrical, and metal products	Batteries	Batteries	Contact is expected to be infrequent	**QT**	**QT**	*QL*	*QL*	*QL*
Construction, paint, electrical, and metal products	Construction and building materials covering large surface areas, including paper articles; metal articles; stone, plaster, cement, glass and ceramic articles	Vinyl flooring	Direct contact, inhalation of emissions / ingestion of dust adsorbed chemical	**QT**[b]	**QT**	**QT**[b]	**QT**[b]	*QL*
Construction, paint, electrical, and metal products	Construction and building materials covering large surface areas, including paper articles; metal articles; stone, plaster, cement, glass and ceramic articles	Wallpaper	Two scenarios, installation, and in-place. Direct contact during installation (teenagers and adults) and while in place; inhalation of emissions / ingestion of dust adsorbed chemical	**QT**[b]	**QT**	**QT**[b]	**QT**[b]	*QL*
Construction, paint, electrical, and metal products	Machinery, mechanical appliances, electrical/ electronic articles	Small articles with the potential for semi-routine contact: phone charge, wireless earbuds, electrical tape	Direct contact during use	*QL*	**QT**	*QL*	*QL*	*QL*

Consumer COU Category	Consumer COU Subcategory	Product/Article	Exposure Scenario and Route	Evaluated Routes				
						Ingestion		
				Inhalation [a]	Dermal	Suspended Dust	Settled Dust	Mouthing
Construction, paint, electrical, and metal products	Machinery, mechanical appliances, electrical/ electronic articles	Insulated cords	Direct contact, inhalation of emissions/ ingestion of dust adsorbed chemical, mouthing by children	**QT**[b]	**QT**	**QT**[b]	**QT**[b]	*QL*
Construction, paint, electrical, and metal products	Paints and coatings	Coating for home DIY, large outdoors	Direct contact during application.	*QL*	**QT**	*QL*	*QL*	*QL*
Construction, paint, electrical, and metal products	Paints and coatings	Automotive coating	Use of product in DIY small-scale auto repair; direct contact during use; inhalation of emissions	**QT**	**QT**	*QL*	*QL*	*QL*
Furnishing, cleaning, treatment care products	Fabric, textile, and leather products; furniture and furnishings	Synthetic leather furniture	Direct contact during use; inhalation of emissions / ingestion of airborne particulate; ingestion by mouthing	**QT**[b]	**QT**	**QT**[b]	**QT**[b]	**QT**
Furnishing, cleaning, treatment care products	Fabric, textile, and leather products; furniture and furnishings	Synthetic leather clothing	Direct contact during use	*QL*	**QT**	*QL*	*QL*	*QL*
Furnishing, cleaning, treatment care products	Fabric, textile, and leather products; furniture and furnishings	Small articles with the potential for semi-routine contact: outdoor furniture, children's bags, wallets, footwear, interior and exterior components of jackets, handbags	Direct contact during use	*QL*	**QT**	*QL*	*QL*	*QL*
Furnishing, cleaning, treatment care products	Floor coverings; construction and building materials covering large surface areas including stone, plaster, cement, glass and ceramic articles; fabrics, textiles, and apparel	Vinyl flooring	Direct contact, inhalation of emissions/ ingestion of dust adsorbed chemical	**QT**[b]	**QT**	**QT**[b]	**QT**[b]	*QL*
Furnishing, cleaning, treatment care products	Floor coverings; construction and building materials covering large surface areas including stone, plaster, cement, glass and ceramic	Wallpaper	Two scenarios, installation, and in-place; direct contact during installation (teenagers and adults) and while in place; inhalation of	**QT**[b]	**QT**	**QT**[b]	**QT**[b]	*QL*

Consumer COU Category	Consumer COU Subcategory	Product/Article	Exposure Scenario and Route	Evaluated Routes				
						Ingestion		
				Inhalation [a]	Dermal	Suspended Dust	Settled Dust	Mouthing
	articles; fabrics, textiles, and apparel		emissions/ingestion of dust adsorbed chemical					
Packaging, paper, plastic, toys, hobby products	Ink, toner, and colorants	Stamp ink	Direct contact during use	*QL*	**QT**	*QL*	*QL*	*QL*
Packaging, paper, plastic, toys, hobby products	Packaging (excluding food packaging) and other articles with routine direct contact during normal use, including rubber articles; plastic articles (hard); plastic articles (soft)	Air mattresses and sleeping mats	Direct contact during use; inhalation of emissions/ingestion of dust adsorbed chemical	**QT**[b]	**QT**	**QT**[b]	**QT**[b]	*QL*
Packaging, paper, plastic, toys, hobby products	Packaging (excluding food packaging) and other articles with routine direct contact during normal use, including rubber articles; plastic articles (hard); plastic articles (soft)	Rubber eraser	Direct contact during use; rubber particles may be inadvertently ingested during use. Eraser may be mouthed by children	*QL*	**QT**	*QL*	*QL*	**QT**
Packaging, paper, plastic, toys, hobby products	Packaging (excluding food packaging) and other articles with routine direct contact during normal use, including rubber articles; plastic articles (hard); plastic articles (soft)	Mobile phone covers	Direct contact during use	*QL*	**QT**	*QL*	*QL*	*QL*
Packaging, paper, plastic, toys, hobby products	Packaging (excluding food packaging) and other articles with routine direct contact during normal use, including rubber articles; plastic articles (hard); plastic articles (soft)	Shower curtain	Direct contact during use; see routine contact scenario inhalation of emissions / ingestion of dust adsorbed chemical while hanging in place	**QT**[b]	**QT**	**QT**[b]	**QT**[b]	*QL*
Packaging, paper, plastic, toys, hobby products	Packaging (excluding food packaging) and other articles with routine direct contact during normal use, including rubber articles; plastic articles (hard); plastic articles (soft)	Small articles with the potential for semi-routine contact: packaging, paper, plastic, toys, hobby products: cutting board, pencils, pouches, bags,	Direct contact during use	*QL*	**QT**	*QL*	*QL*	*QL*

Consumer COU Category	Consumer COU Subcategory	Product/Article	Exposure Scenario and Route	Evaluated Routes				
						Ingestion		
				Inhalation [a]	Dermal	Suspended Dust	Settled Dust	Mouthing
		hose, labels, covers, chewy toys, jewelry, gloves, packaging, mats, lampshade, vinyl floor runner, diving goggles, silly straws, stickers, diving goggles						
Packaging, paper, plastic, toys, hobby products	Packaging (excluding food packaging), including paper articles	Small articles with the potential for semi-routine contact: Packaging, paper, hobby products: pencils, labels, covers, lampshade, stickers	Direct contact during use	*QL*	**QT**	*QL*	*QL*	*QL*
Packaging, paper, plastic, toys, hobby products	Toys, playground, and sporting equipment	Children's Toys (legacy)	Collection of toys; direct contact during use; inhalation of emissions/ingestion of airborne particulate; ingestion by mouthing	**QT**[b]	**QT**	**QT**[b]	**QT**[b]	**QT**
Packaging, paper, plastic, toys, hobby products	Toys, playground, and sporting equipment	Children's Toys (new)	Collection of toys; direct contact during use; inhalation of emissions/ ingestion of airborne PM; ingestion by mouthing	**QT**[b]	**QT**	**QT**[b]	**QT**[b]	**QT**
Packaging, paper, plastic, toys, hobby products	Toys, playground, and sporting equipment	Tire crumb, artificial turf	Direct contact during use (particle ingestion via hand-to-mouth)	**QT**	**QT**	**QT**[c]		
Packaging, paper, plastic, toys, hobby products	Toys, playground, and sporting equipment	Small articles with the potential for semi-routine contact: Fitness balls, jump rope, yoga mat, football, and diving goggles	Direct contact during use	*QL*	**QT**	*QL*	*QL*	*QL*
Other	Novelty articles	Adult toys	Direct contact during use, ingestion by mouthing	*QL*	**QT**	*QL*	*QL*	**QT**
Other	Automotive articles	Car mats	Direct contact during use; see routine contact scenario inhalation	**QT**[b]	**QT**	**QT**[b]	**QT**[b]	*QL*

Consumer COU Category	Consumer COU Subcategory	Product/Article	Exposure Scenario and Route	Evaluated Routes				
						Ingestion		
				Inhalation [a]	Dermal	Suspended Dust	Settled Dust	Mouthing
			of emissions/ingestion of dust adsorbed chemical					
Other	Automotive articles	Tire replacement	Direct contact during use	*QL*	**QT**	*QL*	*QL*	*QL*
Disposal [d]	Disposal	Down the drain products and articles	Down the drain and releases to environmental media	*QL*	*QL*	*QL*	*QL*	*QL*
Disposal [d]	Disposal	Residential end-of-life disposal, product demolition for disposal	Product and article end-of-life disposal and product demolition for disposal	*QL*	*QL*	*QL*	*QL*	*QL*

DIY= Do-it-Yourself; *QL* = Qualitative Consideration; **QT** = Quantitative consideration
[a] Inhalation scenarios consider suspended dust and gas-phase emissions.
[b] These indoor dust articles scenarios consider the surface area from multiple articles such as toys, while furniture and flooring already have large surface areas. For these articles dust can deposit and contribute to significantly larger concentration of dust than single small articles.
[c] The tire crumb and artificial turf ingestion route assessment considers all three types of ingestions, settled dust, suspended dust, and mouthing altogether, but results cannot be provided separately has it was done for all other articles and products.
[d] Disposal consideration; see Section 2 of the *Consumer and Indoor Dust Exposure Assessment for DEHP* (U.S. EPA, 2025c) for qualitative assessments (*i.e.*, batteries, stamp ink, and disposal qualitative assessments) for a detailed qualitative discussion of disposal exposures. Note that exposures resulting from disposing of down the drain are primarily expected to affect the environmental organisms and the general population who are downstream from wastewater releases. However, exposures from disposal in general could not be estimated due to key uncertainties discussed in Section 2 of the *Consumer and Indoor Dust Exposure Assessment for DEHP* (U.S. EPA, 2025c).

4.1.2.1.1 Inhalation and Ingestion Exposure Routes Modeling Approaches

Key parameters for articles modeled in CEM 3.2 are summarized in detail in Section 2 in *Consumer and Indoor Dust Exposure Assessment for DEHP* (U.S. EPA, 2025c). Calculations, sources, input parameters and results are also available in *Consumer Exposure Analysis for DEHP* (U.S. EPA, 2025d). 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 important input parameters for exposure from articles and products is included 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).

Of these, the chemical migration rate from articles to saliva and area mouthed are most important to mouthing exposure scenarios while duration, frequency and amount used have been determined to be key determinants of estimated exposure concentrations according to a sensitivity analysis conducted for CEM input parameters (U.S. EPA, 2023c).

For each scenario, high-, medium-, and low-intensity use exposure scenarios were developed in which values for duration of use, frequency of use, and surface area were determined based on reasonably available information or professional judgment. 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 if CEM default parameters were not applicable an assumption based on article use descriptions by manufacturers was used always choosing the health protective values. For the high intensity use exposure scenarios, EPA used the highest input values. While some of the inputs are conservative, these are considered represent possible high-end exposures.

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. This is because when the consumer product or article is being used, the near-field/far-field modeling allows EPA to more accurately predict a consumer's exposure by assuming a volume of air (*i.e.*, 1 m^3) around the individual as they move throughout the room and/or use a product during the time of use and otherwise follow their prescribed activity pattern (*i.e.*, applying sealant to the baseboard around a living room for a total of 30 minutes). On the other hand, bystanders follow their prescribed activity pattern and inhale far-field concentrations when they are in the room of use. For instance, bystanders may be children playing on the living room floor as the active consumer product user (typically a parent or other adult), applies the sealant on the baseboard that surrounds the room during a 30-minute time frame. In this example, the parent is exposed to a higher concentration of DEHP compared to the children because the parent is closer to the DEHP being released from the sealant. Sometime later, as the sealant dries, through ventilation and as the fumes and particle matter disperse in the room, the parent and the children would be both exposed to a relatively more homogenous air concentration of DEHP that would be reflected in the modeling results for the well-mixed room. The prior is a consumer application scenario best represented by the near-field/far-field modeling, and the latter is an indoor air exposure scenario best represented by the well-mixed room modeling. The well-mixed room modeling should be applied when estimating overall indoor air chemicals exposures occurring in the long-term, once peak concentrations (via emissions or abrasion/resuspension) have dissipated towards a background level of the chemical. This may take days weeks or months after use or installation—depending on the chemical, product/article, room of use, ventilation rate, and room volume. As appropriate, EPA uses the near-field/far-field model because it captures the highest potential chemical concentration that occurs during the consumer condition of use, while the well-mixed room scenario would not capture the short-term (*i.e.*, acute) exposure in the immediate space (volume of air) where the product is been used. See Section 2.1 for weight fraction selection and Section 2.2.3 for parameterization details in the *Consumer and Indoor Dust Exposure Assessment for DEHP* (U.S. EPA, 2025c).

4.1.2.1.2 Dermal Exposure Routes Modeling Approaches

See U.S. EPA (2025c) for details about DEHP dermal exposures to liquid and solid consumer products and articles. The dermal dose of DEHP associated with use of both liquid products and solid articles was calculated in a spreadsheet outside of CEM. All dermal spreadsheet inputs, sources of information, assumptions, and exposure scenario descriptions are available in the *Consumer Exposure Analysis for DEHP* (U.S. EPA, 2025e) and *DEHP Consumer Risk Calculator* (U.S. EPA, 2025f). EPA used a screening approach with a range of conservative and representative input parameters for contact surface area, and duration and frequency of contact. The flux-limited, screening dermal absorption approaches for liquid and solid products and articles assumes a constant rate of absorption of DEHP in contact with the skin independent of concentration in the article/product. Dermal flux value for liquid products was from Hopf et al. (2014) and solid products was from Chemical Manufacturers Association (1991). The flux-limited screening approach provides an upper bound of dermal absorption of DEHP and likely results in some overestimations, see Section 4.1.2.4 discussion on limitations, strengths, and confidence. For each product or article, high-, medium-, and low-intensity use 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. Key parameters for the dermal model are shown in Section 2.3 in (U.S. EPA, 2025c).

The screening dermal exposure risk assessment for air beds resulted in potential risks for the high-, medium-, and low-intensity use exposure scenarios, see Appendix B in U.S. EPA (2025c). EPA refined the screening approach used for dermal exposures to air beds as described in this section for all life stages. Specifically, the Agency moved from a screening approach of assuming flux limited dermal absorption to a more refined approach, which models dermal absorption using DEHP concentration in the article, material-, and DEHP-specific partition coefficients as well as a barrier bedsheet between the air bed and skin.

4.1.2.2 Modeling Dose Results by COU for Consumer

This section summarizes the dose estimates from inhalation, ingestion, and dermal exposure to DEHP in consumer products and articles. Detailed tables of the dose results for acute, intermediate, and chronic exposures are available in the *Consumer Risk Calculator for DEHP* (U.S. EPA, 2025f). Modeling dose results for acute, intermediate, and chronic exposures and data patterns are described in Section 3 in the *Consumer and Indoor Exposure Assessment for DEHP* (U.S. EPA, 2025c).

For teens and young adults (11–20 years old), and adults, dermal contact was a strong driver of exposure to DEHP, with the dose received being generally higher than or similar to the dose received from exposure via inhalation or ingestion. This is likely due to the dermal modeling assumption, per Kissel (2011), that the supply of the DEHP material added to the skin is in excess and not significantly depleted over the course of the product or article's use. This results in a potential overestimation of dose and subsequent risk. The largest dose estimated is for acute and chronic dermal exposure to synthetic leather furniture for all life stages. Among the younger life stages (infant to 11 years old), the pattern was less clear as these ages were designated as bystanders rather than product users, therefore dermal exposure was not modeled for any of the liquid products assessed. Key differences in exposures among life stages 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 life stages.

4.1.2.3 Indoor Dust Assessment

Because PVC products are ubiquitous in modern indoor environments, and DEHP is not chemically-bound to many consumer products and articles in which it is incorporated, it can leach, migrate or evaporate into indoor air and concentrate in household dust. See Section 2.2.3.1.9 of the *Consumer and Indoor Exposure Assessment for DEHP* (U.S. EPA, 2025c) for a detailed presentation of product and article DEHP migration rates observed in the literature. Exposure to DEHP through dust ingestion, dust inhalation, and dermal absorption is a particular concern for young children between the ages of 6 months and 2 years. This is because crawling on the ground and pulling up on ledges increases hand-to-dust contact as does placing their hands and objects in their mouths. Exposure to DEHP via ingestion of dust was assessed for all articles expected to contribute significantly to dust concentrations due to high surface area (exceeding ~1 m^2) for either a single article or collection of like articles as appropriate. In a screening assessment, EPA considered the aggregation of chronic dust ingestion doses, see Section 4.3 in in the *Consumer and Indoor Exposure Assessment for DEHP* (U.S. EPA, 2025c). The highest dose was for preschoolers, aged 3 to 5 years.

Articles included in the indoor assessment included the following:

- car mats;
- vinyl flooring;
- wallpaper in-place;
- insulated cords;
- furniture components (textiles);
- air beds;
- shower curtains; and
- children's toys, new and legacy.

Regarding the mechanism through which exposures or risks to indoor dust may occur (*i.e.*, via migration of DEHP from consumer materials to indoor dust), abraded particles are generally assumed to be initially emitted to the air and thereafter may deposit and resuspend from the surfaces. Abraded particles, like suspended and settled particulate, are subject to cleaning and ventilation losses. Abraded particles, both in the suspended and settled phases, are not assumed to be in equilibrium with the air phase. EPA could not predict how much DEHP originally in an article would become available in household dust where it may be ingested by infants via hand-to-mouth. Hence, the chemical transfer between particulates and the air phase was kinetically modeled in terms of two-phase mass transfer theory. EPA also assessed indoor dust ingestion from the monitoring literature. EPA compared these values in Section 4.3 of the *Consumer and Indoor Exposure Assessment for DEHP* (U.S. EPA, 2025c). Modeling and monitoring results were within the same order or magnitude. With an age group-specific margin of error ranging from 0.6 to 9 depending on the age group. For a detailed discussion of COU-specific uncertainties, see Sections 2 and 5 of the *Consumer and Indoor Exposure Assessment for DEHP* (U.S. EPA, 2025c).

4.1.2.4 Weight of Scientific Evidence Conclusions for Consumer Exposure

Key sources of uncertainty for evaluating exposure to DEHP in consumer goods and strategies to address those uncertainties are described in detail in Section 5.1 of the *Consumer and Indoor Exposure Assessment for DEHP* (U.S. EPA, 2025c). Generally, designation of robust confidence suggests that the supporting scientific evidence weighed against the uncertainties is adequate to characterize exposure assessments. 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 that the supporting scientific evidence weighed against the uncertainties is reasonably adequate to characterize exposure assessments. 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. The DEHP consumer exposure 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 choosing conservative assumptions that are not excessive or unreasonable.

4.1.2.5 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 4-8 summarizes the overall confidence per COU, and a discussion of rationale used to assign the overall confidence. The subsections preceding Table 4-8 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.

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 sometimes limited for weight fractions of DEHP in consumer goods. EPA obtained DEHP weight fractions in various products and articles from material safety data sheets, data bases, and existing literature see Section 2.1 in U.S. EPA (2025c). 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. The screening assessment for dermal exposure largely did not depend on weight fractions as a modeling input. Instead, it was highly dependent on the DEHP experimental dermal load applied from literature for liquid products and solid articles. On the other hand, the refined dermal exposure assessment for airbeds did utilize weight fraction as a key input parameter. 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 varying composition of products and articles within one COU. Overall weight fraction confidence is *moderate* for products/articles with multiple sources but insufficient description on how the concentrations were obtained, *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.

Product Use Patterns
Consumer use patterns such as frequency of use, duration of use, method of application, and skin contact area are expected to differ. Where possible, low, medium, and high 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 are well characterized. The overall confidence for most use patterns is rated *robust*.

Article Use Patterns
To calculate inhalation and ingestion exposures from articles, the high-, medium-, and low-intensity use scenarios default values from CEM 3.2's prepopulated scenarios were selected for indoor use environment/room volume, interzone ventilation, and surface layer thickness. To calculate dermal exposures from articles, use patterns such as frequency of use and skin contact area are expected to have a range of low to high use intensities. For articles, which do not use duration of use as an input in CEM, professional judgment was used to select the duration of use/article contact duration for the low, medium, and high exposure scenario levels for most articles except for vinyl flooring. Vinyl flooring contact duration values were taken from EPA's Standard Operating Procedures for Residential Pesticide Exposure Assessment for the high exposure level (2 hours; time spent on floor surfaces) (U.S. EPA, 2012b), ConsExpo (U.S. EPA, 2012b) for the medium exposure level (1 hour; time a child spends crawling on treated floor), and professional judgment for the low exposure level (0.5 hour). There are more uncertainties in the assumptions and professional judgment for contact duration inputs for articles; thus, EPA has *moderate* confidence in those inputs.

Article Surface Area
The surface area of an article directly affects the potential for DEHP emissions to the environment. For each article modeled for inhalation exposure, low, medium, and high estimates for surface area were calculated see Section 2.2.3 in U.S. EPA (2025c). This approach relied on manufacturer-provided dimensions where possible, or values from EPA's *Exposure Factors Handbook* for floor and wall coverings. For small items that might be expected to be present in a home in significant quantities, such as insulated wires and children's toys, aggregate values were calculated for the cumulative surface area for each type of article in the indoor environment. Overall confidence in surface area is *moderate* for articles like wires because there is less understanding of the number of wires exposed to collect dust, and the great variability that is expected may not be well represented. Overall confidence in surface area is *robust* for articles like furniture, wall coverings, flooring, toys, and shower curtains because there is a good understanding of the presence and dimensions of these articles in indoor environments.

Human Behavior
CEM 3.2 has three different 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 chosen as it is the most protective assumption.

Mouthing durations are a source of uncertainty in human behavior. The data used in this assessment are based on a study in which parents observed children (n = 236) ages 1 month to 5 years of age for 15 minutes each session and 20 sessions in total (Smith and Norris, 2003). There was considerable variability in the data due to behavioral differences among children of the same life stage. For instance, while children aged 6 to 9 months had the highest average mouthing duration for toys at 39 minutes per day, the minimum duration was 0 minutes, and the maximum was 227 minutes per day. The observers noted that the items mouthed were made of plastic roughly 50 percent of the mouthing time, but this was not limited to soft plastic items likely to contain significant plasticizer content. In another study, 169 children aged 3 months to 3 years were monitored by trained observers for 12 sessions at 12 minutes each session (Greene, 2002). They reported mean mouthing durations ranging from 0.8 to 1.3 minutes per day for soft plastic toys and 3.8 to 4.4 minutes per day for other soft plastic objects (except pacifiers). Thus, it is likely that the mouthing durations used in this assessment provide a health protective estimate for mouthing of soft plastic items likely to contain DBP. EPA assigned a *moderate* confidence associated with the duration of activity for mouthing because the magnitude of the overestimation is not well characterized. All other human behavior parameters are well understood or the ranges used capture use patterns representative of various life stages, which results in a *robust* confidence in use patterns.

Inhalation and Ingestion 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. For example, the model used (CEM 3.2) has been peer reviewed, is publicly available, and has been applied in a 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 for consumer exposure modeling is *robust*.

Dermal Modeling of DEHP

Experimental dermal data was identified via the systematic review process to characterize consumer dermal exposures to liquids or mixtures and formulations containing DEHP; see Section 2.3.1 in U.S. EPA (2025c). The confidence in dermal exposure to liquid and solid products model used in this assessment is *moderate*.

EPA identified nine experimental studies directly related to the dermal absorption of DEHP. Of the nine available studies, EPA identified two studies that are most reflective of DEHP exposure from consumer products and articles: one for liquid products (Hopf et al., 2014) and one for solid products (Chemical Manufacturers Association, 1991). Section 2.3.1 in U.S. EPA (2025c) summarized the criteria applied to select these two studies. When available dermal absorption empirical data that is specific to the exposure scenarios of interest is preferrable over modeling approaches.

The Chemical Manufacturers Association (1991) dermal absorption study was conducted *in vivo* using male F344 rats. There have been additional studies conducted to determine the difference in dermal absorption between rat skin and human skin. Specifically, Scott et al. (1987) examined the difference in dermal absorption between rat skin and human skin for four different phthalates (*i.e.*, DMP, DEP, DBP, and DEHP) using *in vitro* dermal absorption testing. Results from the *in vitro* dermal absorption experiments showed that rat skin was more permeable than human skin for all four phthalates examined. For example, rat skin was up to 30 times more permeable than human skin for DEP, and rat skin was up to 4 times more permeable than human skin for DEHP. Although there is uncertainty regarding the magnitude of difference between dermal absorption through rat skin vs. human skin for DEHP, EPA is confident that the *in vivo* dermal absorption data using male F344 rats may lead to an overestimation of dermal absorption of DEHP based on the findings of Scott et al. (1987). The Chemical Manufacturers Association (1991) dermal absorption study provides the best available data for solid articles and met most of the criteria for selection as highlighted in Section 2.3.1 in the *Consumer and Indoor Exposure Assessment for DEHP* (U.S. EPA, 2025c). In fact, this study was the only study identified that measured dermal absorption of DEHP from solid articles and accounted for both the low migration rate of DEHP out of the PVC film (0.13%) and the low dermal absorption of migrated DEHP available for absorption (3.4%).

EPA identified a study of dermal absorption to liquids for DEHP, Hopf et al. (2014), which reported dermal absorption based on metabolically active excised human skin, within just a few hours after excision; therefore, this study was used for determining exposure of humans to liquids containing DEHP. It should be noted that the Agency identified an error with the reported applied dose whereby the units were incorrectly reported in mg/cm^2 instead of $\mu g/cm^2$. Based on supporting information reported within the study's report (*i.e.*, concentration of DEHP, application amount, and skin surface area), the Agency was able to recalculate the correct applied dose in $\mu g/cm^2$. As was the case with dermal contact with solid articles, the flux resulting from dermal contact with liquid formulations of DEHP was low, 0.0013 $\mu g/cm^2$/hour for the neat material and 0.025 $\mu g/cm^2$/h for aqueous solutions of DEHP.

EPA used a screening flux-limited approach to assess dermal exposures to air beds. Upon examination of the dermal exposure results for air beds using the screening flux-limited approach, EPA identified the concentration of DEHP in the article, direct surface contact area between skin and air bed, and duration of contact, to be key drivers of risk estimates resulting in a MOE under the benchmark of 30 (see Section 2.3.2 in U.S. EPA (2025c)). Moreover, the screening flux-limited approach was independent of concentration of DEHP in the air bed, due to an assumption of excess of DEHP available for exposure. This conservative screening assumption did not result in evidence of potential for risk for any products or articles other than air beds. Generally, the screening approach is assumed to represent conservative potential dermal exposure scenarios. To refine its assessment of dermal exposures to air beds, EPA considered the concentration of DEHP in air beds instead of the flux-limited approach and included a barrier bedsheet between air bed and skin to better estimate typical dermal exposures to air beds, based on a wide range of possible usage patterns. This refinement was based on the application of DEHP partitioning coefficients among the air bed, bedsheet, and skin, which were all sourced from peer-reviewed literature (see Section 2.3.2 in U.S. EPA (2025c)). This refinement increased EPA's confidence in the dermal exposure assessment of DEHP in air beds as it considers realistic exposure scenarios based on a wide range of possible usage patterns that consider long and shorter contact durations.

A key source of uncertainty regarding the dermal absorption of DEHP from products or formulations stems from the varying concentrations and co-formulants that exist in products or formulations containing DEHP. Dermal contact with products or formulations that have lower concentrations of DEHP may exhibit lower rates of flux because 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 DEHP would result in decreased or increased dermal absorption. Based on the available dermal absorption data for DEHP, EPA has made assumptions that result in exposure assessments that are the most human health protective in nature.

Experimental dermal data were identified via the systematic review process to estimate dermal exposures to solid products or articles containing DEHP, and a modeling approach was used to estimate exposures; see Appendix A.4 in U.S. EPA (2025c). Because this study is accounting for the low migration rate of DEHP out of the PVC film and the low dermal absorption of that migrated DEHP available for absorption to determine the flux of 0.048 $\mu g/cm^2$/hour, this test system provides the most relevant estimate of dermal absorption from contact with solid articles. However, the study is in rats, whose skin is more permeable than human skin. Additionally, flux is concentration-dependent, and the study used a high percentage of DEHP in the film (40%). Therefore, the flux may provide a conservative estimate of dermal absorption in humans exposed to DEHP in solid articles. EPA has a *moderate* confidence in the dermal exposure to solid products or articles modeling approach.

Ingestion Via Mouthing

For chemical migration rates to saliva, existing data were highly variable both within and between studies. This indicates the significant level of uncertainty for the chemical migration rate, as it may also differ even among similar items due to variations in chemical makeup and polymer structure. As such, an effort was made to choose DEHP migration rates likely to be representative of broad classes of items that make up consumer COUs produced with different manufacturing processes and material formulations. There is no consensus on the correct value to use for this parameter in past assessments of DEHP. The 2003 EU Risk Assessment for DEHP used a migration rate of 53.4 µg/cm^2/h selected from the highest individual estimate from a 1998 study by the Netherlands National Institute for Public Health and the Environment (RIVM) (ECJRC, 2003; RIVM, 1998). The RIVM study measured DEHP in saliva of 20 adult volunteers biting and sucking four PVC disks with a surface of 10 cm^2. Average migration to saliva from the samples tested were 8.4, 14, 4, and 9.6 µg/cm^2/h, and there was considerable variability in the results. The reported standard deviations were very broad, up to twice the mean, for the 3 mouthing approaches (*i.e.*, mild, medium, and harsh mouthing scenarios), which highlights a lack of specificity in the associated data.

In a somewhat more recent report, the ECHA compiled and evaluated new evidence on human exposure to DEHP, including chemical migration rates (ECHA, 2013). They concluded that a chemical migration rate of 14 µg/cm^2/h was likely to be representative of a "typical mouthing scenario" and a migration rate of 45 µg/cm^2/h was a reasonable worst-case estimate of this parameter. The "typical" value was determined by compiling *in vivo* migration rate data from existing studies (Niino et al., 2003; Sugita et al., 2003; Fiala et al., 2000; Meuling et al., 2000; Chen, 1998; RIVM, 1998). The "worst case" value was midway between the two highest individual measurements among all the studies (the higher of which was used in the 2003 EU risk assessment). As such, based on available data for chemical migration rates of DEHP to saliva, the range of values used in this assessment (1.6, 13.3, and 44.8 µg/cm^2/h) are considered likely to capture the true value of the parameter depending on article expected uses. EPA assumes children's mouthing behavior can be harsh, medium, and mild for children's toys. Mouthing behavior for adults using adult toys is not expected to be harsh. Harsh mouthing of adult toys would likely result in the breakage or destruction of the article, and adults tend to control the harshness of their mouthing better than infants and toddlers. EPA calculated a high-intensity use of adult toys using harsh mouthing approaches as part of the screening approach and recognized that this highly conservative result is very unlikely behavior and decided that it should not be further used in risk assessment approaches. The Agency did not identify use pattern information regarding adult toys, and most inputs are based on professional judgment assumptions.

For other items that are not adult toys and were assumed to be mouthed by children, EPA used mouthing duration inputs from Smith and Norris (2003). Smith and Norris (2003) conducted a study on mouthing behaviors in 236 children, using parental observation through a standardized diary form. Each child was observed for a total of 5 hours, divided into 20 15-minute sessions over 2 weeks. Daily mouthing durations were then extrapolated to total daily estimates based on recorded waking hours when the child was not eating. To assess the validity and reliability of the observation method, a subset of 25 children was re-evaluated using parental observations, trained observers, and video recordings. While this study provides robust data on total mouthing time, directly using these values would likely overestimate phthalate exposure since not all mouthed objects contain phthalates. The authors reported that a wide variety of objects were mouthed and provided an age-stratified analysis of material composition for "toys" and "other objects." However, the study does not specify whether these percentages reflect the fraction of total mouthing time spent on plastic items, nor does it distinguish between different types of plastic—including soft plastics more likely to contain phthalates.

Another major limitation of all existing data is that DEHP weight fractions for products tested in mouthing studies skew heavily towards relatively high weight fractions (30–60%), and measurements for weight fractions less than 15 percent are very rarely represented in the data set. Thus, it is unclear whether these migration rate values are applicable to consumer goods with low (<15%) weight fractions of DEHP, where rates might be lower than represented by typical or worst-case values determined by existing data sets.

EPA has a *moderate* confidence in mouthing estimates mainly due to uncertainties with professional judgment inputs used in the absence of use pattern information, as previously mentioned. In general, the chemical migration rate input parameter has a moderate confidence due to the large variability in the empirical data used in this assessment and unknown correlation between chemical migration rate and DEHP concentration in articles.

Table 4-8. Weight of Scientific Evidence Summary Per Consumer COU

Consumer COU Category and Subcategory	Weight of Scientific Evidence	Overall Confidence
Automotive, fuel, agriculture, outdoor use product; Lawn and garden care products Other uses; Automotive articles	Three indoor scenarios were assessed for these COUs including car mats, tire replacements, and hose. These scenarios capture variability in product formulation in the low-, medium-, and high-intensity use estimates. The overall confidence in this indoor COU inhalation and dust ingestion exposure estimate is robust because the CEM default parameters generally represent actual products on the market, relevant use patterns and location of use. See Section 2.1.1 in U.S. (2025c) for number of products, product examples, and weight fraction data. For solid articles dermal exposure EPA used a dermal flux-limited approach, which was estimated based on DEHP *in vivo* dermal absorption in rats. The flux-limited approach likely results in overestimations due to the assumption about excess DEHP in contact with skin. The overall confidence in this dermal exposure estimate is moderate for article exposures. There is some uncertainty regarding the magnitude of difference between dermal absorption through rat skin vs. human skin for DEHP. Due to increased permeability of rat skin as compared to human skin, dermal absorption estimates likely overestimate exposures.	Inhalation and Ingestion – Robust Dermal – Moderate
Construction, paint, electrical, and metal products; Adhesives and sealants; batteries; construction and building materials covering large surface areas, including paper articles, metal articles, stone, plaster, cement, glass and ceramic articles; machinery, mechanical appliances, electrical/electronic articles; paints and coatings	Ten different scenarios were assessed for these COUs for products and articles with differing use patterns for which each scenario had varying number of identified product and article examples: adhesive/sealant for home DIY (large indoors, small outdoors), automotive filler/putty, batteries, vinyl flooring, wallpaper, small articles with the potential for semi-routine contact (phone charge, wireless earbuds, electrical tape), insulated cords, coating for home DIY (large outdoors), automotive coating. These scenarios capture variability in product formulation weight fractions in the low-, medium-, and high-intensity use estimates. The overall confidence in this indoor COU inhalation and dust ingestion (articles only) exposure estimate is robust because the CEM default parameters are representative of typical use patterns and location of use. The stay-at-home activity use input parameter is considered a conservative input that, although representative of actual uses for some populations, is also believed to result in an upper bound	Inhalation – Robust Dermal – Moderate

Consumer COU Category and Subcategory	Weight of Scientific Evidence	Overall Confidence
	exposure. See Sections 2.1.1 and 2.1.2 in U.S. (2025c) for article examples and weight fraction data. For solid articles dermal exposure EPA used a dermal flux-limited approach, which was estimated based on DEHP *in vivo* dermal absorption in rats. The flux-limited approach likely results in overestimations due to the assumption about excess DEHP in contact with skin. The overall confidence in this dermal exposure estimate is moderate for article exposures. There is some uncertainty regarding the magnitude of difference between dermal absorption through rat skin vs. human skin for DEHP. Due to increased permeability of rat skin as compared to human skin, dermal absorption estimates likely overestimate exposures. The overall confidence in this dermal exposure estimate is moderate for liquid product exposures. While Hopf et al. (2014) reported dermal absorption based on metabolically active excised human skin within just a few hours after excision, it should be noted that there may have been a unit error with the reported applied dose. Based on supporting information reported in the study (*i.e.*, concentration of DEHP, application amount, and skin surface area), EPA was able to recalculate the correct applied dose. Although the default parameters applied for dermal absorption estimates generally represent actual products on the market and relevant use patterns due to the reported uncertainty in other modeling inputs, the overall confidence was moderate.	
Furnishing, cleaning, treatment care products; Fabric, textile, and leather products; furniture and furnishings; floor coverings; construction and building materials covering large surface areas including stone, plaster, cement, glass and ceramic articles, fabrics, textiles, and apparel	Five different scenarios were assessed for these COUs for articles with differing use patterns for which each scenario had varying number of identified article examples: synthetic leather furniture, synthetic leather clothing, small articles with the potential for semi-routine contact (outdoor furniture, children's bags, wallets, footwear, interior and exterior components of jackets, handbags), vinyl flooring, wallpaper. These scenarios capture variability in product formulation weight fractions in the low-, medium-, and high-intensity use estimates. The overall confidence in this indoor COU inhalation and dust ingestion (articles only) exposure estimate is robust because the CEM default parameters generally represent actual products on the market, relevant use patterns and location of use because the CEM default parameters are representative of typical use patterns and location of use. The stay-at-home activity use input parameter is considered a conservative input that, although representative of actual uses for some populations, is also believed to result in an upper bound exposure. See Sections 2.1.1 and 2.1.2 in U.S. (2025c) for article examples and weight fraction data. Ingestion via mouthing exposure estimate overall confidence is moderate due to uncertainties in the parameters used for chemical migration to saliva, such as large variability in empirical migration rate data for harsh, medium, and mild mouthing approaches. Additionally, there are uncertainties from the unknown correlation between chemical concentration in articles and chemical migration rates, and no data were reasonably available to compare and confirm selected rate parameters to better understand uncertainties. There are uncertainties in the duration of mouthing inputs, however EPA is confident that the selected inputs from Smith and Norris (2003) likely overestimate phthalate exposure since not all mouthed objects in the study contained phthalates. For solid articles dermal exposure EPA used a dermal flux-limited approach, which was estimated based on DEHP *in vivo* dermal absorption in rats. The flux-limited approach likely results in overestimations due to the assumption about excess DEHP in contact with skin. The overall confidence in this	Inhalation and Dust Ingestion – Robust Mouthing – Moderate Dermal – Moderate

Consumer COU Category and Subcategory	Weight of Scientific Evidence	Overall Confidence
	dermal exposure estimate is moderate for article exposures. There is some uncertainty regarding the magnitude of difference between dermal absorption through rat skin vs. human skin for DEHP. Due to increased permeability of rat skin as compared to human skin, dermal absorption estimates likely overestimate exposures.	
Packaging, paper, plastic, toys, hobby products; Ink, toner, and colorants; packaging (excluding food packaging) and other articles with routine direct contact during normal use, including paper articles, rubber articles, plastic articles (hard), plastic articles (soft); toys, playground, and sporting equipment	Ten different scenarios were assessed for these COUs for products and articles with differing use patterns for which each scenario had varying number of identified product and article examples: stamp ink, air mattresses and sleeping mats, rubber eraser, mobile phone covers, shower curtain, small articles with the potential for semi-routine contact (packaging, paper, plastic, toys, hobby products: cutting board, pencils, pouches, bags, hose, labels, covers, chewy toys, jewelry, gloves, packaging, mats, lampshade, vinyl floor runner, silly straws, stickers, diving goggles), children's toys (legacy, new), tire crumb, artificial turf, small articles with the potential for semi-routine contact (fitness balls, jump rope, yoga mat, football, and diving goggles). These scenarios capture variability in product formulation weight fraction in the low-, medium-, and high-intensity use estimates. The overall confidence in this indoor COU inhalation and dust ingestion exposure estimate is robust because the CEM default parameters generally represent actual products on the market, relevant use patterns and location of use. The stay-at-home activity use input parameter is considered a conservative input that although representative of actual uses for some populations is also believed to result in an upper bound exposure. See Sections 2.1.1 and 2.1.2 in U.S. (2025c) for article examples and weight fraction data. Ingestion via mouthing exposure estimate overall confidence is moderate due to uncertainties in the parameters used for chemical migration to saliva such as large variability in empirical migration rate data for harsh, medium, and mild mouthing approaches. Additionally, there are uncertainties from the unknown correlation between chemical concentration in articles and chemical migration rates, and no data were reasonably available to compare and confirm selected rate parameters to better understand uncertainties. There are uncertainties in the duration of mouthing inputs, however EPA is confident that the selected inputs from Smith and Norris (2003) likely overestimate phthalate exposure since not all mouthed objects in the study contained phthalates. For solid articles dermal exposure EPA used a dermal flux-limited approach, which was estimated based on DEHP *in vivo* dermal absorption in rats. The flux-limited approach likely results in overestimations due to the assumption about excess DEHP in contact with skin. The overall confidence in this dermal exposure estimate is moderate for article exposures. There is some uncertainty regarding the magnitude of difference between dermal absorption through rat skin vs. human skin for DEHP. Due to increased permeability of rat skin as compared to human skin, dermal absorption estimates likely overestimate exposures. The overall confidence in this dermal exposure estimate is moderate for liquid product exposures. While Hopf et al. (2014) reported dermal absorption based on metabolically active excised human skin within just a few hours after excision, it should be noted that there may have been a unit error with the reported applied dose. Based on supporting information reported in the study (*i.e.,* concentration of DEHP, application amount, and skin surface area), EPA was able to recalculate the correct applied dose. Though the default parameters applied for dermal absorption estimates generally represent actual	Inhalation and Dust Ingestion – Robust Mouthing – Moderate Dermal – Moderate

Consumer COU Category and Subcategory	Weight of Scientific Evidence	Overall Confidence
	products on the market and relevant use patterns, due to the reported uncertainty the overall confidence was moderate.	
Other uses; Novelty articles	One indoor scenario was assessed for this COU: adult toys. This scenario captures variability in article formulation in the low-, medium-, and high-intensity use estimates. The overall confidence in this indoor COU dust ingestion exposure estimate is robust because the CEM default parameters generally represent an actual article on the market, relevant use patterns and location of use. The adult toys ingestion exposure estimate overall confidence is moderate due to uncertainties in the parameters used for chemical migration to saliva such as large variability in empirical migration rate data for harsh, medium, and mild mouthing approaches. Additionally, there are uncertainties from the unknown correlation between chemical concentration in articles and chemical migration rates, and no data were reasonably available to compare and confirm selected rate parameters to better understand uncertainties. In addition, there are unknown uncertainties in the use duration input parameters which were assumed based on professional judgment. EPA calculated a high-intensity use of adult toys using harsh mouthing approaches as part of the screening approach, however recognizing that this highly conservative use pattern is very unlikely behavior, it is not to be used to estimate risk. EPA did not identify use pattern information regarding adult toys. For solid articles dermal exposure EPA used a dermal flux-limited approach, which was estimated based on DEHP *in vivo* dermal absorption in rats. The flux-limited approach likely results in overestimations due to the assumption about excess DEHP in contact with skin. The overall confidence in this dermal exposure estimate is moderate for article exposures. There is some uncertainty regarding the magnitude of difference between dermal absorption through rat skin vs. human skin for DEHP. Due to increased permeability of rat skin as compared to human skin, dermal absorption estimates likely overestimate exposures.	Inhalation – Robust Mouthing – Moderate Dermal – Moderate

4.1.3 General Population Exposures to Environmental Releases

General population exposures occur when DEHP is released into the environment and the environmental media is then a pathway for exposure by the general population. As described in the *Environmental Release and Occupational Exposure Assessment for DEHP* (U.S. EPA, 2025u), releases of DEHP are expected in air, water, and land. Figure 4-2 provides a graphic representation of where and in which media DEHP is estimated to be found following environmental release and transport, and the corresponding exposure pathway for the general population.

EPA began its DEHP exposure assessment using a screening level approach that relies on conservative assumptions. Conservative assumptions, including default input parameters for modeling environmental media concentrations, help to characterize exposure resulting from the high-end of the expected distribution. Most of the OESs presented in Table 1-1 report facility location data and releases in the TRI, NEI, and DMR databases. When facility location- or where scenario-specific information is unavailable, the Agency used generic EPA models and default input parameter values as described in the *Environmental Release and Occupational Exposure Assessment for DEHP* (U.S. EPA, 2025u). 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, 2019c).

EPA evaluated the reasonably available information for releases of DEHP from facilities that use, manufacture, or process DEHP under industrial and/or commercial COUs detailed in the *Environmental Release and Occupational Exposure Assessment for DEHP* (U.S. EPA, 2025u). As described in Section 3.3 using the release data, EPA modeled predicted concentrations of DEHP in surface water, sediment, drinking water, ambient air, and soil due to deposition from ambient air in the United States. Table 3-7 summarizes the highest DEHP concentrations in environmental media from environmental releases. The reasoning for assessing different pathways qualitatively or quantitatively is discussed briefly below, and additional detail can be found in *Environmental Media and General Population and Environmental Exposure for DEHP* (U.S. EPA, 2025s).

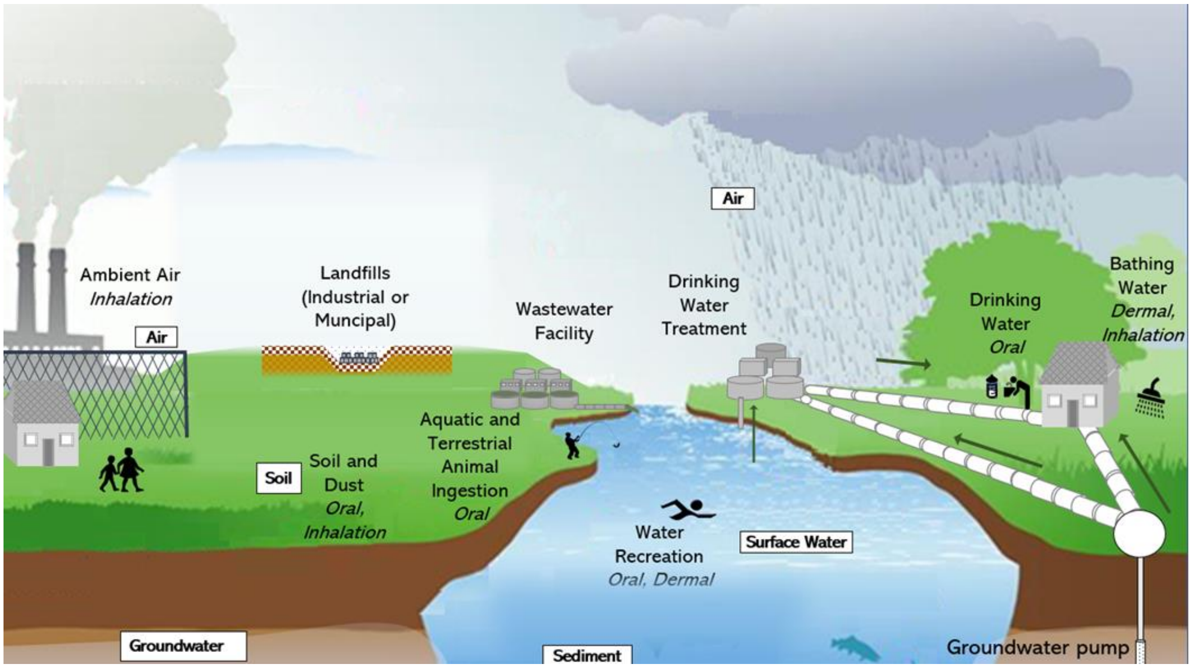

Figure 4-2. Potential Human Exposure Pathways to DEHP for the General Population
Potential routes of exposure are shown in italics under each potential pathway of exposure.

High-end estimates of DEHP concentration in the various environmental media presented in Table 3-7 and in the *Environmental Media and General Population and Environmental Exposure for DEHP* (U.S. EPA, 2025s) were used for screening level purposes in the general population exposure assessment. EPA's *Guidelines for Human Exposure Assessment* (U.S. EPA, 2019c) 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 was 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 DEHP from the largest estimated releases for the purpose of its screening level assessment for environmental and general population exposures. This means that EPA considered the environmental concentration of DEHP in a given environmental media 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 DEHP per body weight were considered to be those at the upper end of the exposure.

Table 4-9 summarizes the high-end exposure scenarios that were considered in the screening level analysis, including the life stage assessed as the most potentially exposed population based on intake rate and body weight. Table 4-9 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 DEHP 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 DEHP in soils receiving DEHP will not be mobile and will have low persistence potential. There is robust confidence that DEHP 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 *Environmental Media and General Population and Environmental Exposure for DEHP* (U.S. EPA, 2025s). Selected OESs represent those resulting in the highest modeled environmental media concentrations for the purpose of a screening level analysis.

Table 4-9. Exposure Scenarios Assessed in General Population Screening Level Analysis

OES	Exposure Pathway	Exposure Route	Exposure Scenario	Life stage	Analysis (Quantitative or Qualitative)
All	Biosolids	All considered qualitatively			Qualitative
All	Landfills	All considered qualitatively			Qualitative
Use of automotive care products; Plastic compounding	Surface water	Dermal	Dermal exposure to DEHP in surface water during swimming	Adult, youth, and children	Quantitative
		Oral	Incidental ingestion of DEHP in surface water during swimming	Adult, youth, and children	Quantitative
Use of automotive care products; Plastic compounding	Drinking water	Oral	Ingestion of drinking water sourced from surface water	Adult, youth, and children	Quantitative
Use of automotive care products; Plastic compounding	Fish ingestion	Oral	Ingestion of fish for general population	Adult and children	Quantitative
			Ingestion of fish for subsistence fishers	Adult	Quantitative
			Ingestion of fish for Tribal populations	Adult	Quantitative
Application of paints, coatings, adhesives, and sealants (stack)	Ambient air	Inhalation	Inhalation of DEHP in ambient air resulting from industrial releases	All	Quantitative
Plastic converting (fugitive)					

EPA also considered biomonitoring data, specifically urinary biomonitoring data from the CDC's NHANES, to estimate exposure using reverse dosimetry (see Section 11 of EPA's *Environmental Media and General Population and Environmental Exposure for DEHP* (U.S. EPA, 2025s). Reverse dosimetry is a powerful tool for estimating exposure, but reverse dosimetry modeling does not distinguish between routes or pathways of exposure and does not allow for source apportionment (*i.e.*, exposure from COUs cannot be isolated from uses that are not subject to TSCA). Instead, reverse dosimetry provides an estimate of the total dose (or aggregate exposure) responsible for the measured biomarker. Therefore, intake doses estimated using reverse dosimetry are not directly comparable to the exposure estimates from the various environmental media presented in this document. However, the total intake dose estimated from reverse dosimetry can help contextualize the exposure estimates from exposure pathways outlined in Table 4-9 as being potentially underestimated or overestimated.

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. DEHP is unlikely to migrate to groundwater via runoff after land application of biosolids due largely to its low water solubility (0.003 mg/L) and high affinity for sorption to soil (log K_{OC} = 5.4; log K_{OW} = 7.6). DEHP will have low persistence potential in the aerobic environments associated with freshly applied biosolids with a typical half-life of 8.1 to 16.8 days in aerobic soils (U.S. EPA, 2025s). EPA did not model groundwater concentrations resulting from land application of biosolids, with the physical and chemical properties indicating that DEHP is unlikely to migrate from land applied biosolids to groundwater via infiltration.

While there are no measured data on DEHP in landfill leachates, the potential to leach from landfills into nearby groundwater or surface water systems is limited. DEHP's high affinity to particulate (log K_{OC} = 5.4) and organic media (log K_{OW} = 7.6) will limit leaching to groundwater and result in high retardation and limited mobility in the subsurface. Similarly, DEHP is not expected to migrate from landfills via groundwater infiltration or surface runoff. EPA concludes that further assessment of DEHP 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 receiving waterbody receiving the effluent) to estimate the resulting environmental media concentrations from COUs. EPA conducted modeling with the U.S. EPA's Variable Volume Water Model (VVWM) with Point Source Calculator (PSC) tool to estimate concentrations of DEHP within surface water and to estimate settled sediment in the benthic region of streams. Releases associated with the Use of automotive care products resulted in the highest total water column concentration, with 30Q5 water concentrations of 140 µg/L. Plastic compounding OES, which had releases reported to TRI, 30Q5 water concentrations of 10.3 µg/L (Table 4-10). Because of relevance to the exposure route, acute incidental general population surface water exposures were derived from the 30Q5 flow concentrations. COUs mapped to this OES are shown in Table 3-1. As described in Section 3.3.1.1, Use of automotive care products OES, which had releases estimated using generic scenarios to a multimedia category, was chosen as an appropriate OES for a screening level assessment based on it resulting in the highest surface water concentration based on conservative assumption of 100 percent release to water as described in Section 3.3. Plastic compounding OES was also included in the assessment based on actual facility release data paired with flow data for the receiving waterbody associated with the release as reported by the NPDES permit. When modeling the Plastic compounding OES with PSC, EPA calculated the exposure concentration at the point of release in the receiving waterbody, applying the reported facility loading that includes any onsite treatment, and immediate dilution from mixing in the receiving waterbody.

These water column concentrations were used in a screening level analysis to estimate the ADR from dermal exposure and incidental ingestion of DEHP while swimming for adults (21+ years), youths (11–15 years), and children (6–10 years). Detailed results for all exposures can be found in EPA's *Environmental Media and General Population and Environmental Exposure for DEHP* (U.S. EPA, 2025s). Exposure scenarios leading to the highest modeled ADR are shown in Table 4-10. The most exposed life stage for incidental ingestion from swimming was youth with an ADR of 7.49×10^{-4} mg/kg-day for the Use of automotive care products OES. The most exposed life stage for incidental dermal contact from swimming was adults with an ADR of 9.5×10^{-4} mg/kg-day for the Use of automotive care products OES.

For the purpose of a screening level assessment, EPA used an MOE approach using high-end exposure estimates to determine if exposure pathways were pathways of concern for potential non-cancer risks. MOEs for general population exposure through dermal exposure and incidental ingestion during swimming in untreated surface water for the most exposed life stage was 1,155 and 1,468, respectively (compared to a benchmark of 30) (Table 4-10). This is a conservative assumption that results in no removal of DEHP prior to release to surface water. Based on a screening level assessment, risks for non-cancer health effects are not expected for the surface water pathway; therefore, the surface water pathway is not considered to be a pathway of concern to DEHP for the general population for the Use of automotive care products OES. Because MOEs were not below the benchmark for the Use of automotive care products OES, which resulted in the highest exposure estimate for this scenario, no other OES and their corresponding COUs (Table 3-1) are expected to result in risk estimates below the benchmark.

Surface Water Pathway – Drinking Water

For the drinking water pathway, modeled surface water concentrations were used to estimate drinking water exposures. As described in Section 2, because of its high hydrophobicity and high affinity for soil sorption, it is unlikely that DEHP will migrate from landfills via groundwater infiltration. Therefore, drinking water exposure in this assessment is focused on drinking water sourced from surface water. For screening level purposes, the OES scenario resulting in the highest modeled surface water concentrations, Use of automotive care products, which had the highest 30Q5 flow concentration, was included in the drinking water exposure analysis. The Plastic compounding OES is also shown in the analysis as the surface water concentrations associated with that OES is based on reported releases to TRI. Because of relevance to the exposure route, drinking water exposures were derived from the 30Q5 flow concentrations for acute drinking water exposure. Chronic drinking water was also considered in COUs mapped to this OES are shown in Table 3-1. EPA evaluated drinking water scenarios assuming no wastewater treatment, no dilution beyond the point of discharge (*i.e.*, the surface water outfall is located very close to the drinking water location), and no further drinking water treatment (Table 4-10). ADR from drinking water for non-cancer effects was also calculated using the 95th percentile ingestion rate for drinking water. ADR values from drinking water exposure to DEHP were calculated for various age groups. Additionally, EPA assessed chronic drinking water exposure using the highest harmonic mean concentration. Detailed results for all exposures including chronic exposure and those for multiple life stages can be found in EPA's *Environmental Media and General Population and Environmental Exposure for DEHP* (U.S. EPA, 2025s), but the most exposed life stage, infants (birth to <1 year), with the exposure duration leading to the highest exposure, is shown in Table 4-10. The most exposed life stage for drinking water was infants with an ADR of 2.0E–02 mg/kg-day.

The MOE for general population exposure through drinking water exposure for the highest exposed life stage was 56 (compared to a benchmark of 30) (Table 4-10). Based on screening level analysis, risk for non-cancer health effects are not expected for the drinking water pathway; therefore, the drinking water pathway is not considered to be a pathway of concern to DEHP for the general population for the Use of automotive care products OES. Because MOEs were not below the benchmark for the Use of automotive care products OES, which resulted in the highest exposure estimate for this scenario, no other OES and their corresponding COUs (Table 3-1) are expected to result in risk estimates below the benchmark.

Table 4-10. Summary of the Highest Exposure and Risk in the General Population through Surface and Drinking Water Exposure

Occupational Exposure Scenario [a]	Water Column Concentrations	Incidental Dermal Surface Water [b]		Incidental Ingestion Surface Water [c]		Drinking Water [d]	
	30Q5 Conc. (µg/L)	ADR (mg/kg-day)	Acute MOE (Benchmark MOE = 30)	ADR (mg/kg-day)	Acute MOE (Benchmark MOE = 30)	ADR (mg/kg-day)	Acute MOE (Benchmark MOE = 30)
Plastic compounding (TRI)	10.3	7.0E–05	16,000	5.51E–05	20,000	1.5E–03	756
Use of automotive care products (Generic Scenarios, P50 flow) [e]	140	9.5E-04	1155	7.49E–04	1468	2.0E-02	56

ADR = acute dose rate; MOE = margin of exposure; 30Q5 = 30 consecutive days of lowest flow over a 5-year period
[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).
[e] This OES discharges to multiple environmental media including surface water. Information on the proportion of the release going to each media type, including surface water, is unknown. EPA cannot determine how much, if any, is released to surface water for OESs with multimedia discharges. It was assumed that there was no wastewater treatment before release. Confidence in all risk estimates for this OES is thus slight because of the slight confidence and high uncertainty in the modeled surface water concentrations and exposure estimates.

Fish Ingestion

The key parameters to estimate human exposure to DEHP via fish ingestion are the surface water concentration, bioaccumulation factor (BAF), and fish ingestion rate. Surface water concentrations for DEHP associated with a particular COU were modeled using VVWM-PSC as described in Section 3.3. The harmonic mean flow and resulting estimated concentrations in surface water and fish tissue were applied to calculate exposure via fish ingestion because the harmonic mean flow is considered representative of long-term DEHP concentrations that would enter fish tissue over time. 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 the *Environmental Media and General Population and Environmental Exposure for DEHP* (U.S. EPA, 2025s).

EPA evaluated exposure and potential risk to DEHP 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. Children were not considered for all populations for reasons explained in Sections 7.2 and 7.3 of the *Environmental Media and General Population and Environmental Exposure for Diethylhexyl Phthalate (DEHP)* (U.S. EPA, 2025s). Only the fish ingestion rate changes for these different populations; the surface water concentration and BAF remain the same. ADR and ADD values from fish ingestion exposure to DEHP were calculated for all populations and multiple age groups and can be found in *Environmental Media and General Population and Environmental Exposure for Diethylhexyl Phthalate (DEHP)* (U.S. EPA, 2025s), but Table 4-11 shows only the scenarios for Tribal populations as they represent the highest exposure because of their elevated fish ingestion rates compared to the general population and subsistence fisher population.

Exposure to Tribal populations were estimated based on a current mean (U.S. EPA, 2011a) and current 95th percentile (Polissar et al., 2016) fish ingestion rate. 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 lifeways. Therefore, current ingestion rates are considered more representative of contemporary rates of fish consumption and are presented below. Heritage rates are discussed in further detail *Environmental Media and General Population and Environmental Exposure for Diethylhexyl Phthalate (DEHP)* (U.S. EPA, 2025s)

For the screening level analysis, EPA used DEHP's water solubility as an upper limit of DEHP concentration in surface water to estimate DEHP concentration in fish tissue. The Agency also incorporated the highest modeled surface water concentrations based on estimated releases from the Use of automotive care products OES and reported releases by the Plastic compounding OES because it exceeded the water solubility limit. Possible reasons for exceeding the water solubility limit include modeled concentrations corresponding to the total water column concentrations (*i.e.*, DEHP suspended in the water and sorbed to suspended sediment) as well as DEHP's tendency to form colloidal suspensions in water. Exposure estimates calculated with the water solubility limit are within the same order of magnitude as Plastic compounding and two orders of magnitude lower than Use of automotive care products, as shown in Table 4-11.

Screening level risk estimates were calculated for all populations and multiple age groups (*Environmental Media and General Population and Environmental Exposure for DEHP* (U.S. EPA, 2025s). Table 4-11 shows only results for the Tribal populations because they have the highest exposure. Risk estimates are below the benchmark for Use of automotive care products at the P50 and P75 flow rates without wastewater treatment, but not at the P90 flow rate. Notably, the modeled surface water concentrations at the P50 and P75 flow rate exceed the water solubility limit by up to one order of magnitude. This OES also discharges to multiple environmental media (POTW or landfill). Because releases are reported to POTW or landfill, there is a reasonable assumption of wastewater treatment. However, EPA cannot determine how much, if any, is released to surface water for OESs with multimedia discharges because no information is reasonably available. Therefore, confidence in all risk estimates for this and other OESs that have multimedia discharges are slight (Table 3-8). EPA does, however, have monitoring studies that support that no tissue concentrations as high as those associated with the P50 (44.42 mg/kg) and P75 (10.66 mg/kg) flow rates have been monitored. The silver pomfret (*Pampus argenteus*) from the industrial coastal city of Shanghai near the Yangtze River Delta had the highest average DEHP concentration in homogenized organs at 1.941 mg/kg ww (Hu et al., 2016). The second highest concentrations within the reasonably available literature from carnivorous fishes were from De Vault (1985) and the Great Lakes Monitoring Program reporting a geometric mean concentration of 1.23 mg/kg ww within northern pike (*Esox lucius*) collected from one river in Wisconsin and one in Ohio. Additionally, DEHP is susceptible to biotransformation and the significant biotransformation of DEHP impacts bioaccumulation and biomagnification potential (Burkhard et al., 2012). Thus, the rapid biotransformation of DEHP in finfish prevents it from accumulating. More details on fish tissue monitoring studies and trophic transfer are provided in *Environmental Media and General Population and Environmental Exposure for Diethylhexyl Phthalate (DEHP)* (U.S. EPA, 2025s).

For the Plastic compounding OES that had the highest surface water concentration based on TRI releases, MOEs are above benchmark at all tribal ingestion rates. EPA has moderate confidence in these risk estimates because they are based on TRI releases to surface water. Because releases associated with the Plastic compounding OES was the highest reported water release, MOEs for all other OESs reporting to TRI or DMR (Table 3-8) will also exceed the benchmark. Overall, the fish ingestion pathway is not expected to be a concern for all populations and for OESs with reported releases.

Table 4-11. Fish Ingestion for Adults in Tribal Populations Summary

Calculation Method	Current Mean Ingestion Rate [b] (Benchmark MOE = 30)		Current 95th Percentile 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 (3.0E–03 mg/L)	3.87E–03	280	1.56E–02	70
Use of automotive care products, HE - generic scenario for multimedia releases, without treatment (9.29E–02, 2.23E–02, and 2.85E–3 mg/L for P50, P75, and P90 flow[c])	1.20E–01 (P50 flow) 2.88E–02 (P75 flow) 3.68E–03 (P90 flow)	9 (P50 flow) 38 (P75 flow) 299 (P90 flow)	4.84E–01 (P50 flow) 1.16E–01 (P75 flow) 1.49E–02 (P90 flow)	2 (P50 flow) 9 (P75 flow) 74 (P90 flow)
Plastic compounding, HE - TRI reported release (4.11E–03 mg/L)	5.31E–03	207	2.14E–02	51

ADR = acute dose rate; ADD = average daily dose; MOE = margin of exposure
[a] The acute and chronic MOEs are identical because the exposure estimates and the POD do not change between acute and chronic exposure scenarios.
[b] Current ingestion rate (mean at 2.7 g/kg-day and 95th percentile at 10.9 g/kg-day used in this assessment) refers to the present-day consumption levels that are suppressed by contamination, degradation, or loss of access.
[c] This OES discharges to multiple environmental media including surface water. Information on the proportion of the release going to each media type, including surface water, is unknown. EPA cannot determine how much, if any, is released to surface water for OESs with multimedia discharges. Confidence in all risk estimates for this OES is thus slight because of the slight confidence and high uncertainty in the modeled surface water concentrations and exposure estimates.

Ambient Air Pathway

The ambient air exposure assessment utilized a previously peer-reviewed screening level analysis to evaluate exposures to the general population in proximity to releasing facilities, including fenceline communities. The approach used is 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, 2022d).

EPA used the IIOAC Model to estimate the high-end (95th percentile) and mean (50th percentile) daily and annual average concentrations across the modeled distribution of DEHP concentrations in ambient air to assess general population exposures at three distances from the release point (100, 100–1,000, and 1,000 m). The daily average concentration is the average of 24 consecutive hourly modeled concentrations within each day modeled in IIOAC across 5 years of meteorological data modeled within IIOAC as described in the IIOAC users guide (U.S. EPA, 2019f). The annual average is a rolling 365-day average of all daily average concentrations across 5 years of meteorological data modeled within IIOAC. EPA also modeled the high-end (95th percentile) and mean (50th percentile) rolling annual average wet, dry, and total deposition rates of DEHP from the ambient air at three distances from the releasing facility (100; 100–1,000, and 1,000 m).

EPA used the highest daily releases (stack and fugitive) across all COUs from the *Environmental Release and Occupational Exposure Assessment for DEHP* (U.S. EPA, 2025u) as direct inputs to the

IIOAC Model to estimate concentrations and deposition rates. The highest daily estimated releases were used to represent a high-end release value for acute, short-term exposures and risk estimates. EPA used the maximum 95th percentile modeled concentrations and deposition rates across a series of exposure scenarios considering particle size and urban/rural topography to characterize exposures and derive risk estimates. The 95th percentile values were used to capture the high-end exposure scenario to better represent a peak concentration rather than a central tendency average concentration for acute exposures.

Calculations for general population exposure to ambient air via inhalation and ingestion from air to soil deposition for life stages expected to be highly exposed based on exposure factors can be found in *Ambient Air Exposure Assessment for DEHP* (U.S. EPA, 2025a). Inhalation exposure to DEHP from ambient air is expected to be much higher than exposure to DEHP via soil ingestion resulting from air to soil deposition and is, therefore, presented below for the screening level analysis.

The maximum daily release value for fugitive releases for DEHP was 8.85 kg/site-day. This value was reported to the 2020 NEI dataset and categorized under the Plastic converting OES as fugitive releases. The maximum daily release value for stack releases for DEHP was 36.23 kg/site-day. This value was reported to the 2017 NEI dataset and categorized under the Application of paints, coatings, adhesives, and sealants OES as stack releases. COUs mapped to this OES are shown in Table 3-1. Although the maximum releases for each release type are from different facilities in different locations and different OESs, for this assessment EPA assumes the releases occurred from the same location at the same time under the same OES to determine a "total exposure" to DEHP from both release types. This approach may overestimate ambient concentrations of DEHP at the distances evaluated since exposures to each release type at the distances evaluated cannot occur at a single location at the same time.

The highest 95th percentile modeled daily average concentration used to derive acute non-cancer risk estimates for fugitive releases was 16.31 $\mu g/m^3$ and for stack releases was 6.92 $\mu g/m^3$. These concentrations occurred at 100 m from the releasing facility and together result in a total exposure from facility releases of 23.23 $\mu g/m^3$.

The highest 95th percentile modeled annual average concentration used to derive chronic risk estimates for fugitive releases was 15.86 µg/m3 and for stack releases was 2.64 $\mu g/m^3$. These concentrations occurred at 100 m from the releasing facility and together result in a total exposure from facility releases of 18.50 $\mu g/m^3$.

Table 4-12 summarizes the total exposures and the associated MOE calculated using the inhalation human equivalent concentration (HEC) described in Section 4.2. The HEC is derived in the *Non-cancer Human Health Hazard Assessment for DEHP* (U.S. EPA, 2025aa) and is based on an 80 kg adult. Based on the 95th percentile air concentrations, MOEs for general population exposure through inhalation of ambient air are 267 for acute and 335 for chronic (both compared to a benchmark of 30) for an adult. Because the HEC was derived for adults, MOEs for other life stages were not calculated. However, considering similar or smaller inhalation rates for younger life stages and greatest body weight difference of a factor of 16.7 between an adult (80 kg) and newborn (4.8 kg) based on EPA's *Exposure Factors Handbook: 2011 Edition* (U.S. EPA, 2011b), MOEs for all life stages will still exceed the benchmark based on the estimates for adults.

The risk estimates described in the preceding paragraph are derived from a highly conservative exposure scenario where such exposures to both fugitive and stack releases cannot physically occur at the same time based on assumptions made around the releases and total exposure. Even under this highly conservative exposure scenario, the derived risk estimates are well above relative benchmarks for non-cancer health effects (greater than an order of magnitude). Therefore, EPA concludes exposure to DEHP via the ambient air pathway, inhalation route is not a concern for the general population for Plastic converting and Application of paints, coatings, adhesives, and sealants OESs. Because MOEs were not below the benchmark for the Plastic converting and Application of paints, coatings, adhesives, and sealants OESs, which resulted in the highest exposure scenario, no other OES and their corresponding COUs (Table 3-1) are expected to result in risk estimates below the benchmark.

Table 4-12. General Population Ambient Air Exposure and Risk Summary

OES[a]	Acute (Daily-Averaged) [b]		Chronic (Annual-Averaged) [b]	
	Air Concentration [c] (µg/m³)	MOE	Air Concentration[c] (µg/m³)	MOE
Plastic converting (fugitive releases]	16.31	N/A	15.86	N/A
Application of paints, coatings, adhesives, and sealants [stack releases]	6.92	N/A	2.64	N/A
Total exposure	23.23	267	18.50	335

MOE = margin of exposure; OES = occupational exposure scenario
[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.
[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.

Based on the 95th percentile total annual particle deposition rate for DEHP, the MOE is 11,559,812 for the oral HED. Again, even under this highly conservative exposure scenario, the derived risk estimate is six orders of magnitude greater than the benchmark MOE of 30. Therefore, EPA concludes that soil ingestion resulting from air to soil deposition is not a pathway of concern for the general population.

4.1.3.2 Daily Intake Estimates for the U.S. Population Using NHANES Urinary Biomonitoring Data

EPA used a screening level approach to calculate sentinel exposures to the general population from TSCA releases. EPA also analyzed urinary biomonitoring data from the CDC's NHANES dataset to provide context for aggregate exposures in the U.S. non-institutionalized civilian population. The NHANES dataset reports urinary concentrations for fifteen phthalate metabolites specific to individual phthalate diesters. Reverse dosimetry was used to calculate estimated daily intake of DEHP using NHANES reported urinary concentrations from 2017 to 2018 for four metabolites of DEHP: mono(2-ethylhexyl) phthalate (MEHP), mono(2-ethyl-5-hydroxyhexyl) phthalate (MEHHP), mono(2-ethyl-5-carboxypentyl) phthalate (MECPP), mono(2-ethyl-5-oxohexyl) phthalate (MEOHP). Urinary MEHP, MEHHP, MECPP, and MEOHP levels were used to calculate daily intake values for various demographic groups reported within NHANES (Table 4-13). Median daily intake estimates across demographic groups ranged from 0.53 to 2.11 µg/kg-day, while 95th percentile daily intake estimates ranged from 1.48 to 6.44 µg/kg-day. The highest daily intake value estimated was for male toddlers (3 to <6 years old) and was 6.44 µg/kg-day at the 95th exposure percentile. Detailed results of the NHANES analysis can be found in Section 11 of EPA's *Environmental Media and General Population and Environmental Exposure for DEHP* (U.S. EPA, 2025s).

General population exposure estimates calculated from exposure to ambient air, surface water, fish ingestion, and soil from TSCA releases are not directly analogous to daily intake values estimated via reverse dosimetry from NHANES. While NHANES may be used to provide context for aggregate exposures in the U.S. population, NHANES is not expected to capture exposures from specific COUs that may result in high-dose exposure scenarios (*e.g.,* occupational exposures to workers), as compared to EPA's general population exposure assessment which evaluates sentinel exposures for specific exposure scenarios corresponding to TSCA releases. However, as a screening level analysis, media specific general population exposure estimates calculated were compared to daily intake values calculated using reverse dosimetry of NHANES biomonitoring data. Comparison of the values shows that the exposure estimates resulting from incidental dermal contact or ingestion of surface water (assuming no wastewater treatment) (Table 4-10) and fish ingestion (Table 4-11) are lower than median and 95th percentile daily intake values estimated using NHANES (Table 4-13).

Exposure estimates for the general population via ambient air, surface water, and drinking water releases quantified in this document may be overestimates. This is because exposure estimates from some of the individual pathways exceed (*i.e.*, drinking water, ambient air) the total intake values calculated from NHANES measured even at the 95th percentile of the U.S. population for all ages. Further, this is consistent with the U.S. CPSC's conclusion that DEHP exposure comes primarily from diet for women, infants, toddlers, and children and that the outdoor environment is not a major source of exposure to DEHP (U.S. CPSC, 2014).

Table 4-13. Daily Intake Values for DEHP Based on Urinary Biomonitoring from the 2017–2018 NHANES Cycle

Demographic	50th Percentile Daily Intake (95% CI) (µg/kg-day)	95th Percentile Daily Intake (95% CI) (µg/kg-day)
All	1.07 (0.96–1.18)	4.5 (3.86–5.15)
Females	1.1 (0.98–1.23)	4.22 (3.54–4.91)
Males	1.07 (0.91–1.23)	4.62 (3.71–5.53)
White non-Hispanic	1.11 (0.94–1.28)	3.74 (2.89–4.59)
Black non-Hispanic	0.84 (0.65–1.03)	4.1 (3.52–4.67)
Mexican-American	0.91 (0.75–1.07)	5.45 (3.67–7.23)
Other race	1.18 (1.01–1.36)	5.34 (3.25–7.43)
Above poverty level	1.29 (1.06–1.51)	5.89 (4.34–7.43)
Below poverty level	1.04 (0.91–1.16)	3.79 (3.17–4.42)
Toddlers (3 to <6 years old)	2.11 (1.86–2.35)	6.41 (5.13–7.69)
Children (6 to <11 years old)	1.32 (1.12–1.52)	4.62 (3.55–5.69)
Adolescents (12 to <16 years old)	0.69 (0.52–0.85)	2.05 (–5.34 to 9.43)
Adults (16+ years old)	0.54 (0.4–0.68)	1.78 (–0.23 to 3.79)
Male toddlers (3 to <6 years old)	2.11 (1.85–2.38)	6.44 (4.68–8.2)
Male children (6 to <11 years old)	1.24 (0.98–1.51)	4.68 (3.32–6.04)
Male adolescent (12 to <16 years old)	0.66 (0.56–0.76)	2.51[a]
Male adults (16+ years old)	0.54 (0.29–0.79)	2.17[a]
Female toddlers (3 to <6 years old)	2 (1.68–2.31)	6.17 (3.81–8.52)
Female children (6 to <11 years old)	1.38 (1.11–1.65)	4.35 (2.46–6.23)
Female adolescents (12 to <16 years old)	0.74 (0.5–0.98)	1.58[a]
Females of reproductive age	0.53 (0.36–0.71)	1.48 (–1.55 to 4.52)

Demographic	50th Percentile Daily Intake (95% CI) (µg/kg-day)	95th Percentile Daily Intake (95% CI) (µg/kg-day)
(16–49 years old)		
Female adults (16+ years old)	0.53 (0.36–0.71)	1.48 (–1.55 to 4.52)
[a] 95% confidence intervals (CI) could not be calculated due to small sample size or a standard error of zero.		

4.1.3.3 Overall Confidence in General Population Screening Level Exposure Assessment

The weight of scientific evidence supporting the general population exposure estimate is 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 *Environmental Media and General Population and Environmental Exposure for DEHP* (U.S. EPA, 2025s). 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 for surface water, ambient air, and fish ingestion, EPA 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 a screening level analysis. 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 evaluation. Despite slight to moderate confidence in the estimated values themselves, confidence in exposure estimates capturing high-end exposure scenarios was robust given the conservative assumptions used for the estimates.

4.1.4 Human Milk Exposures

Infants are a potentially susceptible subpopulation for various reasons including their higher exposure per body weight, immature metabolic systems, and the potential for chemical toxicants to disrupt sensitive developmental processes. Reasonably available information from studies of experimental animal models also indicates that DEHP is a developmental and reproductive toxicant (U.S. EPA, 2025r). EPA considered exposure and hazard information, as well as pharmacokinetic models, to determine the most scientifically appropriate approach to evaluate infant exposure to DEHP from human milk ingestion (U.S. EPA, 2025s).

EPA identified 13 biomonitoring studies—two from the U.S. and one from Canada—which measured concentrations of DEHP or its metabolites in human milk. None characterized if any of the study participants may be occupationally exposed to DEHP. DEHP or its metabolites were consistently detected in human milk across all 13 studies; the minimum and maximum measured concentrations varied by up to four orders of magnitude. However, one of the U.S. studies by Hines et al. (2009) that detected concentrations at less than 0.4 µg/L was given the most weight because its study design minimized potential contamination from food consumption or medical devices. A full description of the strengths and limitations of the studies and their reported concentrations are in Section 10 of the *Environmental Media and General Population and Environmental Exposure for DEHP* (U.S. EPA, 2025s). It is important to note that biomonitoring data do not distinguish between exposure routes or pathways and does not allow for source apportionment. In other words, biomonitoring data reflect total infant exposure through human milk ingestion and the contribution of specific COUs to overall exposure cannot be determined.

Furthermore, no human health studies have evaluated only lactational exposure from quantified levels of DEHP or its metabolites in human milk. Although EPA explored the potential to model milk concentrations and concluded that there is insufficient information (*e.g.,* sensitive and specific half-life data) available to support modeling of the milk pathway, EPA also concluded that modeling is not needed to adequately evaluate risks associated with exposure through milk. This conclusion is because the POD used in this assessment is based on male reproductive effects resulting from maternal dosing throughout sensitive phases of development in multigenerational studies encompassing both gestation and lactation. EPA has robust confidence in the assessment without quantifying the direct exposure to a nursing infant because the calculated MOE is based on the ratio of quantified (1) maternal dose resulting in hazard to offspring via exposure during gestation and lactation in studies in rodents and (2) maternal exposure to humans who may be pregnant and nursing. In other words, it is most scientifically defensible to use maternal exposure in humans to compare to hazard values expressed in terms of maternal dose from studies in animals. The uncertainty in this approach is limited to the toxicokinetic differences between rats and humans regarding the absorption, distribution, metabolism, and excretion (ADME) of phthalates from maternal oral exposure into milk, and this uncertainty is accounted for with the UF_A in the benchmark MOE. Therefore, EPA has confidence that the risk estimates calculated based on adult (maternal) exposure throughout this assessment are protective of a nursing infant. Further discussion of the human milk pathway is provided in Section 10 of the *Environmental Media and General Population and Environmental Exposure for DEHP* (U.S. EPA, 2025s).

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 DEHP 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.

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 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. The 95th percentile is defined as an estimate of individual exposure or dose for those persons at the upper end of an exposure or dose distribution, conceptually above the 90th percentile, but not higher than the individual in the population who has the highest exposure or dose (*e.g.*, 99.9th percentile) (U.S. EPA, 1994a) (U.S. EPA, 2011a). As the midpoint of that range, the 95th percentile was selected to be representative of occupational exposures in the upper tail of the distribution. 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 Hazard

4.2.1 Background

This section briefly summarizes the non-cancer and cancer human health hazards of DEHP (Sections 4.2.2 and 4.2.3, respectively). Additional information on the non-cancer and cancer human health hazards of DEHP are provided in the *Non-cancer Human Health Hazard Assessment for DEHP* (U.S. EPA, 2025aa) and the *Cancer Human Health Hazard Assessment for DEHP, DBP, BBP, DIBP, and DCHP* (U.S. EPA, 2025b).

4.2.2 Non-Cancer Human Health Hazards of DEHP

EPA identified developmental/reproductive toxicity as the most appropriate non-cancer hazard associated with oral exposure to DEHP in experimental animal models for use in human health risk assessment. Existing assessments of DEHP—including by the Agency for Toxic Substances and Disease Registry (ATSDR, 2022), the U.S. Consumer Product Safety Commission (U.S. CPSC, 2014), Health Canada (2020), the European Chemicals Agency (ECHA, 2017a), and the Australian National Industrial Chemicals Notification and Assessment Scheme (NICNAS, 2010)—also consistently identified developmental/reproductive toxicity as a sensitive and robust non-cancer effect following oral exposure to DEHP. In 2022, ATSDR also identified effects on the developing female reproductive tract and effects on glucose homeostasis following oral exposure, along with developmental/reproductive toxicity following inhalation exposure in experimental animal models.

EPA selected a point of departure (POD) of 4.8 mg/kg-day (human equivalent dose [HED] of 1.1 mg/kg-day) to estimate non-cancer risks from oral exposure to DEHP for acute, intermediate, and chronic durations of exposure in the risk evaluation of DEHP. The POD is a no-observed-adverse-effect level (NOAEL) associated with effects on the developing male reproductive system at the LOAEL of 14 or 15 mg/kg-day from a three-generation reproduction study (Blystone et al., 2010; TherImmune Research Corporation, 2004) and a co-critical study presented in publications by Andrade and Grande (2006b; 2006a; 2006) which established a NOAEL of 5 mg/kg-day, along with 13 additional studies reporting effects on the developing male reproductive system consistent with disrupted androgen action and phthalate syndrome at lowest-observed-adverse-effect levels (LOAELs) in a narrow range of 10 to 15 mg/kg-day.

The Agency has performed ¾-body weight scaling to yield the HED of 1.1 mg/kg-day. Body weight scaling to the three-quarters power is EPA's default approach for deriving an HED in the absence of more chemical-specific information (*e.g.,* PBPK model or data derived extrapolation factor) for such an extrapolation (U.S. EPA, 2011c). A total uncertainty factor of 30 was selected for use as the benchmark MOE (based on an interspecies uncertainty factor [UF_A] of 3× and an intraspecies uncertainty factor [UF_H] of 10×). The UF_H of 10× accounts for variability in toxicokinetics and toxicodynamics within the human population to account for differences in sensitivity. However, data are not available to characterize the magnitude of variability/sensitivity across the human population. Therefore, consistent with agency guidance (U.S. EPA, 2002b), EPA selected a default UF_H of 10×. Consistent with Agency guidance (U.S. EPA, 2011c), the UF_A was reduced from a factor of 10 to 3× because allometric body-weight scaling was used to derive an HED, which accounts for toxicokinetic differences between species. The remaining UF_A of 3× accounts for species differences in toxicodynamics. EPA considered reducing the UF_A further to a value of 1 based on apparent differences in toxicodynamics between rats and humans. As discussed in Section 3.1.4 of EPA's *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, 2023d), several explant (Lambrot et al., 2009; Hallmark et al., 2007) and xenograft studies (van Den Driesche et al., 2015; Spade et al., 2014; Heger et al., 2012; Mitchell et al., 2012) using human donor fetal testis tissue have been conducted to investigate the antiandrogenicity of mono-2-ethylhexyl phthalate (MEHP; a monoester metabolite of DEHP), DBP, and monobutyl phthalate (MBP; a monoester metabolite of DBP) in a human model.

Generally, results from human explant and xenograft studies suggest that human fetal testes are less sensitive than rat testes to the antiandrogenic effects of phthalates, however, effects on Sertoli cells and increased incidence of MNGs have been observed in four human xenograft studies of DBP (van Den Driesche et al., 2015; Spade et al., 2014; Heger et al., 2012; Mitchell et al., 2012). As discussed in EPA's draft approach document (U.S. EPA, 2023d), the available human explant and xenograft studies have limitations and uncertainties, which preclude definitive conclusions related to species differences in sensitivity. For example, key limitations and uncertainties of the human explant and xenograft studies include: small sample size; human testis tissue was collected from donors of variable age and by variable non-standardized methods; and most of the testis tissue was taken from fetuses older than 14 weeks, which is outside of the critical window of development (*i.e.*, gestational weeks 8 to 14 in humans). Therefore, EPA did not further reduce the UF_A to a value of 1.

Overall, based on the strengths, limitations, and uncertainties discussed in the *Non-cancer Human Health Hazard Assessment for DEHP* (U.S. EPA, 2025aa), EPA has robust overall confidence in the selected POD based on effects on the developing male reproductive system consistent with a disruption of androgen action and phthalate syndrome, specifically increased male reproductive tract malformations observed in the principal study. This POD will be used to characterize risk from exposure to DEHP 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 *Non-cancer Human Health Hazard Assessment for DEHP* (U.S. EPA, 2025aa). Risk estimates based on the selected POD are relevant for females of reproductive age and males at any life stage. Additionally, there is epidemiological evidence that DEHP exposure can adversely affect the developing male reproductive system consistent with phthalate syndrome in males of any age, with effects including decreases in anogenital distance (AGD) and testosterone and effects on sperm parameters in humans, and that DEHP exposure at higher concentrations can cause other health effects in females as well (see the *Non-cancer Human Health Hazard Assessment for DEHP* (U.S. EPA, 2025aa). Therefore, EPA considers the selected POD to be relevant across sexes, life stages, and exposure durations.

Although several PBPK models have been developed for DEHP (Martínez et al., 2018; Sharma et al., 2018; Adachi et al., 2015; Lorber et al., 2010; Cahill et al., 2003; Keys et al., 1999) these models are not fit for purpose and have not been validated to support route-to-route extrapolation for regulatory risk assessment. Given that no reasonably available data were available for the dermal route that were suitable for deriving route-specific PODs, EPA used the acute/intermediate/chronic oral POD to evaluate risks from dermal exposure to DEHP. Differences between oral and dermal absorption are accounted for in dermal exposure estimates in the risk evaluation for DEHP. Although inhalation studies were available, EPA did not consider any of these studies to be suitable for quantitative derivation of a route-specific POD. For the inhalation route, EPA extrapolated 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, 1994b) 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 DEHP in the risk evaluation of DEHP are summarized in Table 4-14.

EPA has robust overall confidence in the selected POD for acute, intermediate and chronic durations based on the following weight of scientific evidence (see Section 4.3 of the *Non-Cancer Human Health Hazard Assessment for DEHP* (U.S. EPA, 2025aa) for further discussion of the weight of scientific evidence):

- DEHP exposure resulted in treatment-related effects on the developing male reproductive system consistent with a disruption of androgen action during the critical window of development in numerous oral exposure studies in rodents, of which 15 studies (comprising 19 publications) were well-conducted and provided robust evidence of a refined threshold, with effects occurring in a narrow dose range of 10 to 15 mg/kg-day, with the NOAEL of 4.8 mg/kg-day.
- Available epidemiology studies provide further evidence of male reproductive effects and underscore the human relevance of these endpoints, indicating moderate to robust evidence of effects on the developing male reproductive system in humans, including decreases in AGD and testosterone and effects on sperm parameters.
- Similar to EPA, five regulatory bodies (Health Canada, 2020; EFSA, 2019; ECHA, 2017a; U.S. CPSC, 2014; NICNAS, 2010) identified the developing male reproductive tract as the most sensitive and robust outcome to use for human health risk assessment and have consistently selected the same set of co-critical studies indicating a NOAEL of approximately 5 mg/kg-day and a LOAEL of approximately 15 mg/kg-day.

4.2.3 Cancer Human Health Hazards of DEHP

Information pertaining to the genotoxicity and carcinogenicity of DEHP is summarized in the *Cancer Human Health Hazard Assessment for DEHP, DBP, BBP, DIBP, and DCHP* (U.S. EPA, 2025b). DEHP has been evaluated for genotoxicity in a number of *in vitro* and *in vivo* test systems. Overall, available data support the conclusion that DEHP and its metabolites are not mutagenic, but that there is some limited evidence that DEHP may be weakly genotoxic, inducing effects such as deoxyribonucleic acid (DNA) damage and/or chromosomal aberrations. As noted by ATSDR (2022), these effects may be secondary to oxidative stress.

DEHP has been evaluated extensively for carcinogenicity in experimental rodent models, including seven chronic dietary studies of rats, two chronic dietary studies of mice, five chronic dietary studies of transgenic mice, one chronic inhalation study of hamsters, and one chronic intraperitoneal injection study of hamsters. Across available studies, dose-related increases in hepatocellular adenomas and/or carcinomas have been observed in rats and mice of both sexes, while dose-related increases in pancreatic acinar cell tumors (PACTs) and Leydig cell tumors have been observed in male rats. EPA has concluded that these tumor types, sometimes referred to as the "tumor triad," are related to PPARα activation. This conclusion is in part informed by inferences from hypolipidemic drugs that lower lipid-levels in humans by activating PPARα, and also induce the tumor triad in rats, but not humans. Notably, during the

August 2025 peer-review meeting, SACC agreed with EPA and was in consensus that the tumor triad is related to PPARα activation in rats.

Under the *Guidelines for Carcinogen Risk Assessment* (U.S. EPA, 2005), EPA reviewed the weight of evidence for the carcinogenicity of DEHP and in the draft DEHP cancer assessment concluded that DEHP is *not likely to be carcinogenic to humans* at doses below levels that do not result in PPARα activation. However, as discussed further in the *Cancer Human Health Hazard Assessment* (U.S. EPA, 2025b), SACC stated that tumors in the triad occur in rodents at doses much higher than humans might be exposed to under environmentally relevant conditions and that data suggest a lack of or diminished response in humans (or human tissue) exposed to DEHP. Based on these considerations, the majority of SACC recommended that EPA revise its DEHP cancer classification to *not likely to be carcinogenic to humans* with the "at doses below levels that do not result in PPARα activation" caveat removed. EPA agreed with the SACC majority opinion, and therefore revised its final cancer classification for DEHP to *not likely to be carcinogenic to humans.*

Table 4-14. Non-Cancer HECs and HEDs Used to Estimate Risks

Target Organ System	Species	Duration	POD (mg/kg-day)	Effect	HED[a] (mg/kg-day)	HEC (mg/m^3) [ppm]	Benchmark MOE	Reference (TSCA Study Quality Rating)
Developing male reproductive system	Rat	Continuous exposure for 3 generations	NOAEL = 4.8	↑total reproductive tract malformations in F1 and F2 males at 14 mg/kg-d	1.1	6.2 [0.39]	UF_A= 3 UF_H=10 *Total UF=30*	(Blystone et al., 2010; TherImmune Research Corporation, 2004) (High)

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

[a] 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 for the remaining uncertainty associated with interspecies differences in toxicodynamics. EPA used a default intraspecies (UF_H) of 10 to account for variation in sensitivity within human populations.

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 4-15.

Table 4-15. Exposure Scenarios, Populations of Interest, and Hazard Values

Population of Interest and Exposure Scenario	**Workers** Male and female adolescents and adults (16+ years old) and females of reproductive age directly working with DEHP under light activity (breathing rate of 1.25 m^3/h) (for further details see (U.S. EPA, 2025u)) Exposure Durations and Frequencies • *Acute* – 8 hours for a single workday • *Intermediate* – 8 hours per workday for up to 22 days per 30-day period • *Chronic* – 8 hours per workday for up to 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 DEHP within the same work area as workers (breathing rate of 1.25 m^3/h) (for further details see (U.S. EPA, 2025u)) Exposure Durations and Frequencies • *Acute, Intermediate, and Chronic* – same as workers Exposure Routes • Inhalation, dermal (mist and dust deposited on surfaces)
	Consumers [a] 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 DEHP through product or articles use (for further details see (U.S. EPA, 2025c)) Exposure Frequencies [a] • *Acute* – 1 day exposure • *Intermediate* – 30 days per year • *Chronic* – 365 days per year Exposure Routes • Inhalation, dermal, and oral
	Bystanders [a] Male and female infants (<1 year), toddlers (1–2 years), and children (3–5 years and 6–10 years) incidentally exposed to DEHP through product use (for further details see (U.S. EPA, 2025c)) Exposure Frequencies • *Acute* – 1 day exposure • *Intermediate* – 30 days per year • *Chronic* – 365 days per year Exposure Routes • Inhalation

Population of Interest and Exposure Scenario	**General Population** Male and female infants, children, youth, and adults exposed to DEHP through drinking water, surface water, soil from air to soil deposition, and fish ingestion (for further details see (U.S. EPA, 2025s)) Exposure Durations and Frequencies • *Acute* – Exposed to DEHP continuously for a 24-hour period • *Chronic* – Exposed to DEHP continuously up to 78 years (depending on life stage) Exposure Routes – Inhalation, dermal, and oral (depending on exposure scenario)
	Cumulative Exposure Based on NHANES Biomonitoring Children aged 3–5, 6–11 years, and 11 to <16 years; male and female adults 16+ years; and females 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, 2025al)) 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.*, ↑ incidence of male reproductive tract malformations) (for further details see (U.S. EPA, 2025aa)) HEC Daily, continuous = 6.2 mg/m^3 (0.39 ppm) HED Daily = 1.1 mg/kg-day; dermal and oral Total UF (benchmark MOE) = 30 (UF_A = 3; UF_H = 10) **Hazard Relative Potency (Cumulative Risk)** 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, 2025al)). RPF_{DEHP} = 0.84 RPF_{DBP} = 1 (index chemical) RPF_{BBP} = 0.52 RPF_{DIBP} = 0.53 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)

[a] Durations of use are not presented in this table as they varied according to products and articles used. For a summary of all durations of exposure modeled for consumers and bystanders, see the *Consumer Exposure Analysis for DEHP* (U.S. EPA, 2025d).

4.3.1.1 Estimation of Non-Cancer Risks

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, short-term, 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

As described in Section 4.1.5, EPA considered aggregate risk 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 is 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 estimates may be interpreted in relation to benchmark MOEs, similarly, as to described in the preceding Section 4.3.1.1.

4.3.2 Risk Estimates for Workers

This section provides discussion and characterization of risk estimates for workers from inhalation and dermal exposures across all routes. In this section, risks are calculated for all exposed workers based on DEHP-derived PODs described in Section 4.2.2. This section provides discussion and characterization of risk estimates for workers, including female workers of reproductive age and ONUs, for the various

OESs and COUs. For OESs where no reasonably available ONU exposure data were found, the worker central tendency value was presented. Therefore, the MOEs for these ONUs, will be comparable to the worker central tendency MOEs, although there is lower confidence in the exposure values for ONUs, given that EPA relied on central tendency exposure estimates for workers as surrogate data to estimate exposure to ONUs. For occupational risk estimates, females of reproductive age are the most sensitive exposed population with the lowest worker MOEs below the benchmark MOEs. The lower MOEs for female workers of reproductive age is a function of the lower body weight (72.4 kg) for this population compared to the average adult worker (80 kg), which includes both male and female workers.

Furthermore, the acute exposure as presented in the risk calculator, results in the lowest worker MOEs for this population (U.S. EPA, 2025ae). This is due to the fact that the endpoint is relevant to acute exposures, and the calculation of intermediate and chronic duration exposures to workers incorporates non-exposure days, therefore reducing the daily dose for the longer durations. This means that PPE that raises the MOE above the benchmark for a female worker of reproductive age in the acute exposure duration will also raise the MOE above the benchmark for all other workers and exposure durations. Risk estimates for other populations of workers, durations, and health effects for all the COUs/OES, as well as aggregate exposures, and PPE needed to raise the MOE above the benchmark are shown in Table 4-17, the *Environmental Release and Occupational Exposure Assessment for DEHP* (U.S. EPA, 2025u), and the *Occupational Risk Calculator for DEHP* (U.S. EPA, 2025ae). Additionally, the risk calculator contains MOE calculations and PPE information for all the OES.

Table 4-17 includes three main sections according to the route of exposure: inhalation, dermal, and aggregate exposure. Assigned Protection Factors (APF) are the workplace level of respiratory protection that a respirator or class of respirators is expected to provide to employees when implemented as part of a continuous, effective respiratory program which includes training, fit testing, maintenance and use requirements. For inhalation, typical respirator APF values of 5, 10, 25, 50, 1,000 and 10,000 were compared to the calculated MOE and the benchmark MOE to determine the level of APF that could be used to bring MOEs above the benchmark MOE. Table 4-17 shows that using PPE for inhalation scenarios when the MOEs are below the benchmark MOE reduces the exposures to above benchmark MOE. Given that risk estimates to workers from aggregate exposure are driven exclusively by inhalation, EPA did not present the APF that could be used to bring MOEs above the benchmark for aggregate exposure but instead rely on the effect of PPE for inhalation to depict that information. Descriptions of the different APFs are included in the notes below the table. The appropriateness of any protection factor that demonstrates exposures resulting in a worker MOE above the benchmark MOE may require additional considerations (*e.g.*, chemical-specific form, formulation, exposure scenario, etc.). The presented protection factors simply represent a value by which corresponding PPE may theoretically increase the estimated worker MOE above the benchmark MOE. The practicality and feasibility of implementing any PPE corresponding to a protection factor is part of a larger evaluation of effective occupational exposure control strategies and will be further discussed in any forthcoming risk management actions.

As a general matter, for all COUs there is uncertainty regarding the representativeness of these data with respect to the full distribution of exposures. This uncertainty is due to the inherent variability in the full distribution for each COU and how well the exposure estimates reflect that variability. Although each exposure assessment is intended to present a set of conditions from which an understanding of occupational risks may be constructed, the variability in the determinants of exposure (*e.g.*, frequency, duration, etc.) from facility to facility within the full distribution of any COU is unknown. As a result, the worker exposure estimates presented for any particular COU may not be characteristic of all exposure scenarios. The central tendency represents a plausible estimate of exposure for those workers at or near the middle of the exposure estimate distribution. Similarly, the high-end represents a plausible estimate (or range) of exposure for those workers at the upper end of the exposure estimate distribution. Workers in this part of the distribution may represent a special population of workers or exposure group who are highly exposed due to the nature of their specific activities (*e.g.*, higher concentration, frequency, duration, and/or surface area of exposure). Worker exposure monitoring data often does not distinguish between these subpopulations and their differing exposures that stem from their normal activities. As a result, worker exposure distributions, in some cases, (absent of subpopulation distinction) can appear to show exposure values at the upper end of the distribution which may seem to be unlikely or implausible but may be routine and expected due to the normal occupational activities of those subpopulations.

The worker MOEs presented in the "Overview of Risk Estimates" subsections below calculated without the use of PPE. Table 4-16 provides more information on PPE that may be used to increase the worker MOEs above the benchmark MOE.

4.3.2.1 Manufacturing

4.3.2.1.1 Overview of Risk Estimates

For the manufacture of DEHP, inhalation exposure from vapors is expected to be the dominant route of exposure. MOEs for high-end acute, intermediate, and chronic inhalation exposure ranged from 362 to 584 for average adult workers and females of reproductive age, while high-end dermal MOEs for the same populations and exposure scenarios ranged from 7,908 to 12,566 (benchmark = 30). The central tendency MOEs for the same populations and exposure scenarios ranged from 664 to 1,071 for inhalation exposure and 15,816 to 25,133 for dermal exposure. Aggregation of inhalation and dermal exposures led to negligible differences in risk when compared to risk estimates from inhalation exposure alone.

4.3.2.1.2 Overview of Exposure Data

EPA used PBZ air concentration data to assess inhalation exposures, with the data sources having a medium and high data quality rating from the systematic review process (Liss and Hartel, 1983; Nuodex Inc., 1983). Data from these sources were DEHP-specific from 2 separate DEHP manufacturing facilities, comprising a total of 45 PBZ samples. It is important to note that a high number of these exposure values (37 of 45 samples) were below the LOD, and there is uncertainty in the actual exposure value for any measurement below the LOD (*i.e.*, actual values could range from 0 to the LOD). The procedure for how to include ND values mathematically in the calculation of air concentration recommended by EPA's *Guidelines for Statistical Analysis of Occupational Exposure Data* (U.S. EPA, 1994a) involves a statistical method for addressing this uncertainty based on the variability represented by the data. For calculations involving samples below the LOD, the guidelines recommend using the LOD/√2 if the geometric standard deviation (GSD) is less than 3.0 and LOD/2 if the GSD is 3.0 or greater. The Manufacturing exposure scenarios included ND as LOD/2 according to these guidelines. The high-end and central tendency worker inhalation exposure results for this OES are based on the 95th and 50th percentile exposure values from 45 full-shift samples collected from two DEHP manufacturing plants (Liss and Hartel, 1983; Nuodex Inc., 1983). These data had data quality ratings ranging from medium to high. EPA determined that all data were of acceptable quality without notable deficiencies and integrated all the data into the final exposure assessment.

4.3.2.1.3 Risk Characterization of COUs

There is uncertainty about how well these data represent the true distribution of inhalation concentrations in this scenario, the lack of ONU exposure data, for which EPA used central tendency worker data as surrogate data (resulting in lower confidence in the ONU exposure data relative to worker exposure data), and that the data come from two DEHP manufacturing facilities. This scenario represents a worker with 8 exposure hours per day and 250 exposure days per year with continuous DEHP exposure each working day. The representativeness of this scenario is influenced by the variability in worker activities, schedules, and facility operations across the full distribution of facilities covered by this COU. Given that worker inhalation exposure for this OES was based data from 45 full-shift samples collected from two DEHP manufacturing plants (Liss and Hartel, 1983; Nuodex Inc., 1983) determined to be medium to high quality data, the central tendency (50th percentile) and the high-end (95th percentile) are expected to be plausible estimates of worker exposures within the COUs covered under the Manufacturing OES (*i.e.,* Manufacturing COU: Domestic manufacturing; Importing).

4.3.2.2 Rubber Manufacturing

4.3.2.2.1 Overview of Risk Estimates

For rubber manufacturing, inhalation exposure from dust generation is expected to be the dominant route of exposure. In support of this, MOEs for high-end acute, intermediate, and chronic inhalation exposure ranged from 0.98 to 1.6 for average adult workers and female workers of reproductive age, while high-end dermal MOEs ranged from 214 to 340 (benchmark = 30). For central tendency, MOEs for the same population and exposure scenarios ranged from 4.8 to 7.7 for inhalation exposure and 428 to 681 for dermal exposures. Note that because EPA did not have ONU-specific exposure data, the central tendency data for workers was used to estimate ONU exposure that resulted in MOEs for ONUs that ranged from 4.8 to 7.7 for inhalation exposure and 428 to 681 for dermal exposures. Aggregation of inhalation and dermal exposures led to negligible differences in risk when compared to risk estimates from inhalation exposure alone.

4.3.2.2.2 Overview of Exposure Data

EPA did not identify any references with discrete, full-shift samples for this OES through systematic review; however, the European Commission document provided maximum concentrations based on time-weighted average area samples from a plant performing rubber calendaring (ECJRC, 2003). Data were comprised of 25 area samples total with range of 0.04 to 26.7 mg/m^3 and mean of 2.48 mg/m^3 and standard deviation of 5.98 mg/m^3; however, sampling duration was only provided for 6 area samples described as the highest air concentration values for each sampling event. EPA assessed high-end worker inhalation exposures for this OES by calculating the 8-hour TWA using the sampling event with highest air concentration. Similarly, EPA assessed the central tendency exposures using the 8-hour TWA from the sampling event with lowest reported air concentration. The reported range for these data was 0.04 mg/m^3 to 26.7 mg/m^3. EPA used the six area samples for which duration was provided (ranging from 1 hour to 5 hours 20 min) because sample collection duration was not available for the summary data. When calculating 8-hour TWA based on the six area samples, EPA considered any time outside of the sample collection period to be zero exposure. This is a reasonable assumption given that the longest collection times (5 hours) resulted in the lowest 8-hour TWA. The resulting calculations of 8-hr TWA agreed with the EU's report for what they considered a reasonable high end 8-hour TWA (10 mg/m^3). EPA compared the central tendency calculated by EPA using the lowest concentration provided by the six area samples for which sample duration was provided (1.7 mg/m^3) against the mean for the 25 samples of unknown duration (2.48 mg/m^3) and note that the mean for the 25 samples is similar to but higher than the 8-hour TWA from the lowest of the measurements for which sample duration was provided. EPA has higher confidence in the values based on 8-hour TWA, given the high variability among the data indicated by the high standard deviation relative to the mean, and the fact that the actual individual measurements (concentration and duration) were not presented for the 25 underlying measurements. These data had a quality rating of high, meaning they are of acceptable quality.

4.3.2.2.3 Risk Characterization of COUs

There is uncertainty about how well these data represent the monitoring data in capturing the true distribution of inhalation concentrations for this OES and the lack of ONU exposure data, for which EPA used central tendency worker data as surrogate data (resulting in lower confidence in the ONU exposure data relative to worker exposure data). Additionally, the monitoring dataset consisted of datapoints for unknown worker classifications and the sample type (PBZ vs. area) was not known for six of the seven samples. This scenario represents a worker with 8 exposure hours per day and 250 exposure days per year with continuous DEHP exposure each working day. The representativeness of this scenario is influenced by the relevance of the worker classifications to this COU as well as the variability in worker activities, schedules, and facility operations across the full distribution of facilities covered by this OES. The report (ECJRC, 2003) states that some of these data may have been collected as a result of compliance activities which can yield elevated exposure measurements. Furthermore, these data were recorded between 1987 and 1996 from operations which may not reflect current rubber manufacturing practice. Considering that the worker inhalation exposures for this OES were based on high quality monitoring data (PBZ and/or area sampling) from the European Commission document (ECJRC, 2003), EPA considers central tendency (50th percentile of the maximum concentration) and high end (95th percentile of the maximum concentration) to be reasonable estimates of worker exposures within the COUs covered under the Rubber manufacturing OES (*i.e.,* Processing – Incorporation into article COU: [Plasticizer in basic organic chemical manufacturing; plastics product manufacturing; rubber product manufacturing; miscellaneous manufacturing; PVC extruding]; Processing – Incorporation into formulation, mixture, or reaction product COU: [Plasticizer in basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint and coating manufacturing; adhesive manufacturing; plastic material and resin manufacturing; synthetic rubber manufacturing; all other basic inorganic chemical manufacturing; wholesale and retail trade; services; ink, toner and colorant manufacturing]).

4.3.2.3 Plastics Compounding

4.3.2.3.1 Overview of Risk Estimates

For plastics compounding, inhalation exposure from dust generation is expected to be the dominant route of exposure. In support of this, MOEs for high-end and central tendency acute, intermediate, and chronic inhalation exposure ranged from 94 to 151 for average adult workers and female workers of reproductive age, while high-end dermal MOEs ranged from 214 to 340 (benchmark = 30). For central tendency dermal, MOEs ranged from 428 to 681. Aggregation of inhalation and dermal exposures led to negligible differences in risk when compared to risk estimates from inhalation exposure alone.

4.3.2.3.2 Overview of Exposure Data

EPA received occupational inhalation exposure data through public comment relevant to plastic compounding. In the draft risk evaluation, data from literature and from the OSHA CEHD were used for these occupational exposure estimates. However, the data received through public comment was more recent, from multiple sites, and with metadata that indicated variability in the worker activities, operations, and resulting exposures. As a result, the exposure data received through public comment was incorporated into the occupational exposure assessment.

The inhalation exposure results for this OES are based on PBZ inhalation monitoring data from full and partial shift samples collected from three U.S. PVC compounding and processing facilities (Vinyl Institute, 2025) from workers involved in bagging, kneading, and blending operations. A single value representing the highest 8-hr TWA provided for plastic compounding (0.085 mg/m^3) was used as a sentinel exposure for a screening-level analysis for all worker activities within the OES for all populations. Note that risk estimates from the screening level analysis are presented above in Section 4.3.2.3.2, and if resulting MOEs were below the benchmark, EPA would next refine the exposure estimates. There is uncertainty in the precise exposure for any value less than the LOD (*e.g.,* actual value between no exposure and the LOD). These data had a data quality rating of high and included workers across a variety of departments and facility operations. EPA determined that all data were of acceptable quality without notable deficiencies. Several references were not included in the analysis as they did not provide discrete sample data (Huang et al., 2011; Modigh et al., 2002) or the age of the data (Salisbury, 1984) was not anticipated to be reflective of current occupational exposures in light of recent inhalation monitoring data submission (Vinyl Institute, 2025).

4.3.2.3.3 Risk Characterization of COUs

There is uncertainty about how well these data represent the monitoring data in capturing the true distribution of inhalation concentrations for this OES. This scenario represents a worker with 8 exposure hours per day and 250 exposure days per year with continuous DEHP exposure each working day. The representativeness of this scenario is influenced by the variability in worker activities, schedules, and facility operations across the full distribution of facilities covered by this OES. However, the worker exposure was based on recent (~10 years old) high quality data comprising samples collected from a plastic compounding operation (Vinyl Institute, 2025) which included supporting metadata on workers across a variety of departments and facility operations. Therefore, the exposure values are considered plausible estimates of worker exposure within the COUs covered under the Plastics compounding OES (*i.e.,* Processing COUs: Incorporation into formulation, mixture, or reaction product [Plasticizer in basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint and coating manufacturing; adhesive manufacturing; plastic material and resin manufacturing; synthetic rubber manufacturing; all other basic inorganic chemical manufacturing; wholesale and retail trade; services; ink, toner and colorant manufacturing]).

4.3.2.4 Plastics Converting

4.3.2.4.1 Overview of Risk Estimates

For plastics converting, inhalation exposure from dust generation is expected to be the dominant route of exposure for workers, as shown by the relative MOEs for this scenario: MOEs for high-end and central tendency acute, intermediate, and chronic inhalation exposure ranged from 156 to 252 for average adult workers and female workers of reproductive age, while high-end dermal MOEs ranged from 214 to 340 (benchmark = 30). For central tendency dermal, MOEs ranged from 428 to 681. Aggregation of inhalation and dermal exposures led to negligible differences in risk when compared to risk estimates from inhalation exposure alone.

4.3.2.4.2 Overview of Exposure Data

EPA received occupational inhalation exposure data through public comment relevant to plastic converting. In the draft risk evaluation, data from literature and from the OSHA CEHD were used for these occupational exposure estimates. However, the data received through public comment was more recent, from multiple sites, and with metadata that indicated variability in the worker activities, operations, and resulting exposures. As a result, the exposure data received through public comment was incorporated into the occupational exposure assessment.

The inhalation exposure results for this OES are based on PBZ inhalation monitoring data from full and partial shift samples collected from three U.S. PVC compounding and processing (converting) facilities (Vinyl Institute, 2025) from workers involved in calendering and hose extrusion. These data had a data quality rating of high. EPA determined that all data were of acceptable quality without notable deficiencies and integrated all data relevant to this OES into the final exposure assessment. There were 5 PBZ samples from workers relevant to plastics converting, and all 5 of these samples were below the LOD. Therefore, EPA used the LOD (0.051 mg/m^3) in a screening level assessment. Several references were not included in the analysis as they did not provide discrete sample data (Huang et al., 2011; Modigh et al., 2002; Dirven et al., 1993) or the age of the data (Salisbury, 1984) was not anticipated to be reflective of current occupational exposures in light of recent inhalation monitoring data submission (Vinyl Institute, 2025).

4.3.2.4.3 Risk Characterization of COUs

There is uncertainty about how well these data represent the monitoring data in capturing the true distribution of inhalation concentrations for this OES and the lack of ONU exposure data, for which EPA used central tendency worker data as surrogate data (resulting in lower confidence in the ONU exposure data relative to worker exposure data). This scenario represents a worker with 8 exposure hours per day and 250 exposure days per year with continuous DEHP exposure each working day. The representativeness of this scenario depends on the variability in worker activities, schedules, and facility operations across the full distribution of facilities covered by this OES. However, the worker exposure was based on recent (~ 10 years old) high quality data comprising samples collected from a plastic converting operation (Vinyl Institute, 2025) which included supporting metadata on workers across a variety of departments and facility operations. Therefore the exposure values are considered representative estimates of worker exposure for this OES of worker exposures within the COUs covered under the Plastics converting OES (*i.e.,* Processing COUs: Incorporation into article [Plasticizer in basic organic chemical manufacturing; plastics product manufacturing; rubber product manufacturing; miscellaneous manufacturing; PVC extruding] and Industrial Use – Other Uses COU: [Solid rocket motor insulation and other aerospace applications; automotive articles]).

4.3.2.5 Incorporation into Other Formulations, Mixtures, or Reaction Products Not Otherwise Specified

4.3.2.5.1 Overview of Risk Estimates

For the incorporation of DEHP into other formulations, mixtures, or reaction products not otherwise specified, inhalation exposure from vapor generation is expected to be the dominant route of exposure for workers, as shown by the relative MOEs for this scenario: MOEs for high-end acute, intermediate, and chronic inhalation exposure ranged from 362 to 584 for average adult workers and female workers of reproductive age, while high-end dermal MOEs for the same populations and exposure scenarios ranged from 7,908 to 12,566 (benchmark = 30). The central tendency MOEs for the same populations and exposure scenarios ranged from 664 to 1,071 for inhalation exposure and 15,816 to 25,133 for dermal exposure. Aggregation of inhalation and dermal exposures led to negligible differences in risk when compared to risk estimates from inhalation exposure alone.

4.3.2.5.2 Overview of Exposure Data

No references with full-shift samples were identified for this OES through systematic review; however, data were available for a similar OES (Manufacturing). These OES are expected to have similar exposure potential based on the similarity of worker activities and chemical physical form in each OES. Therefore, EPA assessed worker and ONU exposures using monitoring data for the Manufacturing OES as a surrogate for this OES. These data were from two facilities and comprised a total of 45 PBZ samples, of which 37 were non-detects (ND). As with manufacturing, this exposure scenarios included ND as LOD/2 according to EPA's *Guidelines for Statistical Analysis of Occupational Exposure Data* (U.S. EPA, 1994a). These data had data quality ratings ranging from medium to high, meaning they are of acceptable quality.

4.3.2.5.3 Risk Characterization of COUs

There is uncertainty about how well these data represent this OES and the true distribution of inhalation concentrations in this scenario, given the lack of ONU exposure data, for which EPA used central tendency worker data as surrogate (resulting in lower confidence in the ONU exposure data relative to worker exposure data), and the fact that the data come from two DEHP manufacturing facilities. as a surrogate OES. This scenario represents a worker with 8 exposure hours per day and 250 exposure days per year with continuous DEHP exposure each working day. The representativeness of this scenario is influenced by the variability in worker activities, schedules, and facility operations across the full distribution of facilities covered by this OES. However, the manufacturing OES used as a surrogate is expected to have similar exposure potential based on the similarity of worker activities and chemical physical form in each OES. Given that worker inhalation exposure for the manufacturing OES was based data from 45 full-shift samples collected from two DEHP manufacturing plants (Liss and Hartel, 1983; Nuodex Inc., 1983) determined to be medium to high quality data, the central tendency (50th percentile) and the high-end (95th percentile) are expected to be plausible estimates of the worker exposures within the COUs covered under the Incorporation into formulations, mixtures, or reaction products OES (*i.e.*, Processing COU: Incorporation into formulation, mixture, or reaction product:[Plasticizer in basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint and coating manufacturing; adhesive manufacturing; plastic material and resin manufacturing; synthetic rubber manufacturing; all other basic inorganic chemical manufacturing; wholesale and retail trade; services; ink, toner and colorant manufacturing]; and Processing COU: Other uses [Miscellaneous processing (cyclic crude and intermediate manufacturing; processing aid specific to hydraulic fracturing)].

4.3.2.6 Import and Repackaging

4.3.2.6.1 Overview of Risk Estimates

For the repackaging of DEHP, inhalation exposure from vapor is expected to be the dominant route of exposure for workers, as shown by the relative MOEs for this scenario:, MOEs for high-end acute, intermediate, and chronic inhalation exposure ranged from 15 to 25 for average adult workers and female workers of reproductive age, while high-end dermal MOEs for the same populations and exposure scenarios ranged from 7,908 to 12,566 (benchmark = 30). For the MOEs below the benchmark, the lowest MOE was for females of reproductive age for acute exposures (MOE = 15), and MOEs increased with longer duration due to incorporation of non-exposure days for intermediate (MOE = 21) and chronic (MOE = 22) duration. MOEs were similar but slightly higher for average workers compared to females of reproductive age, a reflection of higher body weights in the determination of dose, with MOEs of 17, 23, and 25 for acute, intermediate, and chronic durations, respectively. The central tendency MOEs for the same populations and exposure scenarios ranged from 57 to 92 for inhalation exposure and 15,816 to 25,133 for dermal exposure. Aggregation of inhalation and dermal exposures led to negligible differences in risk when compared to risk estimates from inhalation exposure alone. See Table 4-17 for the presentation of MOEs for all populations and durations across the OES.

4.3.2.6.2 Overview of Exposure Data

No references with discrete full-shift samples were identified for this OES through systematic review; however, the European Union Risk Assessment Report on DEHP provided minimum, maximum, and mean air concentrations based on area samples collected from a DEHP manufacturing facility and the European Union Risk Assessment Report on DINP provided a mean concentration for DEHP based on personal samples collected from a phthalate ester producer (ECJRC, 2008, 2003). The European Union Risk Assessment Report on DINP contained inhalation monitoring data for several phthalates including DEHP. EPA assessed the high-end worker inhalation exposure result for this OES using the maximum concentration from the European Union Risk Assessment on DEHP and the central tendency worker inhalation exposure result for this OES using the mean DEHP concentration from the European Union Risk Assessment on DINP (ECJRC, 2008, 2003). These data had data quality ratings of high, meaning they are of acceptable quality.

4.3.2.6.3 Risk Characterization of COUs

There is uncertainty about how well these data represent the monitoring data in capturing the true distribution of inhalation concentrations for this OES and the lack of ONU exposure data, for which EPA used central tendency worker data as surrogate (resulting in lower confidence in the ONU exposure data relative to worker exposure data). Additionally, the vapor monitoring dataset consisted of an unknown number of datapoints with unknown sample durations. This scenario represents a worker with 8 exposure hours per day and 250 exposure days per year with continuous DEHP exposure each working day. The representativeness of this scenario is influenced by the variability in worker activities, schedules, and facility operations across the full distribution of facilities covered by this OES. The European Union Risk Assessment Report on DINP provided a mean concentration for DEHP based on personal samples collected from a phthalate ester producer (ECJRC, 2008, 2003), and EPA determined that this study was of high quality and considers this mean concentration to be a plausible estimate of central tendency for worker exposure for this OES. Given the limited reporting of sample data from the European Union Risk Assessment on DEHP, EPA used the maximum concentration of the area sample data to determine high-end worker inhalation exposure for this OES. However, even though this high-end value is based on the maximum area sample concentration instead of a 95th percentile of the distribution, this value was based on a high-quality study specific to DEHP and considered to be a plausible estimate of high-end worker exposure within the COUs covered under the Import and repackaging OES (*i.e.*, Manufacture COU: Importing; and Processing COU: Repackaging [Repackaging in wholesale and retail trade and in paint and coating manufacturing]).

4.3.2.7 Spray Application of Paints, Coatings, Adhesives, and Sealants

4.3.2.7.1 Overview of Risk Estimates

For the spray applications of paints, coatings, adhesives, and sealants containing DEHP, inhalation exposure from mist generation is expected to be the dominant route of exposure for workers, as shown by the relative MOEs for this scenario: MOEs for high-end acute, intermediate, and chronic inhalation exposure ranged from 0.4 to 0.6 for average adult workers and female workers of reproductive age, while high-end dermal MOEs for the same populations and exposure scenarios ranged from 411 to 653 (benchmark = 30). The central tendency MOEs for the same populations and exposure scenarios ranged from 26 to 42 for inhalation exposure and 822 to 1,307 for dermal exposure. Note that because EPA did not have ONU-specific exposure data, the central tendency data for workers was used to estimate ONU exposure; therefore, MOEs for ONUs also ranged from 26 to 42 for inhalation exposure and 822 to 1,307 for dermal exposure. Aggregation of inhalation and dermal exposures led to negligible differences in risk when compared to risk estimates from inhalation exposure alone.

4.3.2.7.2 Overview of Exposure Data

EPA did not identify inhalation monitoring data specific to DEHP for the spray applications of paints, coatings, adhesives, and sealants OES during systematic review of literature sources. EPA assessed exposures from spray application using the Automotive Refinishing Spray Coating Mist Inhalation Model which estimates worker inhalation exposure based on the concentration of the chemical of interest in the nonvolatile portion of the sprayed product and the concentration of over-sprayed mist/particles (OECD, 2011). The model is based on PBZ monitoring data for mists during automotive refinishing. EPA used the 50th and 95th percentile mist concentrations along with the maximum and central tendency concentration of DEHP identified in diffusion bonding formulations to estimate the central tendency and high-end inhalation exposures, respectively. Engineering controls (*e.g.*, spray booth type) have greater impact on the inhalation exposures than the spray equipment type, with down-draft ventilation being more effective in reducing mist exposures compared to cross-draft ventilation. While the applicability of engineering controls for this ESD to other exposure scenarios (non-automotive spray applications) covered by this COU is uncertain, it is expected that any scenarios in this COU which do not employ the ventilation engineering controls characteristic of the automotive refinishing spray industry may have higher air concentrations.

4.3.2.7.3 Risk Characterization of COUs

The primary uncertainty comes from the lack of DEHP-specific monitoring data, with the ESD serving 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. Additionally, it is uncertain whether the substrates coated, and products used to generate the surrogate data are representative of those associated with DEHP-containing paints, coatings, adhesives, or sealant formulations. EPA only assessed mist exposures to DEHP over a full 8-hour work shift to estimate the level of exposure, though other activities may result in vapor exposures other than mist, and application duration may be variable depending on the job site. Additionally, the lack of ONU exposure data requires the use of central tendency worker data as surrogate data (resulting in lower confidence in the ONU exposure data relative to worker exposure data), which may not be fully representative of ONU exposures. EPA assessed 250 days of exposure per year based on workers using paints, coatings, adhesives, or sealant formulations on every working day, however, application sites may use DEHP-containing paints, coatings, adhesives, or sealant formulations at much lower or variable frequencies. The ESD on which this assessment is based, presents several primary factors which may impact worker exposure estimates and the expected representativeness of any range of exposures.

Two of the factors are spray gun type (conventional or high volume low pressure [HVLP]) and spray booth type (cross-draft, downdraft, semi-downdraft). There is more overspray and mist generation with the conventional spray guns than the HVLP spray guns which results in higher potential exposures. Additionally, there are higher exposures associated with the cross-draft booths than downdraft booths. However, as stated in the ESD, downdraft booths only account for 50 percent or fewer of spray booths. Furthermore, the booth type has a greater impact on the PBZ concentrations than the spray gun type. This OES is not limited to automotive spray applications where the ESD information on the prevalence of these booths or certain booth types may be more relevant. This OES assesses exposures to spray application for all substrate sizes and types where paints, coatings, adhesives, and sealants may be applied. Therefore, the central tendency exposure values may be representative of downdraft/HVLP applications for automotive scenarios whereas conventional spray gun/cross-draft booth (or a simple curtain booth) may be more representative of smaller substrates (*e.g.*, playground equipment, recreational boat applications, etc.). Effectively, the difference in the central tendency and high-end value is representative of the difference in the spray equipment, engineering controls, and resulting exposure reduction.

As discussed in Appendix E, certain coating products containing DEHP that are used in industrial applications require spray applications at specific pressure measurements, indicating foreseeable use in scenarios with higher potential exposures. It is for these reasons, that the full range of exposures, including central tendency and high-end, are expected to be plausible estimates of worker exposures for spray scenarios within the COUs covered under the Application of paints, coatings, adhesives, and sealants OES (*i.e.*, Industrial use COU: Construction, paint, electrical, and metal products [paints and coatings] and Commercial use COUs: Construction, paint, electrical, and metal products [adhesives and sealants; paints and coatings] and Furnishing, cleaning, and treatment care products [all-purpose waxes and polishes]).

4.3.2.8 Non-Spray Application of Paints, Coatings, Adhesives, and Sealants

4.3.2.8.1 Overview of Risk Estimates

For the non-spray applications of paints, coatings, adhesives, and sealants containing DEHP, inhalation exposure from vapor generation is expected to be the dominant route of exposure for workers, as shown by the relative MOEs for this scenario: MOEs for high-end acute, intermediate, and chronic inhalation exposure ranged from 1.0 to 1.6 for average adult workers and female workers of reproductive age, while high-end dermal MOEs for the same populations and exposure scenarios ranged from 411 to 653 (benchmark = 30). The central tendency MOEs for the same populations and exposure scenarios ranged from 4.8 to 7.7 for inhalation exposure and 822 to 1,307 for dermal exposure. Note that because EPA did not have ONU-specific exposure data, the central tendency data for workers was used to estimate ONU exposure; therefore, MOEs for ONUs also ranged from 4.8 to 7.7 for inhalation exposure and 822 to 1,307 for dermal exposure. Aggregation of inhalation and dermal exposures led to negligible differences in risk when compared to risk estimates from inhalation exposure alone.

4.3.2.8.2 Overview of Exposure Data

No references with discrete full-shift samples were identified for this OES through systematic review; however, a European Union Risk Assessment on phthalic esters (including DEHP) provided a maximum concentration based on personal samples collected during mixed operations at a rubber manufacturing (calendering) facility (ECJRC, 2003). The Rubber Manufacturing OES was selected as a surrogate, because it represented the highest air concentration of DEHP across all non-spray OES, given that volatilization is the primary contributor to the air concentration. Data were comprised of 25 area samples total with range of 0.04 to 26.7 mg/m^3 and mean of 2.48 mg/m^3 and standard deviation of 5.98 mg/m^3. EPA used the six area samples for which duration was provided (ranging from 1 hour to 5 hours 20 min) because sample collection duration was not available for the summary data. When calculating 8-hour TWA based on the six area samples, EPA considered any time outside of the sample collection period to be zero exposure. This is a reasonable assumption given that the longest collection times (5 hours) resulted in the lowest 8-hr TWA. The resulting calculations of 8-hr TWA agreed with the EU's report for what they considered a reasonable high end 8-hour TWA (10 mg/m^3). EPA compared the central tendency calculated by EPA using the lowest concentration provided by the six area samples for which sample duration was provided (1.7 mg/m^3) against the mean for the 25 samples of unknown duration (2.48 mg/m^3) and note that the mean for the 25 samples is similar to but higher than the 8-hour TWA from the lowest of the measurements for which sample duration was provided. EPA has higher confidence in the values based on 8-hour TWA, given the high variability among the data indicated by the high standard deviation relative to the mean, and the fact that the actual individual measurements (concentration and duration) were not presented for the 25 underlying measurements. These data had a quality rating of high, meaning they are of acceptable quality.

EPA acknowledges that the central tendency for the non-spray application results in an MOE lower than the spray application. It is important to note that the spray application scenario comprises modeling that includes monitoring data from the automotive spray paints/coatings industry which includes a variety of engineering controls, spray booth configurations, spray gun pressures, etc.; whereas the non-spray application is based on area monitoring data from a rubber manufacturing (calendering) operation that may not be representative of occupational exposures for non-spray applications.

To address the uncertainty regarding the relevance of the rubber calendering operation at high temperature (200 °C) as a surrogate for non-spray application of paints, coatings, adhesives, and sealants, EPA compared the dose from non-spray application of application of paints, coatings, adhesives, and sealants for DEHP (based on rubber calendering) to another phthalate (DBP) which had inhalation monitoring data for non-spray application of paints, coatings, adhesives, and sealants from operations at ambient temperatures. The DBP data were comprised of two full-shift PBZ monitoring samples in OSHA's CEHD from two different inspections one from 2011 of a fabric coating mill and one from a janitorial services company (OSHA, 2019) and an additional 12 8-hour TWA monitoring samples by Rohm and Haas Co. (Rohm & Haas, 1990). EPA characterized the data by taking the 50th percentile and the 95th percentile of the combined dataset to represent the central tendency and high end. Importantly, the DEHP inhalation dose to females of reproductive age using rubber calendering data as a surrogate for non-spray applications of paints, coatings, adhesives, and sealants (0.23 mg/kg-day at central tendency and 1.12 mg/kg-day for high-end; (U.S. EPA, 2025u)) is very similar to DBP for this same OES (0.21 mg/kg-day at central tendency and 1.02 mg/kg-day for high-end (U.S. EPA, 2025t)), thereby increasing EPA's confidence in the use of rubber manufacturing inhalation monitoring data as a surrogate for non-spray application of paints, coatings, adhesives, and sealants. However, while EPA has moderate confidence in these data when used to estimate worker exposure to rubber manufacturing, EPA's confidence in these same data to estimate exposure for non-spray application of paints, coatings, adhesives, and sealants is lower, at slight to moderate, given the use of a surrogate OES.

4.3.2.8.3 Risk Characterization of COUs

There is uncertainty about how well these data represent the monitoring data in capturing the true distribution of inhalation concentrations for this OES and the lack of ONU exposure data, for which EPA used central tendency worker data as surrogate (resulting in lower confidence in the ONU exposure data relative to worker exposure data). Additionally, the monitoring dataset consisted of six unknown sample types and a mixed composition of phthalate esters. This scenario represents a worker with 8 exposure hours per day and 250 exposure days per year based on continuous DEHP exposure each working day for a typical worker schedule. The representativeness of this scenario is influenced by the variability in worker activities, schedules, and facility operations across the full distribution of facilities. There is uncertainty in how well the industrial operations in the monitoring study reflect the non-spray applications covered by this OES. However, the exposure estimates are based on DEHP monitoring data from a surrogate OES which represents the highest air concentrations from a non-spray application, given that volatilization if the primary contributor to the air concentration. Furthermore, as mentioned above, the DEHP inhalation dose similar to DBP for this same OES, thereby increasing EPA's confidence in the use of rubber manufacturing inhalation monitoring data as a surrogate for non-spray application of paints, coatings, adhesives, and sealants. However, these data were determined to be of high quality and represent time-weighted average personal and area samples from a plant performing rubber calendering (ECJRC, 2003) and are considered to be plausible yet high-end estimates of worker exposures for non-spray scenarios within the COUs covered under the Application of paints, coatings, adhesives, and sealants OES (*i.e.*, Industrial use COU: Construction, paint, electrical, and metal products [paints and coatings] and Commercial use COUs: Construction, paint, electrical, and metal products [adhesives and sealants; paints and coatings] and Furnishing, cleaning, and treatment care products [all-purpose waxes and polishes].

4.3.2.9 Textile Finishing

4.3.2.9.1 Overview of Risk Estimates

For textile finishing using products containing DEHP, dermal exposure from liquid is expected to be the dominant route of exposure for workers, as shown by the relative MOEs for this scenario:, MOEs for high-end acute, intermediate, and chronic inhalation exposure ranged from 185,273 to 347,431 for average adult workers and female workers of reproductive age, while high-end dermal MOEs for the same populations and exposure scenarios ranged from 214 to 396 (benchmark = 30). The central tendency MOEs for the same populations and exposure scenarios ranged from 2,569,919 to 4,819,205 for inhalation exposure and 428 to 791 for dermal exposure. Aggregation of inhalation and dermal exposures led to negligible differences in risk when compared to risk estimates from dermal exposure alone.

4.3.2.9.2 Overview of Exposure Data

During textile finishing using DEHP-containing products, worker inhalation and dermal exposures to liquids containing DEHP may occur while transferring products to finishing and coating equipment, cleaning of transport containers, finishing and coating operations, and cleaning of process vessels. EPA did not identify inhalation monitoring data for the textile finishing OES during systematic review. Based on the presence of DEHP in textile fabrics (Laursen et al., 2003), EPA assessed worker inhalation exposures to DEHP as an exposure to particulates of textile fabrics. Therefore, EPA estimated worker inhalation exposures during disposal using the Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR) (also referred to as the "PNOR Model") (U.S. EPA, 2021d). To estimate fabric particulate concentrations in the air, EPA used a subset of the PNOR (U.S. EPA, 2021d) data that came from facilities with the NAICS code starting with 313 to 314 (Textile Manufacturing). EPA multiplied these dust concentrations by the maximum product concentrations to estimate DEHP particulate concentrations in the air. This dataset consisted of 71 measurements. EPA used the highest expected concentration of DEHP in textile products to estimate the concentration of DEHP present in particulates. For this OES, EPA selected 8.6×10^{-6} percent by mass as the highest expected DEHP concentration based on the reported concentrations for several fabrics (Laursen et al., 2003). The estimated exposures are based on the operating assumption that DEHP is present in particulates of the fabrics at this fixed concentration throughout the working shift. Given the assumptions of DEHP present in dust at the concentration in the fabric products containing DEHP, EPA considers the exposure estimate to represent an upper bound for worker exposure. The model (U.S. EPA, 2021d) estimates an 8-hour TWA for particulate concentrations by assuming exposures outside the sample duration are zero. The model does not determine exposures during individual worker activities.

4.3.2.9.3 Risk Characterization of COUs

The PNOR (*i.e.,* dust) concentration data provides a reliable range of dust concentrations that a worker may experience in the textile industry. However, the variability in composition of workplace dust is uncertain. The exposure and risk estimates represent an air composition where the concentration of DEHP in workplace dust is equivalent to the maximum concentration of DEHP in the textile finishing product. The representativeness of the concentration of DEHP in the workplace dust is influenced by the variability in the true distribution of air compositions across all facilities and textile operations covered under this OES. The likelihood of the maximum DEHP concentration in dust and the PBZ air to be comprised entirely by DEHP-containing particles is unknown. EPA considers central tendency values of exposure to be most representative of worker exposures within the COUs covered under the Textile finishing OES (*i.e.,* Commercial Use – Furnishing, cleaning, and treatment care products COU: [Fabric, textile, and leather products; furniture and furnishings; and Fabric enhancer]), given the fact that: the air concentrations were modeled assuming that the: dust present during textile finishing is at the level in the subset of the PNOR (U.S. EPA, 2021d) data from facilities associated with the NAICS code for textile manufacturing; the dust is comprised entirely of abraded textile products containing DEHP; and the concentration of DEHP in those textile products in at the highest concentration reported in fabrics

(Laursen et al., 2003). The high-end estimates are more likely to occur under the more conservative combination of these parameters, and even under these conditions that comprise high-end, the resulting MOEs for inhalation risk were four orders of magnitude above the benchmark.

4.3.2.10 Fabrication and Final Use of Products or Articles

4.3.2.10.1 Overview of Risk Estimates

For fabrication and final use of products or articles, inhalation exposure from vapor generation is expected to be the dominant route of exposure for workers, as shown by the relative MOEs for this scenario:, MOEs for high-end acute, intermediate, and chronic inhalation exposure ranged from 68 to 94 for average adult workers and female workers of reproductive age, while high-end dermal MOEs for the same populations and exposure scenarios ranged from 214 to 357 (benchmark = 30). For central tendency, MOEs for the same population and exposure scenarios ranged from 199 to 337 for inhalation exposure and 428 to 715 for dermal exposures. Aggregation of inhalation and dermal exposures led to negligible differences in risk when compared to risk estimates from inhalation exposure alone.

4.3.2.10.2 Overview of Exposure Data

The worker inhalation exposure results for this OES were calculated from personal samples collected from the 2019 OSHA CEHD data (OSHA, 2019). The time-weighted averages were calculated based on samples that shared the same Inspection, Establishment, and Sampling number and had a sum of sampling time greater than three hours. EPA calculated 8-hour TWAs by assuming exposures outside the sampling time were zero. These data had a data quality rating of high. As all data were deemed of acceptable quality without notable deficiencies, EPA elected to integrate all the data in the final exposure assessment. These data were comprised of seven PBZ samples, all above the LOD. EPA considered the 50th percentile of the TWA to represent central tendency, and the 95th percentile of the TWA to represent the high-end exposure of workers.

4.3.2.10.3 Risk Characterization of COUs

There is uncertainty about how well these data represent the monitoring data in capturing the true distribution of inhalation concentrations for this OES. Additionally, due to the lack of discrete TWA data, samples from the OSHA CEHD were combined by inspection number, establishment name, and sample number to calculate an 8-hour TWA in cases where the sum of sampling time was greater than 3 hours. This method represents workers that are exposed to DEHP for 3 hours during their shift, which may underestimate exposures if they were to be exposed for the full shift duration. Due to the lack of data for ONUs, EPA used a discrete TWA area sample for both the high-end and central tendency exposures. Finally, this scenario represents a worker with eight exposure hours per day and 250 exposure days per year with continuous DEHP exposure each working day; The representativeness of this scenario is influenced by the variability in worker activities, schedules, and facility operations across the full distribution of facilities covered by this OES. Given the possibility of underestimation of exposure, EPA considers the high-end (95th percentile of the TWA) to be most representative of worker exposures within the COUs covered under the Fabrication or final use of products or articles OES (*i.e.*, Commercial use COU: Construction, paint, electrical, and metal products [batteries and capacitors; construction and building materials covering large surface areas, including paper articles; metal articles; stone, plaster, cement, glass and ceramic articles; machinery, mechanical appliances, electrical/electronic articles]; automotive, fuel, agriculture, and outdoor use products [lawn and garden care products]; packaging, paper, plastic, toys, hobby products [packaging (excluding food packaging) and other articles with routine direct contact during normal use, including paper articles; rubber articles; plastic articles (hard); plastic articles (soft); packaging (excluding food packaging), including paper articles; toys, playground, and sporting equipment]; furnishing, cleaning, and treatment care products [floor coverings; construction and building materials covering large surface areas including stone, plaster, cement, glass and ceramic articles fabrics, textiles, and apparel].

To determine the potential impact of any underestimation of exposure on risk characterization for this OES, EPA reviewed the resulting MOEs (72–337) and determined that, even if you assumed that the exposure data reflected a 3-hour exposure and the exposure was actually for a full shift, the MOEs would still be above benchmark.

4.3.2.11 Use of Dyes, Pigments, and Fixing Agents

4.3.2.11.1 Overview of Risk Estimates

For the use of dyes, pigments, and fixing agents containing DEHP, inhalation exposure from vapor generation is expected to be the dominant route of exposure for workers, as shown by the relative MOEs for this scenario:, MOEs for high-end acute, intermediate, and chronic inhalation exposure ranged from 1.0 to 1.6 for average adult workers and female workers of reproductive age, while high-end dermal MOEs for the same populations and exposure scenarios ranged from 411 to 653 (benchmark = 30). The central tendency MOEs for the same populations and exposure scenarios ranged from 4.8 to 7.7 for inhalation exposure and 822 to 1,307 for dermal exposure. Note that because EPA did not have ONU-specific exposure data, the central tendency data for workers was used to estimate ONU exposure, resulting in MOEs for ONUs ranging from 4.8 to 7.7 for inhalation exposure and 822 to 1,307 for dermal exposure. Aggregation of inhalation and dermal exposures led to negligible differences in risk when compared to risk estimates from inhalation exposure alone.

4.3.2.11.2 Overview of Exposure Data

No references with full-shift samples were identified for this OES through systematic review. However, the Rubber Manufacturing OES was selected as a surrogate as it represented the highest air concentration of DEHP across all non-spray scenarios with monitoring data, given that volatilization was the primary contributor to the air concentration. Data were comprised of 25 area samples total with range of 0.04 to 26.7 mg/m^3 and mean of 2.48 mg/m^3 and standard deviation of 5.98 mg/m^3. EPA used the six area samples for which duration was provided (ranging from 1 hour to 5 hours 20 min) because sample collection duration was not available for the summary data. When calculating 8-hour TWA based on the six area samples, EPA considered any time outside of the sample collection period to be zero exposure. This is a reasonable assumption given that the longest collection times (5 hours) resulted in the lowest 8-hr TWA. The resulting calculations of 8-hr TWA agreed with the EU's report for what they considered a reasonable high end 8-hour TWA (10 mg/m^3). EPA compared the central tendency calculated by EPA using the lowest concentration provided by the six area samples for which sample duration was provided (1.7 mg/m^3) against the mean for the 25 samples of unknown duration (2.48 mg/m^3) and note that the mean for the 25 samples is similar to but higher than the 8-hour TWA from the lowest of the measurements for which sample duration was provided. EPA has higher confidence in the values based on 8-hour TWA, given the high variability among the data indicated by the high standard deviation relative to the mean, and the fact that the actual individual measurements (concentration and duration) were not presented for the 25 underlying measurements. These data had a quality rating of high, meaning they are of acceptable quality.

There is uncertainty regarding the relevance of the rubber calendering operation as a surrogate for Use of dyes, pigments, and fixing agents. The operating temperature of 200°C for rubber calendering likely results in a higher air concentration of DEHP and thereby overestimate exposure when used as a surrogate for Use of dyes, pigments, and fixing agents. To address this uncertainty, EPA compared the dose from Use of dyes, pigments, and fixing agents for DEHP and from non-spray application of paints, coatings, adhesives, and sealants (both based on rubber calendering) to another phthalate (DBP) which had inhalation monitoring data for non-spray application of paints, coatings, adhesives, and sealants from operations at ambient temperatures. The DBP data were comprised of two full-shift PBZ monitoring samples in OSHA's CEHD from two different inspections one from 2011 of a fabric coating mill and one from a janitorial services company (OSHA, 2019) and an additional twelve 8-hour TWA monitoring samples by Rohm and Haas Co. (Rohm & Haas, 1990). EPA characterized the data by taking the 50th percentile and the 95th percentile of the combined dataset to represent the central tendency and high end. Importantly, the DEHP inhalation dose to females of reproductive age using rubber calendering data as a surrogate for dyes, pigments and fixing agents and non-spray applications of paints, coatings, adhesives, and sealants (0.23 mg/kg-day at central tendency and 1.12 mg/kg-day for high-end; (U.S. EPA, 2025u)) is similar to DBP for this same OES (0.21 mg/kg-day at central tendency and 1.02 mg/kg-day for high-end (U.S. EPA, 2025t)), thereby increasing EPA's confidence in the use of rubber manufacturing inhalation monitoring data as a surrogate for non-spray application of paints, coatings, adhesives, and sealants. However, while EPA has moderate confidence in these data when used to estimate worker exposure to rubber manufacturing, EPA's confidence in these same data to estimate exposure for use of dyes, pigments, and fixing agents is lower, at slight to moderate, given the use of a surrogate OES.

4.3.2.11.3 Risk Characterization of COUs

4.3.2.12 Formulation for Diffusion Bonding

This scenario represents a worker with 8 exposure hours per day and 250 exposure days per year with continuous DEHP exposure each working day. The representativeness of this scenario is influenced by the variability in worker activities, schedules, and facility operations across the full distribution of facilities covered by this OES. EPA did not identify any data on exposure to ONUs, therefore central tendency worker data was used as a surrogate (resulting in lower confidence in the ONU exposure data relative to worker exposure data). There is uncertainty as to how well the data from the surrogate OES (rubber manufacturing) represent the true distribution of air concentrations in the use of dyes, pigments, and fixing agents OES. However, the exposure estimates are based on DEHP monitoring data from a surrogate OES which represents the highest air concentrations from a non-spray application, given that volatilization is the primary contributor to the air concentration. Furthermore, as mentioned above, the DEHP inhalation dose using rubber calendering data as a surrogate for Use of dyes, pigments, and fixing agents is very similar to DBP for this same OES, thereby increasing EPA's confidence in the use of rubber manufacturing inhalation monitoring data as a surrogate for non-spray application of paints, coatings, adhesives, and sealants. These data were determined to be of high quality (ECJRC, 2003) and are considered to be plausible estimates of worker exposures for COUs covered by under the Use of dyes and pigments, and fixing agents OES (i.e., Commercial use COU: Packaging, paper, plastic, toys, hobby products [ink, toner and colorants]).

4.3.2.12.1 Overview of Risk Estimates

For use of formulations for diffusion bonding containing DEHP, inhalation exposure from vapor generation is expected to be the dominant route of exposure for workers, as shown by the relative MOEs for this scenario: MOEs for high-end acute, intermediate, and chronic inhalation exposure ranged from 1.0 to 1.6 for average adult workers and female workers of reproductive age, while high-end dermal MOEs for the same populations and exposure scenarios ranged from 411 to 653 (benchmark = 30). The central tendency MOEs for the same populations and exposure scenarios ranged from 23 to 38 for inhalation exposure and 822 to 1,307 for dermal exposure. Specifically, the central tendency MOEs were below the benchmark for acute exposure durations, ranging from 23 to 26, and were above the benchmark with longer exposure durations that incorporated non-exposure days, ranging from 32 to 38 for intermediate and chronic durations. Note that because EPA did not have ONU-specific exposure data, the central tendency data for workers was used to estimate ONU exposure resulting in MOEs for ONUs ranging from 23 to 38 for inhalation exposure and 822 to 1,307 for dermal exposure. Aggregation of inhalation and dermal exposures led to negligible differences in risk when compared to risk estimates from inhalation exposure alone.

4.3.2.12.2 Overview of Exposure Data

EPA did not identify inhalation monitoring data specific to DEHP for the Formulations for diffusion bonding OES during systematic review of literature sources. EPA assessed exposures from spray application using the Automotive Refinishing Spray Coating Mist Inhalation Model which estimates worker inhalation exposure based on the concentration of the chemical of interest in the nonvolatile portion of the sprayed product and the concentration of over sprayed mist/particles (OECD, 2011). The model is based on PBZ monitoring data for mists during automotive refinishing. EPA used the 50th and 95th percentile mist concentrations along with the maximum and central tendency concentration of DEHP identified in diffusion bonding formulations to estimate the central tendency and high-end inhalation exposures, respectively.

4.3.2.12.3 Risk Characterization of COUs

The primary uncertainty comes from the lack of DEHP-specific monitoring data, with the ESD serving 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. The inhalation monitoring data used were specific to the spray application of coating materials, so the estimates may not be representative of exposure during other application methods. Additionally, it is uncertain whether the substrates coated, and products used to generate the surrogate data are representative of those associated with DEHP-containing diffusion bonding formulations. EPA only assessed mist exposures to DEHP over a full 8-hour work shift to estimate the level of exposure, though other activities may result in exposures other than mist and application duration may be variable depending on the job site. This scenario represents a worker with 8 exposure hours per day and 250 exposure days per year with continuous DEHP exposure based on workers using diffusion bonding formulations on every working day. However, application sites may use DEHP-containing diffusion bonding formulations at lower or variable frequencies.

The representativeness of this scenario is influenced by the variability in worker activities, schedules, and facility operations across the full distribution of facilities covered by this OES. Additionally, the lack of ONU exposure data led to the use of central tendency worker data as surrogate data, which may not be fully representative of ONU exposures (resulting in lower confidence in the ONU exposure data relative to worker exposure data). Although no inhalation monitoring data was identified that was specific to DEHP use in formulations for diffusion bonding, EPA used the Automotive Refinishing Spray Coating Mist Inhalation Model, which estimates worker inhalation exposure based on the concentration of the chemical of interest in the nonvolatile portion of the sprayed product and the concentration of over sprayed mist/particles (OECD, 2011). The model is based on PBZ monitoring data for mists during automotive refinishing, which is considered a relevant surrogate scenario. EPA used the 50th and 95th percentile mist concentrations along with the central tendency and maximum concentration of DEHP identified in diffusion bonding formulations to estimate the central tendency and high-end inhalation exposures, respectively. As described in Section 4.3.2.7, EPA considers the central tendency and high-end exposure from this model to be a plausible estimate of worker exposures within the COUs covered under the Formulations for diffusion bonding OES (*i.e.*, Industrial Use: Construction, paint, electrical, and metal products [Adhesives and Sealants]), emphasizing the fact that the concentrations of DEHP used are specific to diffusion bonding products, along with the more generic mist concentrations derived from a relevant surrogate OES.

4.3.2.13 Use of Laboratory Chemicals

4.3.2.13.1 Overview of Risk Estimates

For the use of laboratory chemicals containing DEHP, inhalation exposure from dust or vapor generation is expected to be the dominant route of exposure for workers, as shown by the relative MOEs for this scenario: MOEs for high-end acute, intermediate, and chronic inhalation exposure ranged from 80 to 128 for average adult workers and female workers of reproductive age, while high-end dermal MOEs for the same populations and exposure scenarios ranged from 214 to 340 (benchmark = 30). The central tendency MOEs for the same populations and exposure scenarios ranged from 797 to 1,367 for inhalation exposure and 428 to 724 for dermal exposure. Aggregation of inhalation and dermal exposures led to slightly lower MOE values. MOEs for high-end acute, intermediate, and chronic aggregated exposure ranged from 59 to 91 for average adult workers and female workers of reproductive age, while high-end aggregated MOEs for the same populations and exposure scenarios ranged from 288 to 456.

4.3.2.13.2 Overview of Exposure Data

No references with discrete full-shift samples were identified for this OES through systematic review; however, the European Union Risk Assessment for DEHP provided a minimum and maximum based on their collected full-shift area samples from a laboratory used during DEHP production (ECJRC, 2008). A report from Modigh et al. provided full-shift, personal sampling data statistics for two non-detected samples for laboratory staff at a plant producing DEHP (Modigh et al., 2002). For central tendency exposure, EPA used the LOD of two PBZ samples from laboratory staff working in a facility producing DEHP, as both samples were below the LOD (Modigh et al., 2002). Note that these PBZ samples were from laboratory staff. To estimate high-end worker exposure, EPA used the mean of three PBZ samples from mechanics in a facility producing DEHP, given that maintenance may be conducted in the laboratory. These data had data quality ratings ranging from medium to high, meaning they are of acceptable quality.

4.3.2.13.3 Risk Characterization of COUs

There is uncertainty regarding how well these data represent the monitoring data in capturing the true distribution of inhalation concentrations for this OES and the lack of ONU exposure data, for which EPA used central tendency worker data as surrogate (resulting in lower confidence in the ONU exposure data relative to worker exposure data). This scenario represents a worker with 8 exposure hours per day and 250 exposure days per year with continuous DEHP exposure each working day. The representativeness of this scenario is influenced by the variability in worker activities, schedules, and facility operations across the full distribution of facilities covered by this OES. Although no studies were identified that included discrete full-shift samples for this OES, EPA used monitoring data from two studies that sampled laboratories to estimate worker inhalation exposures to vapor (ECJRC, 2008; Modigh et al., 2002). EPA used the maximum of three full-shift area samples for the high-end worker exposures and the minimum of two full-shift PBZ samples, which was below the limit of detection, for the central tendency worker exposures. The primary strength of this approach is that it uses monitoring data specific to this OES from studies that were rated medium to high quality. Therefore, EPA considers the central tendency and high-end exposures to be plausible estimates of worker exposures within the COUs covered under the Use of laboratory chemicals OES (*i.e.*, Commercial Use: Other uses [laboratory chemicals]).

4.3.2.14 Use of Automotive Care Products

4.3.2.14.1 Overview of Risk Estimates

For the use of automotive care products containing DEHP, inhalation exposure from vapor generation is expected to be the dominant route of exposure for workers, as shown by the relative MOEs for this scenario: MOEs for high-end acute, intermediate, and chronic inhalation exposure ranged from 72 to 117 for average adult workers and female workers of reproductive age, while high-end dermal MOEs for the same populations and exposure scenarios ranged from 411 to 653 (benchmark = 30). The central tendency MOEs for the same populations and exposure scenarios ranged from 145 to 249 for inhalation exposure and 822 to 1,390. Aggregation of inhalation and dermal exposures led to negligible differences in risk when compared to risk estimates from inhalation exposure alone.

4.3.2.14.2 Overview of Exposure Data

No references with discrete worker full-shift samples were identified for this OES through systematic review; however, the European Union Risk Assessment on DEHP provided a minimum (below limit of detection) concentration and maximum concentration based on their collected full-shift samples during the application of car sealings and under-coatings (ECJRC, 2008). EPA assessed the high-end worker inhalation exposure result for this OES using the maximum concentration and central tendency worker inhalation exposure result for this OES using the midpoint between zero and the maximum concentration from the European Union Risk Assessment on DEHP as the minimum given in the sample was below the limit of detection (ECJRC, 2008). EPA did not use the substitution method for LOD/2 because the report did not provide any details on the number of non-detects, the LOD or values other than the minimum (below the LOD) or the maximum exposure values. These data had a data quality rating of high, meaning they are of acceptable quality.

4.3.2.14.3 Risk Characterization of COUs

There is uncertainty about how well these data represent the vapor monitoring data in capturing the true distribution of inhalation concentrations for this OES and the lack of ONU exposure data, for which EPA used central tendency worker data as surrogate (resulting in lower confidence in the ONU exposure data relative to worker exposure data). This scenario represents a worker with 8 exposure hours per day and 250 exposure days per year with continuous DEHP exposure each working day. The representativeness of this scenario is influenced by the variability in worker activities, schedules, and facility operations across the full distribution of facilities covered by this OES. Although EPA did not identify studies reporting discrete worker full-shift samples, EPA used the maximum concentration resulting from full-shift samples during the application of car sealings and under-coatings provided in the European Union Risk Assessment on DEHP (ECJRC, 2008) to represent high-end exposure, and the midpoint between zero and the maximum concentration to represent central tendency. These data had a data quality rating of high and were considered plausible estimates of worker exposures within COUs covered under the Use of automotive care products OES (*i.e.*, Commercial Use: Other uses [automotive articles]).

4.3.2.15 Use in Hydraulic Fracturing

4.3.2.15.1 Overview of Risk Estimates

For the use in hydraulic fracturing, vapor inhalation and dermal exposure to liquids containing DEHP are both considered to be significant routes of exposure for workers, as shown by the relative MOEs for this scenario: MOEs for high-end acute, intermediate, and chronic inhalation exposure ranged from 362 to 48,667 for average adult workers and female workers of reproductive age, while high-end dermal MOEs for the same populations and exposure scenarios ranged from 411 to 54,454 (benchmark = 30).

The central tendency MOEs for the same populations and exposure scenarios ranged from 664 to 267,667 for inhalation exposure and 822 to 326,726 for dermal exposure. Aggregation of inhalation and dermal exposures led to lower MOEs compared to either individual route; MOEs for high-end acute, intermediate, and chronic aggregated exposure ranged from 118 to 24,354 for average adult workers and female workers of reproductive age, while the central tendency MOEs for the same populations and exposure scenarios ranged from 226 to 139,132 for aggregated exposure.

4.3.2.15.2 Overview of Exposure Data

No references with full-shift samples were identified for this OES through systematic review; however, data were available for a similar OES (Manufacturing). These OES are expected to have similar exposure potential, while acknowledging the differences in worker activities in each OES. EPA assessed worker and ONU exposures using monitoring data for the Manufacturing OES as a surrogate for this OES. These data were from two facilities and comprised a total of 45 PBZ samples, of which 37 were non-detects (ND). As with manufacturing, this exposure scenarios included ND as LOD/2 according to EPA's *Guidelines for Statistical Analysis of Occupational Exposure Data* (U.S. EPA, 1994a). had data quality ratings ranging from medium to high, meaning they are of acceptable quality.

4.3.2.15.3 Risk Characterization of COUs

There is uncertainty about how well these data represent this OES and the true distribution of inhalation concentrations in this scenario, given the lack of ONU exposure data, for which EPA used central tendency worker data as surrogate (resulting in lower confidence in the ONU exposure data relative to worker exposure data), and the fact that the data come from two DEHP manufacturing facilities as a surrogate for hydraulic fracturing exposures. This scenario represents a worker with 8 exposure hours per day and 1 to 3 exposure days per year based on data obtained from Frac Focus (2022). The manufacturing OES used as a surrogate is expected to have similar exposure potential based on the similarity of worker activities and chemical physical form in each OES. Given that worker inhalation exposure for the manufacturing OES was based data from 45 full-shift samples collected from two DEHP manufacturing plants (Liss and Hartel, 1983; Nuodex Inc., 1983) determined to be medium to high quality data, the central tendency (50th percentile) and the high-end (95th percentile) are expected to be plausible estimates of worker exposure within the COUs covered under the Use in hydraulic fracturing OES (*i.e.,* Industrial Use: Other uses [hydraulic fracturing]).

4.3.2.16 Recycling

4.3.2.16.1 Overview of Risk Estimates

For recycling of products containing DEHP, inhalation exposure from dust or vapor generation is expected to be the dominant route of exposure for workers, as shown by the relative MOEs for this scenario: MOEs for high-end acute, intermediate, and chronic inhalation exposure ranged from 156 to 252 for average adult workers and female workers of reproductive age, while high-end dermal MOEs for the same populations and exposure scenarios ranged from 214 to 340 (benchmark = 30). The central tendency dermal, MOEs ranged from 428 to 681. Aggregation of inhalation and dermal exposures led to negligible differences in risk when compared to risk estimates from inhalation exposure alone.

4.3.2.16.2 Overview of Exposure Data

EPA did not identify inhalation monitoring data for the recycling OES during systematic review. Based on plastic recyclers relying heavily on the plastic converting processes, EPA used plastic converting inhalation monitoring data as surrogate data. EPA received occupational inhalation exposure data through public comment relevant to plastic converting. In the draft risk evaluation, data from literature and from the OSHA CEHD were used for these occupational exposure estimates. However, the data received through public comment was more recent, from multiple sites, and with metadata that indicated variability in the worker activities, operations, and resulting exposures. As a result, the exposure data received through public comment was incorporated into the occupational exposure assessment.

The inhalation exposure results for this OES are based on inhalation monitoring data from full and partial shift samples collected from three U.S. PVC compounding and processing (converting) facilities (Vinyl Institute, 2025) from workers involved in calendering and hose extrusion. These data had a data quality rating of high. EPA determined that all data were of acceptable quality without notable deficiencies and integrated the data into the final exposure assessment. There were 5 PBZ samples from workers relevant to plastics converting, and all 5 of these samples were below the LOD. Therefore, EPA used the LOD (0.051 mg/m^3) in a screening level assessment for the recycling OES.

4.3.2.16.3 Risk Characterization of COUs

There is uncertainty about how well these data represent this OES and the true distribution of inhalation concentrations in this scenario; the lack of ONU exposure data, for which EPA used central tendency worker data as surrogate (resulting in lower confidence in the ONU exposure data relative to worker exposure data). This scenario represents a worker with 8 exposure hours per day and 250 exposure days per year based on continuous DEHP exposure each working day for a typical worker schedule. There is uncertainty in the representativeness of this assessment for the recycling OES due to the use of a surrogate (plastic converting) exposure scenario. However, because plastic recyclers relying heavily on the plastic converting processes, EPA considers this surrogate data to be a reasonable representation of exposures to workers from plastics recycling and a plausible estimate of worker exposures within the COUs covered under the Recycling OES (*i.e.*, Processing COU: Recycling).

4.3.2.17 Waste Handling, Treatment and Disposal

4.3.2.17.1 Overview of Risk Estimates

For waste handling, treatment and disposal, the inhalation exposure from dust generation is expected to be the dominant route of exposure for workers, as shown by the relative MOEs for this scenario: MOEs for high-end acute, intermediate, and chronic inhalation exposure ranged from 5.2 to 8.3 for average adult workers and female workers of reproductive age, while high-end dermal MOEs for the same populations and exposure scenarios ranged from 214 to 340 (benchmark = 30) for both OES. The central tendency MOEs for the same populations and exposure scenarios ranged from 75 to 121 for inhalation exposure and 428 to 681 for dermal exposure for both OES. Aggregation of inhalation and dermal exposures led to negligible differences in risk when compared to risk estimates from inhalation exposure alone.

4.3.2.17.2 Overview of Exposure Data

EPA did not identify inhalation monitoring data for the Waste handling, treatment, and disposal OES during systematic review. Based on the presence of DEHP as an additive in plastics (U.S. CPSC, 2015), EPA assessed worker inhalation exposures to DEHP as an exposure to particulates of discarded plastic materials. Therefore, EPA estimated worker inhalation exposures during disposal using the PNOR Model (U.S. EPA, 2021d). To estimate plastic particulate concentrations in the air, EPA used a subset of the PNOR (U.S. EPA, 2021d) data that came from facilities with the NAICS code starting with 56 (Administrative and Support and Waste Management and Remediation Services). This dataset consisted of 130 measurements. EPA used the highest expected concentration of DEHP in plastic products to estimate the concentration of DEHP present in particulates. For this OES, EPA selected 44 percent by mass as the highest expected DEHP concentration based on the product SDS for Vinoprene 647 (HB Chemical, 2015). The estimated exposures are based on the operating assumption that DEHP is present in particulates of the plastic at this fixed concentration throughout the working shift. The model (U.S. EPA, 2021d) estimates an 8-hour TWA for particulate concentrations by assuming exposures outside the sample duration are zero. The model does not determine exposures during individual worker activities. Given the assumptions of DEHP present in dust at the concentration in the plastic product representing the highest concentration of DEHP identified in SDS for relevant products for this OES, EPA considers the exposure estimate to represent an upper bound for worker exposure.

4.3.2.17.3 Risk Characterization of COUs

Although the PNOR (*i.e.*, dust) concentration data provides a reliable range of dust concentrations that a worker may experience in the disposal industry, the composition of workplace dust is uncertain. The exposure and risk estimates represent an air composition where the concentration of DEHP in workplace dust is equivalent to the maximum concentration of DEHP in PVC plastics. The representativeness of the concentration of DEHP in the workplace dust will be influenced by the variability in the true distribution of air compositions across all facilities and disposed products or articles covered under this OES. EPA considers central tendency values of exposure to be most representative of worker exposures within the COUs covered under the Waste handling, treatment, and disposal OES (*i.e.*, Disposal COU), given the fact that the air concentrations were modeled assuming that: the dust present during waste handling, treatment, and disposal is at the level in the subset of the PNOR data from facilities associated with the NAICS code for Administrative and Support and Waste Management and Remediation Services (U.S. EPA, 2021d); the dust is comprised entirely of abraded plastic products containing DEHP; and the concentration of DEHP in the abraded plastic is the highest concentration reported in SDS (*i.e.*, 44% DEHP in Vinoprene 647 (HB Chemical, 2015)). The high-end estimates are more likely to occur under the more conservative combination of factors which may lead to overestimation.

4.3.2.18 Distribution in Commerce

For purposes of assessment, distribution in commerce consists of the activities associated with the transportation of DEHP or DEHP-containing products and/or articles between sites that manufacture, process, and use DEHP. Additionally, this OES includes the transportation of DEHP-containing wastes to recycling sites or for final disposal. EPA expects all the DEHP or DEHP-containing products and/or articles to be transported in a closed system or otherwise to be transported in a form (*e.g.*, articles containing DEHP) such that there is negligible potential for releases except during an incident. Therefore, no occupational exposures are reasonably expected to occur, and no separate assessment was performed for estimating releases and exposures from the COUs covered under the OES Distribution in commerce (*e.g.*, Distribution in commerce COU).

4.3.2.19 Overall Confidence in Worker Risks

As described in Section 4.1.1.5 and the *Environmental Release and Occupational Exposure Assessment for DEHP* (U.S. EPA, 2025u), EPA has slight to moderate confidence in the assessed inhalation and dermal OESs, and robust confidence in the non-cancer POD selected to characterize risk from acute, intermediate, and chronic duration exposures to DEHP (see Section 4.2 and (U.S. EPA, 2025aa)). Overall, EPA has moderate to robust confidence in the risk estimates calculated for worker inhalation and dermal exposure scenarios. EPA has less confidence in ONU exposure estimates for scenarios where the worker central tendency is used as a surrogate ONU exposure estimate in the absence of data. Sources of uncertainty associated with these occupational COUs are discussed above in Section 4.3.2.

4.3.2.20 Consideration of Personal Protective Equipment (PPE)

OSHA and NIOSH recommend employers utilize the hierarchy of controls[7] to address hazardous exposures in the workplace. The hierarchy of controls strategy outlines, in descending order of priority, the use of elimination, substitution, engineering controls, administrative controls, and lastly PPE. The hierarchy of controls prioritizes the most effective measures, which eliminate or substitute the harmful chemical (*e.g.*, use a different process, substitute with a less hazardous material), thereby preventing or reducing exposure potential. Following elimination and substitution, the hierarchy recommends engineering controls to isolate employees from the hazard, followed by administrative controls or changes in work practices to reduce exposure potential (*e.g.*, source enclosure, local exhaust ventilation systems). Administrative controls are policies and procedures instituted and overseen by the employer to protect worker exposures. OSHA and NIOSH recommend the use of PPE (*e.g.*, respirators, gloves) as the last means of control, when the other control measures cannot reduce workplace exposure to an acceptable level.

4.3.2.20.1 Respiratory Protection

OSHA's Respiratory Protection Standard (29 CFR 1910.134) requires employers in certain industries to address workplace hazards by implementing engineering control measures and, if these are not feasible, providing respirators that are applicable and suitable for the purpose intended. Respirator selection provisions are provided in section 1910.134(d) and require that appropriate respirators be selected based on the respiratory hazard(s) to which the worker will be exposed, in addition to workplace and user factors that affect respirator performance and reliability. APFs are provided in Table 1 under section 1910.134(d)(3)(i)(A) (see below in Table 4-16) and refer to the level of respiratory protection that a respirator or class of respirators is expected to provide to employees when the employer implements a respiratory protection program according to the requirements of OSHA's Respiratory Protection Standard.

Workers are required to use respirators that meet or exceed the required level of protection listed in Table 4-16. Based on the APF, inhalation exposures may be reduced by a factor of 5 to 10,000, if respirators are properly worn and fitted.

Table 4-16. Assigned Protection Factors for Respirators in OSHA Standard 29 CFR 1910.134

Type of Respirator	Quarter Mask	Half Mask	Full Facepiece	Helmet/ Hood	Loose-Fitting Facepiece
1. Air-Purifying Respirator	5	10	50	–	–
2. Power Air-Purifying Respirator (PAPR)	–	50	1,000	25/1,000	25
3. Supplied-Air Respirator (SAR) or Airline Respirator					
• Demand mode	–	10	50	–	–
• Continuous flow mode	–	50	1,000	25/1,000	25
• Pressure-demand or other positive-pressure mode	–	50	1,000	–	–
4. Self-Contained Breathing Apparatus (SCBA)					
• Demand mode	–	10	50	50	–
• Pressure-demand or other positive-pressure mode (*e.g.*, open/closed circuit)	–	–	10,000	10,000	–
Source: 29 CFR 1910.134(d)(3)(i)(A)					

[7] See https://www.osha.gov/sites/default/files/Hierarchy_of_Controls_02.01.23_form_508_2.pdf.

Table 4-17. Occupational Risk Summary Table

COU		OES	Worker Population	Exposure Level	Inhalation Risk Estimates (Benchmark MOE = 30)				Dermal Risk Estimates (Benchmark MOE = 30)			Aggregate Risk Estimates (Benchmark MOE = 30)			
Life Cycle Stage – Category	Subcategory				Acute	Inter.	Chronic	APF[a]	Acute	Inter.	Chronic	Acute	Inter.	Chronic	APF[a]
Manufacturing – Domestic Manufacturing	Domestic manufacturing	Manufacturing	Average Adult Worker	CT	733	1,000	1,071	N/A	15,816	21,567	23,091	701	956	1,023	N/A
				HE	400	545	584	N/A	7,908	10,784	11,546	381	519	556	N/A
			Females of Reproductive Age	CT	664	905	969	N/A	17,214	23,474	25,133	639	872	933	N/A
				HE	362	494	529	N/A	8,607	11,737	12,566	348	474	507	N/A
			ONU[b]	CT	733	1,000	1,071	N/A	–	–	–	–	–	–	–
Manufacturing – Importing	Importing	Import and repackaging	Average Adult Worker	CT	63	86	92	N/A	15,816	21,567	23,091	63	85	91	N/A
				HE	**17**	**23**	**25**	APF 5	7,908	10,784	11,546	**17**	**23**	**25**	APF 5
Processing – Repacking	Repackaging in wholesale and retail trade and in paint and coating manufacturing		Females of Reproductive Age	CT	57	78	83	N/A	17,214	23,474	25,133	57	77	83	N/A
				HE	**15**	**21**	**22**	APF 5	8,607	11,737	12,566	**15**	**21**	**22**	APF 5
			ONU[b]	CT	63	86	92	N/A	–	–	–	–	–	–	–
Processing – Incorporation into article	Plasticizer in basic organic chemical manufacturing; plastics product manufacturing; rubber product manufacturing; miscellaneous manufacturing; PVC extruding	Rubber manufacturing	Average Adult Worker	CT	**5.3**	**7.2**	**7.7**	APF 10	428	584	625	**5.2**	**7.1**	**7.6**	APF 10
				HE	**1.1**	**1.5**	**1.6**	APF 50	214	292	313	**1.1**	**1.5**	**1.6**	APF 50
Processing – Incorporation into formulation, mixture, or reaction product	Plasticizer in basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint and coating manufacturing; adhesive manufacturing; plastic material and resin manufacturing; synthetic rubber manufacturing; all other basic inorganic chemical manufacturing; wholesale and retail trade; services; ink, toner and colorant manufacturing		Females of Reproductive Age	CT	**4.8**	**6.5**	**7.0**	APF 10	466	636	681	**4.7**	**6.4**	**6.9**	APF 10
				HE	**1.0**	**1.3**	**1.4**	APF 50	233	318	340	**1.0**	**1.3**	**1.4**	APF 50
			ONU[b]	CT	**5.3**	**7.2**	**7.7**	APF 10	428	584	625	**5.2**	**7.1**	**7.6**	APF 10
Processing – Incorporation into formulation, mixture, or reaction product	Plasticizer in basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint and coating manufacturing; adhesive manufacturing; plastic material and resin manufacturing; synthetic rubber manufacturing; all other basic inorganic chemical manufacturing; wholesale and retail trade; services; ink, toner and colorant manufacturing	Plastic compounding	Average Adult Worker	CT	104	141	151	N/A	428	584	625	83	114	122	N/A
				HE	104	141	151	N/A	214	292	313	70	95	102	N/A
			Females of Reproductive Age	CT	94	128	137	N/A	466	636	681	78	106	114	N/A
				HE	94	128	137	N/A	233	318	340	67	91	98	N/A
			ONU[b]	CT	104	141	151	N/A	428	584	625	83	114	122	N/A

COU		OES	Worker Population	Exposure Level	Inhalation Risk Estimates (Benchmark MOE = 30)				Dermal Risk Estimates (Benchmark MOE = 30)			Aggregate Risk Estimates (Benchmark MOE = 30)			
Life Cycle Stage – Category	**Subcategory**				**Acute**	**Inter.**	**Chronic**	**APF[a]**	**Acute**	**Inter.**	**Chronic**	**Acute**	**Inter.**	**Chronic**	**APF[a]**
Processing – Incorporation into formulation, mixture, or reaction product	Plasticizer in basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint and coating manufacturing; adhesive manufacturing; plastic material and resin manufacturing; synthetic rubber manufacturing; all other basic inorganic chemical manufacturing; wholesale and retail trade; services; ink, toner and colorant manufacturing	Incorporation into formulation, mixture, or reaction product	Average Adult Worker	CT	733	1,000	1,071	N/A	15,816	21,567	23,091	701	956	1,023	N/A
				HE	400	545	584	N/A	7,908	10,784	11,546	381	519	556	N/A
			Females of Reproductive Age	CT	664	905	969	N/A	17,214	23,474	25,133	639	872	933	N/A
Processing – Other uses	Miscellaneous processing (cyclic crude and intermediate manufacturing; processing aid specific to hydraulic fracturing)			HE	362	494	529	N/A	8,607	11,737	12,566	348	474	507	N/A
			ONU[b]	CT	733	1,000	1,071	N/A	–	–	–	–	–	–	–
Processing – Incorporation into article	Plasticizer in basic organic chemical manufacturing; plastics product manufacturing; rubber product manufacturing; miscellaneous manufacturing; PVC extruding	Plastic converting	Average Adult Worker	CT	173	235	252	N/A	428	584	625	123	168	180	N/A
				HE	173	235	252	N/A	214	292	313	96	130	140	N/A
Industrial Use – Other uses	Solid rocket motor insulation and other aerospace applications		Females of Reproductive Age	CT	156	213	228	N/A	466	636	681	117	160	171	N/A
				HE	156	213	228	N/A	233	318	340	94	128	137	N/A
	Automotive Articles		ONU[b]	CT	173	235	252	N/A	428	584	625	123	168	180	N/A
Industrial Use – Other uses	Paints and coatings	Spray application of paints, coatings, adhesives, and sealants	Average Adult Worker	CT	**29**	40	42	APF 5	822	1,121	1,201	**28**	38	41	APF 5
Industrial Use – Construction, paint, electrical, and metal products	Paints and coatings														
Commercial Use – Construction, paint, electrical, and metal products	Adhesives and sealants			HE	**0.4**	**0.5**	**0.6**	APF 1000	411	561	600	**0.4**	**0.5**	**0.6**	APF 1000
	Paints and coatings		Females of Repro. Age	CT	**26**	36	38	APF 5	895	1,221	1,307	**25**	35	37	N/A
				HE	**0.4**	**0.5**	**0.5**	APF 1000	448	610	653	**0.4**	**0.5**	**0.5**	APF 1000
Commercial Use – Furnishing, cleaning, and treatment care products	All-purpose waxes and polishes		ONU[b]	CT	**29**	40	42	APF 5	822	1,121	1,201	**28**	38	41	APF 5
Industrial Use – Construction, paint, electrical, and metal products	Paints and coatings	Non-spray application of paints, coatings, adhesives, and sealants	Average Adult Worker	CT	**5.3**	**7.2**	**7.7**	APF 10	822	1,121	1,201	**5.2**	**7.1**	**7.6**	APF 10
Commercial Use – Construction, paint, electrical, and metal products	Paints and coatings			HE	**1.1**	**1.5**	**1.6**	APF 50	411	561	600	**1.1**	**1.5**	**1.6**	APF 50
Commercial Use – Construction, paint, electrical, and metal products	Adhesives and sealants		Females of Repro. Age	CT	**4.8**	**6.5**	**7.0**	APF 10	895	1,221	1,307	**4.7**	**6.5**	**6.9**	APF 10
				HE	**1.0**	**1.3**	**1.4**	APF 50	448	610	653	**1.0**	**1.3**	**1.4**	APF 50
			ONU[b]	CT	**5.3**	**7.2**	**7.7**	APF 10	–	–	–	–	–	–	–

COU		OES	Worker Population	Exposure Level	Inhalation Risk Estimates (Benchmark MOE = 30)				Dermal Risk Estimates (Benchmark MOE = 30)			Aggregate Risk Estimates (Benchmark MOE = 30)			
Life Cycle Stage – Category	Subcategory				Acute	Inter.	Chronic	APF[a]	Acute	Inter.	Chronic	Acute	Inter.	Chronic	APF[a]
Commercial Use – Furnishing, cleaning, and treatment care products	Fabric, textile, and leather products; furniture and furnishings	Textile finishing	Average Adult Worker	CT	2,838,710	3,870,968	4,819,205	N/A	428	584	727	428	584	727	N/A
	Fabric enhancer			HE	204,651	279,070	347,431	N/A	214	292	364	214	292	363	N/A
			Females of Repro. Age	CT	2,569,919	3,504,435	4,362,886	N/A	466	636	791	466	636	791	N/A
				HE	185,273	252,645	314,534	N/A	233	318	396	233	317	395	N/A
			ONU[b]	CT	2,838,710	3,870,968	4,819,205	N/A	428	584	727	428	584	727	N/A
Commercial Use – Construction, paint, electrical, and metal products	Batteries and capacitors	Fabrication or use of final products and articles	Average Adult Worker	CT	220	300	337	N/A	428	584	657	145	198	223	N/A
	Construction and building materials covering large surface areas, including paper articles; metal articles; stone, plaster, cement, glass and ceramic articles			HE	80	109	123	N/A	214	292	328	58	79	89	N/A
	Machinery, mechanical appliances, electrical/electronic articles		Females of Repro. Age	CT	199	272	305	N/A	466	636	715	140	190	214	N/A
Commercial Use – Automotive, fuel, agriculture, and outdoor use products	Lawn and garden care products			HE	72	99	111	N/A	233	318	357	55	75	85	N/A
Commercial Use – Packaging, paper, plastic, toys, hobby products	Packaging (excluding food packaging) and other articles with routine direct contact during normal use, including paper articles; rubber articles; plastic articles (hard); plastic articles (soft)		ONU[b]	CT	220	300	337	N/A	428	584	657	145	198	223	N/A
	Packaging (excluding food packaging), including paper articles														
	Toys, playground, and sporting equipment														
Commercial Use – Furnishing, Cleaning, and Treatment care products	Floor coverings; Construction and building materials covering large surface areas including stone, plaster, cement, glass and ceramic articles fabrics, textiles, and apparel														
Commercial Use – Packaging, paper, plastic, toys, hobby products	Ink, toner and colorants	Use of Dyes, Pigments, and Fixing Agents	Average Adult Worker	CT	**5.3**	**7.2**	**7.7**	APF 10	822	1,121	1,201	**5.2**	**7.1**	**7.6**	APF 10
				HE	**1.1**	**1.5**	**1.6**	APF 50	411	561	600	**1.1**	**1.5**	**1.6**	APF 50
			Females of Repro. Age	CT	**4.8**	**6.5**	**7.0**	APF 25	895	1,221	1,307	**4.7**	**6.5**	**6.9**	APF 25
				HE	**1.0**	**1.3**	**1.4**	APF 50	448	610	653	**1.0**	**1.3**	**1.4**	APF 50
			ONU[b]	CT	**5.3**	**7.2**	**7.7**	APF 10	–	–	–	–	–	–	–
Industrial Use – Construction, paint, electrical, and metal products	Adhesives and Sealants	Formulation for Diffusion Bonding	Average Adult Worker	CT	**26**	35	38	APF 5	822	1,121	1,201	**25**	34	37	N/A
				HE	**1.1**	**1.5**	**1.6**	APF 50	411	561	600	**1.1**	**1.5**	**1.6**	APF 50
			Females of Repro. Age	CT	**23**	32	34	APF 5	895	1,221	1,307	**23**	31	33	N/A
				HE	**1.0**	**1.4**	**1.5**	APF 50	448	610	653	**1.0**	**1.4**	**1.5**	APF 50
			ONU[b]	CT	**26**	35	38	APF 5	–	–	–	–	–	–	–

COU		OES	Worker Population	Exposure Level	Inhalation Risk Estimates (Benchmark MOE = 30)				Dermal Risk Estimates (Benchmark MOE = 30)			Aggregate Risk Estimates (Benchmark MOE = 30)			
Life Cycle Stage – Category	**Subcategory**				**Acute**	**Inter.**	**Chronic**	**APF[a]**	**Acute**	**Inter.**	**Chronic**	**Acute**	**Inter.**	**Chronic**	**APF[a]**
Commercial Use – Other uses	Laboratory chemicals	Use of Laboratory Chemicals	Average Adult Worker	CT	880	1,200	1,367	N/A	428	584	665	288	393	447	N/A
				HE	88	120	128	N/A	214	292	313	62	85	91	N/A
			Females of Repro. Age	CT	797	1,086	1,237	N/A	466	636	724	294	401	457	N/A
				HE	80	109	116	N/A	233	318	340	59	81	87	N/A
			ONU [b]	CT	880	1,200	1,367	N/A	428	584	665	288	393	447	N/A
				HE	880	1,200	1,285	N/A	428	584	625	288	393	421	N/A
Commercial Use – Other uses	Automotive articles	Use of Automotive Care Products	Average Adult Worker	CT	160	218	249	N/A	822	1,121	1,277	134	183	208	N/A
				HE	80	109	117	N/A	411	561	600	67	91	98	N/A
			Females of Repro. Age	CT	145	198	225	N/A	895	1,221	1,390	125	170	194	N/A
				HE	72	99	106	N/A	448	610	653	62	85	91	N/A
			ONU [b]	CT	176	240	273	N/A	–	–	–	–	–	–	–
				HE	147	200	214	N/A	–	–	–	–	–	–	–
Industrial Use – Other uses	Hydraulic fracturing	Use in Hydraulic Fracturing	Average Adult Worker	CT	733	22,000	267,667	N/A	822	24,673	300,187	388	11,630	141,498	N/A
				HE	400	4,000	48,667	N/A	411	4,112	50,031	203	2,028	24,670	N/A
			Females of Repro. Age	CT	664	19,917	242,322	N/A	895	26,854	326,726	381	11,436	139,132	N/A
				HE	362	3,621	44,059	N/A	448	4,476	54,454	200	2,002	24,354	N/A
			ONU [b]	CT	733	22,000	267,667	N/A	–	–	–	–	–	–	–
				HE	733	7,333	89,222	N/A	–	–	–	–	–	–	–
Processing – Recycling	Recycling	Recycling	Average Adult Worker	CT	173	235	252	N/A	428	584	625	123	168	180	N/A
				HE	173	235	252	N/A	214	292	313	96	130	140	N/A
			Females of Repro. Age	CT	156	213	228	N/A	466	636	681	117	160	171	N/A
				HE	156	213	228	N/A	233	318	340	94	128	137	N/A
			ONU [b]	CT	173	235	252	N/A	428	584	625	123	168	180	N/A
Disposal: Disposal	Disposal	Waste handling, treatment and disposal	Average Adult Worker	CT	83	113	121	N/A	428	584	625	70	95	102	N/A
				HE	**5.7**	**7.8**	**8.3**	APF 10	214	292	313	**5.6**	**7.6**	**8.1**	APF 10
			Females of Repro. Age	CT	75	102	110	N/A	466	636	681	65	88	94	N/A
				HE	**5.2**	**7.1**	**7.6**	APF 10	233	318	340	**5.1**	**6.9**	74	APF 10
			ONU [b]	CT	83	113	121	N/A	428	584	625	70	95	102	N/A

[a] This value is the protection factor of personal protective equipment required to raise the acute MOE above the benchmark of 30. The Assigned Protection Factors (APF) associated with different types of respirators based on function (air-purifying, powered air purifying, supplied air) and fit (quarter mask, half-mask, full-face piece, helmet/hood, loose-fitting facepiece) are presented above. It should be noted that certain respirators are only applicable to specific types of inhalation exposure. See the OSHA Small Entity Compliance Guide for the Respiratory Protection Standard for detailed descriptions on the respirators corresponding to the APFs in the table.

[b] CT = central tendency; HE = high-end; MOE = margin of exposure, APF = assigned protection factor, Pop = Population, Expos = Exposure, Repro = Reproductive, Inter = Intermediate

[c] Benchmark MOE = 30. **Bold text** in a gray shaded cell indicates an MOE is below the benchmark value of 30.

4.3.3 Risk Estimates for Consumers

Table 4-18 summarizes the dermal, inhalation, ingestion, and aggregate MOEs used to characterize non-cancer risk for acute, intermediate, and chronic exposure to DEHP, and presents these values for all life stages for each COU. A screening level assessment for consumers considers high-intensity exposure scenarios risk estimates and relies on conservative assumptions to assess exposures that would be expected to be on the high end of the expected exposure distribution. For instance, as described in 4.1.2.5, for ingestion via mouthing EPA used a migration rate of 45 $\mu g/cm^2/h$ from article mouthing experiments among children as a reasonable worst-case estimate, per (ECHA, 2013). 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 at, below, or under the benchmark of 30. Further, Table 4-18 provides MOEs for the modeling indoor exposure assessment. The main objective in reconstructing the indoor environment using consumer products and articles commonly present in indoor spaces is to calculate exposure and risk estimates by COU, and by product and article, from indoor dust ingestion and inhalation.

EPA identified article-specific information by COU to construct relevant and representative exposure scenarios. Exposure to DEHP via ingestion of dust was assessed for all articles expected to contribute significantly to dust concentrations due to high surface area (exceeding ~1 m^2) for either a single article or collection of like articles as appropriate. See Section 4.1.2.3 for a brief discussion of the assumptions associated with DEHP migration from articles indoor dust. Articles included in the indoor environment assessment included: car mats, vinyl flooring, in-place wallpaper, insulated cords, furniture components (textiles), air beds, shower curtains, tire crumb, and children's toys (new and legacy). COUs associated with articles included in the indoor environment assessment are indicated with footnote d in Table 4-18. For a detailed discussion of COU-specific uncertainties, see Section 2 and 5 of the *Consumer and Indoor Exposure Assessment for DEHP* (U.S. EPA, 2025c).

Table 4-18. Consumer Risk Summary Table

Consumer Condition of Use Category: Subcategory	Product or Article	Exposure Duration	Exposure Route	Exposure Scenario [a]	Life stage (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)	Adults (21+ years)
Construction, paint, electrical, and metal products: Adhesives and sealants	Auto repair putty	Acute	Dermal	High	–	–	–	–	1.7E04	1.9E04	1.8E04
			Ingestion	–	–	–	–	–	–	–	–
			Inhalation	–	–	–	–	–	–	–	–
		Intermediate	Dermal	High	–	–	–	–	2.6E05	2.8E05	2.7E05
			Ingestion	–	–	–	–	–	–	–	–
			Inhalation	–	–	–	–	–	–	–	–
		Chronic	–	–	–	–	–	–	–	–	–
	Flooring adhesive	Acute	Dermal	High	–	–	–	–	4,300	4,700	4,400
			Ingestion	–	–	–	–	–	–	–	–
			Inhalation	High	1700 [b]	1800 [b]	2200 [b]	2700 [b]	3600 [b]	4600 [b]	5300 [b]
			Aggregate	High	1,700	1,800	2,200	2,700	2,000	2,300	2,400
		Intermediate	Dermal	High	–	–	–	–	6.5E04	7.1E04	6.7E04
			Ingestion	–	–	–	–	–	–	–	–
			Inhalation	High	4.1E04[b]	5.4E04 [b]	6.9E04 [b]	8.0E04 [b]	4.1E04 [b]	5.4E04 [b]	6.9E04[b]
			Aggregate	High	4.1E04	3.0E04	3.5E04	3.6E04	4.1E04	3.0E04	3.5E04
		Chronic	–	–	–	–	–	–	–	–	–
	Inductance loop sealant	Acute	Dermal	High	–	–	–	–	870	950	890
			Ingestion	–	–	–	–	–	–	–	–
			Inhalation	–	–	–	–	–	–	–	–
		Intermediate	–	–	–	–	–	–	–	–	–
		Chronic	Dermal	High	–	–	–	–	1.6E05	1.7E05	1.6E05
			Ingestion	–	–	–	–	–	–	–	–
			Inhalation	–	–	–	–	–	–	–	–
Construction, paint, electrical, and metal products: Batteries	Batteries	Qualitative assessment. Unclear how DEHP is incorporated into batteries. If DEHP is in battery components in the battery interior (*e.g.*, polymer electrolytes), there is little possibility of consumer exposure via inhalation, ingestion, or dermal. If DEHP is in the exterior of the battery, inhalation and ingestion exposures are expected to be negligible due to the small surface area of batteries and because batteries are commonly encased and not exposed to indoor dust. Dermal exposures to DEHP used on the battery exterior would be evaluated with the PVC articles with potential for semi-routine dermal exposure.									
Other: Automotive articles	Car mats	Acute	Dermal	High	–	–	–	–	1.8E04	2.0E04	1.8E04
			Ingestion [c]	High	5.1E04	4.3E04	4.0E04	1.0E05	1.7E05	2.1E05	3.9E05
			Inhalation [c]	High	2,400	2,600	3,200	4,600	6,500	7,600	9,400
			Aggregate	High	2,300	2,400	3,000	4,400	4,600	5,300	6,100
		Intermediate	–	–	–	–	–	–	–	–	–
		Chronic	Dermal	High	–	–	–	–	1.3E05	1.4E05	1.3E05

Consumer Condition of Use Category: Subcategory	Product or Article	Exposure Duration	Exposure Route	Exposure Scenario [a]	Life stage (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)	Adults (21+ years)
			Ingestion [c]	High	5.5E04	4.7E04	4.4E04	1.1E05	1.9E05	2.3E05	4.3E05
			Inhalation [c]	High	2,600	2,800	3,400	4,900	7,000	8,200	1.0E04
			Aggregate	High	2,500	2,600	3,200	4,700	6,400	7,500	9,200
	Tire replacement	Acute	Dermal	High	1,700	2,000	2,300	2,900	3,600	4,000	3,700
			Ingestion	–	–	–	–	–	–	–	–
			Inhalation	–	–	–	–	–	–	–	–
		Intermediate	–	–	–	–	–	–	–	–	–
		Chronic	Dermal	High	1,700	2,000	2,300	2,900	3,600	4,000	3,700
			Ingestion	–	–	–	–	–	–	–	–
			Inhalation	–	–	–	–	–	–	–	–
Furnishing, cleaning, treatment care products: Fabric, textile, and leather products; furniture and furnishings	Clothing	Acute	Dermal	High [d]	–	–	–	–	–	–	–
				Medium	–	–	–	–	350	380	360
			Ingestion	–	–	–	–	–	–	–	–
			Inhalation	–	–	–	–	–	–	–	–
		Intermediate	–	–	–	–	–	–	–	–	–
		Chronic	Dermal	High [d]	–	–	–	–	–	–	–
				Medium	–	–	–	–	2,500	2,700	2,600
			Ingestion	–	–	–	–	–	–	–	–
			Inhalation	–	–	–	–	–	–	–	–
	Furniture components (textile)	Acute	Dermal	High [d]	–	–	–	–	–	–	–
				Medium	–	–	210	270	350	380	360
				Low	–	1,000	1,200	1,400	1,800	2,000	1,800
			Ingestion [c]	High	86	130	190	2,100	3,700	4,600	1.0E04
				Medium	680	860	1,200	9,400	1.7E04	2.1E04	4.7E04
				Low	8.9E04	6.2E04	1.1E05	8.4E07	1.5E08	1.9E08	4.2E08
			Inhalation [c]	High	46	48	60	86	120	140	180
				Medium	210	220	270	390	560	650	810
				Low	1.9E06	2.0E06	2.5E06	3.6E06	5.1E06	6.0E06	7.4E06
			Aggregate	High	**30**	36	45	82	120	140	170
				Medium	160	180	110	160	210	240	250
				Low	8.50E04	980	1,140	1,400	1,800	2,000	1,800
		Intermediate	–	–	–	–	–	–	–	–	–
		Chronic	Dermal	High [d]	–	–	–	–	–	–	–
				Medium	–	–	210	270	350	380	360

Consumer Condition of Use Category: Subcategory	Product or Article	Exposure Duration	Exposure Route	Exposure Scenario [a]	Life stage (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)	Adults (21+ years)
Furnishing, cleaning, treatment care products: Fabric, textile, and leather products; furniture and furnishings	Furniture components (textile)			Low	–	1,000	1,200	1,400	1,800	2,000	1,800
			Ingestion [c]	High	86	130	190	2,100	3,700	4,600	1.0E04
				Medium	680	860	1,200	9,400	1.7E04	2.1E04	4.7E04
				Low	8.9E04	6.2E04	1.1E05	8.4E07	1.5E08	1.9E08	4.2E08
			Inhalation [c]	High	48	51	62	90	130	150	180
				Medium	220	230	290	410	580	680	850
				Low	2.0E06	2.1E06	2.6E06	3.8E06	5.3E06	6.2E06	7.8E06
			Aggregate	High [d]	31	37	47	86	120	140	180
				Med	170	180	110	160	220	240	250
				Low	8.40E04	980	1,100	1,400	1,800	2,000	1,800
Furnishing, cleaning, treatment care products: Fabric, textile, and leather products; furniture and furnishings	Small articles with the potential for semi-routine contact: outdoor furniture, children's bags, wallets, footwear, interior and exterior components of jackets, handbags	Acute	Dermal	High	1,700	2,000	2,300	2,900	3,600	4,000	3,700
			Ingestion	–	–	–	–	–	–	–	–
			Inhalation	–	–	–	–	–	–	–	–
		Intermediate	–	–	–	–	–	–	–	–	–
		Chronic	Dermal	High	1,700	2,000	2,300	2,900	3,600	4,000	3,700
			Ingestion	–	–	–	–	–	–	–	–
			Inhalation	–	–	–	–	–	–	–	–
Construction, paint, electrical, and metal products: Floor coverings; construction and building materials covering large surface areas including stone, plaster, cement, glass and ceramic articles; Fabrics, textiles, and apparel And Furnishing, cleaning, treatment care products: Floor coverings; construction and building materials covering large	Vinyl flooring	Acute	Dermal	High	430	500	580	710	900	990	920
			Ingestion [c]	High	2,900	2,300	2,100	5,900	1.0E04	1.3E04	3.0E04
			Inhalation [c]	High	260	280	340	490	700	820	1,000
			Aggregate	High	150	170	200	280	380	430	480
		Intermediate	–	–	–	–	–	–	–	–	–
		Chronic	Dermal	High	430	500	580	710	900	990	920
			Ingestion [c]	High	3,200	2,600	2,300	6,500	1.2E04	1.5E04	3.2E04
			Inhalation [c]	High	280	290	360	520	730	850	1,100
			Aggregate	High	160	170	200	290	390	440	490
	Wallpaper (In Place)	Acute	Dermal	High	3,400	4,000	4,600	5,700	7,200	7,900	–
			Ingestion [c]	High	2.0E06	1.6E06	1.5E06	4.2E06	7.4E06	9.3E06	2.1E07
			Inhalation [c]	High	1.9E05	2.0E05	2.4E05	3.5E05	5.0E05	5.8E05	7.2E05
			Aggregate	High	3,300	3,900	4,500	5,600	7,100	7,800	7.0E05
		Intermediate	–	–	–	–	–	–	–	–	–
		Chronic	Dermal	High	3,400	4,000	4,600	5,700	7,200	7,900	–

Consumer Condition of Use Category: Subcategory	Product or Article	Exposure Duration	Exposure Route	Exposure Scenario [a]	Life stage (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)	Adults (21+ years)
surface areas including stone, plaster, cement, glass and ceramic articles; Fabrics, textiles, and apparel			Ingestion [c]	High	2.2E06	1.8E06	1.6E06	4.6E06	8.1E06	1.0E07	2.3E07
			Inhalation [c]	High	1.9E05	2.1E05	2.5E05	3.7E05	5.2E05	6.0E05	7.5E05
			Aggregate	High	3,300	3,900	4,500	5,600	7,100	7,800	7.3E05
	Wallpaper (Installation)	Acute	Dermal	High	–	–	–	–	450	490	460
			Ingestion	–	–	–	–	–	–	–	–
			Inhalation	–	–	–	–	–	–	–	–
		Intermediate	–	–	–	–	–	–	–	–	–
		Chronic	–	–	–	–	–	–	–	–	–
Automotive, fuel, agriculture, outdoor use products: Lawn and garden care products	Small articles with the potential for semi-routine contact: garden hose	Acute	Dermal	High	1,700	2,000	2,300	2,900	3,600	4,000	3,700
			Ingestion	–	–	–	–	–	–	–	–
			Inhalation	–	–	–	–	–	–	–	–
		Intermediate	–	–	–	–	–	–	–	–	–
		Chronic	Dermal	High	1,700	2,000	2,300	2,900	3,600	4,000	3,700
			Ingestion	–	–	–	–	–	–	–	–
			Inhalation	–	–	–	–	–	–	–	–
Construction, paint, electrical, and metal products: Machinery, mechanical appliances, electrical/electronic articles	Insulated cords	Acute	Dermal	High	8,500	1.0E04	1.2E04	1.4E04	1.8E04	2.0E04	1.8E04
			Ingestion [c]	High	93	160	250	4.9E04	8.7E04	1.1E05	2.5E05
			Inhalation [c]	High	2,900	3,100	3,800	5,400	7,600	8,900	1.1E04
			Aggregate	High	90	150	230	3,600	5,100	5,800	6,800
		Intermediate	–	–	–	–	–	–	–	–	–
		Chronic	Dermal	High	8,500	1.0E04	1.2E04	1.4E04	1.8E04	2.0E04	1.8E04
			Ingestion [c]	High	94	160	250	4.9E04	8.7E04	1.1E05	2.4E05
			Inhalation [c]	High	3,000	3,200	3,900	5,600	8,000	9,300	1.2E04
			Aggregate	High	90	150	230	3,700	5,200	6,000	6,900
	Small articles with the potential for semi-routine contact: phone charge, wireless earbuds, electrical tape	Acute	Dermal	High	1,700	2,000	2,300	2,900	3,600	4,000	3,700
			Ingestion	–	–	–	–	–	–	–	–
			Inhalation	–	–	–	–	–	–	–	–
		Intermediate	–	–	–	–	–	–	–	–	–
		Chronic	Dermal	High	1,700	2,000	2,300	2,900	3,600	4,000	3,700
			Ingestion	–	–	–	–	–	–	–	–
			Inhalation	–	–	–	–	–	–	–	–
Other: Novelty articles	Adult toys	Acute	Dermal	High	–	–	–	–	–	4,000	3,700
				Medium	–	–	–	–	–	7,900	7,400
			Ingestion	High [d]	–	–	–	–	–	–	–

Consumer Condition of Use Category: Subcategory	Product or Article	Exposure Duration	Exposure Route	Exposure Scenario [a]	Life stage (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)	Adults (21+ years)
				Medium	–	–	–	–	–	220	250
			Inhalation	–	–	–	–	–	–	–	–
			Aggregate	High [d]	–	–	–	–	–	–	–
				Medium	–	–	–	–	–	220	240
		Intermediate	–	–	–	–	–	–	–	–	–
		Chronic	Dermal	High	–	–	–	–	–	4,000	3,700
				Medium	–	–	–	–	–	7,900	7,400
			Ingestion	High [d]	–	–	–	–	–	–	–
				Medium	–	–	–	–	–	220	250
			Inhalation	–	–	–	–	–	–	–	–
			Aggregate	High [d]	–	–	–	–	–	–	–
				Medium	–	–	–	–	–	220	240
Packaging, paper, plastic, toys, hobby products: Ink, toner, and colorants	Stamp ink	Qualitative assessment: The product is intended for use in the manufacturing of pre-inked handstamps for the purpose of marking or printing on porous substrates such as paper or paper board. Therefore, there is no direct exposure during typical use of this product.									
Packaging, paper, plastic, toys, hobby products: Packaging (excluding food packaging) and other articles with routine direct contact during normal use, including rubber articles;	Air beds (article concentration and barrier refinement)	Acute	Dermal	High	57	130	170	220	290	310	300
			Ingestion [c]	High	6,200	5,000	4,500	1.3E04	2.3E04	2.9E04	6.4E04
			Inhalation [c]	High	690	730	900	1,300	1,800	2,100	2,700
			Aggregate	High	52	110	140	190	240	270	270
		Intermediate	–	–	–	–	–	–	–	–	–
		Chronic	Dermal	High	580	1,400	1,700	2,300	2,900	3,200	3,000
			Ingestion [c]	High	6,800	5,500	4,800	1.4E04	2.5E04	3.1E04	6.9E04
			Inhalation [c]	High	720	760	940	1,400	1,900	2,200	2,800
			Aggregate	High	310	450	540	800	1,100	1,300	1,400
	Mobile phone covers	Acute	Dermal	High	570	660	770	950	1,200	1,300	1,200
			Ingestion	–	–	–	–	–	–	–	–
			Inhalation	–	–	–	–	–	–	–	–
		Intermediate	–	–	–	–	–	–	–	–	–
		Chronic	Dermal	High	570	660	770	950	1,200	1,300	1,200
			Ingestion	–	–	–	–	–	–	–	–
			Inhalation	–	–	–	–	–	–	–	–
	Eraser	Acute	Dermal	High	8,500	1.0E04	1.2E04	1.4E04	1.8E04	2.0E04	1.8E04
			Ingestion	–	–	–	250	430	–	–	–
			Inhalation	–	–	–	–	–	–	–	–
		Intermediate	–	–	–	–	–	–	–	–	–

Consumer Condition of Use Category: Subcategory	Product or Article	Exposure Duration	Exposure Route	Exposure Scenario [a]	Life stage (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)	Adults (21+ years)
plastic articles (hard); plastic articles (soft)		Chronic	Dermal	High	8,500	1.0E04	1.2E04	1.4E04	1.8E04	2.0E04	1.8E04
			Ingestion	–	–	–	250	430	–	–	–
			Inhalation	–	–	–	–	–	–	–	–
	Shower curtains	Acute	Dermal	High	3,400	4,000	4,600	5,700	7,200	7,900	7,400
			Ingestion [c]	High	1,900	1,500	1,300	3,800	6,800	8,500	1.9E04
			Inhalation [c]	High	62	66	81	120	170	190	240
			Aggregate	High	59	62	75	110	160	180	230
		Intermediate	–	–	–	–	–	–	–	–	–
	Shower curtains	Chronic	Dermal	High	3,400	4,000	4,600	5,700	7,200	7,900	7,400
			Ingestion [c]	High	2,000	1,600	1,500	4,200	7,400	9,300	2.1E04
			Inhalation [c]	High	65	69	85	120	170	200	250
			Aggregate	High	62	65	79	120	160	190	240
Packaging, paper, plastic, toys, hobby products: Packaging (excluding food packaging) and other articles with routine direct contact during normal use, including rubber articles; plastic articles (hard); plastic articles (soft)	Small articles with the potential for semi-routine contact: packaging, paper, plastic, toys, hobby products: cutting board, pencils, pouches, bags, hose, labels, covers, chewy toys, jewelry, gloves, packaging, mats, lampshade, vinyl floor runner, diving goggles, silly straws, stickers, diving goggles	Acute	Dermal	High	1,700	2,000	2,300	2,900	3,600	4,000	3,700
			Ingestion	–	–	–	–	–	–	–	–
			Inhalation	–	–	–	–	–	–	–	–
		Intermediate	–	–	–	–	–	–	–	–	–
		Chronic	Dermal	High	1,700	2,000	2,300	2,900	3,600	4,000	3,700
			Ingestion	–	–	–	–	–	–	–	–
			Inhalation	–	–	–	–	–	–	–	–
Packaging, paper, plastic, toys, hobby products: Packaging (Excluding Food Packaging), Including Paper Articles	Small articles with the potential for semi-routine contact: Packaging, paper, hobby products: pencils, labels,	Acute	Dermal	High	1,700	2,000	2,300	2,900	3,600	4,000	3,700
			Ingestion	–	–	–	–	–	–	–	–
			Inhalation	–	–	–	–	–	–	–	–
		Intermediate	–	–	–	–	–	–	–	–	–
		Chronic	Dermal	High	1,700	2,000	2,300	2,900	3,600	4,000	3,700
			Ingestion	–	–	–	–	–	–	–	–

Consumer Condition of Use Category: Subcategory	Product or Article	Exposure Duration	Exposure Route	Exposure Scenario [a]	Life stage (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)	Adults (21+ years)
	covers, lampshade, stickers		Inhalation	–	–	–	–	–	–	–	–
Construction, paint, electrical, and metal products: Paints and coatings	Auto coatings	Acute	Dermal	High	–	–	–	–	1.7E04	1.9E04	1.8E04
			Ingestion	–	–	–	–	–	–	–	–
			Inhalation	High	2000 [b]	2100 [b]	2500 [b]	3500 [b]	4500 [b]	5500 [b]	6600 [b]
			Aggregate	High	2,000	2,100	2,500	3,500	3,600	4,200	4,800
		Intermediate	–	–	–	–	–	–	–	–	–
		Chronic	Dermal	High	–	–	–	–	1.2E05	1.3E05	1.2E05
			Ingestion	–	–	–	–	–	–	–	–
			Inhalation	High	170 [b]	180 [b]	220 [b]	300 [b]	370 [b]	450 [b]	540 [b]
			Aggregate	High	170	180	220	300	370	450	540
	Concrete sealant	Acute	Dermal	High	–	–	–	–	870	950	890
			Ingestion	–	–	–	–	–	–	–	–
			Inhalation	High	9700 [b]	1.0E04 [b]	1.3E04 [b]	1.6E04 [b]	5200 [b]	7000 [b]	7700 [b]
			Aggregate	High	9,700	1.0E04	1.3E04	1.6E04	740	840	800
		Intermediate	Dermal	High	–	–	–	–	2.6E04	2.8E04	2.7E04
			Ingestion	–	–	–	–	–	–	–	–
			Inhalation	High	2.9E05 [b]	3.1E05 [b]	3.8E05 [b]	4.7E05 [b]	1.6E05 [b]	2.1E05 [b]	2.3E05[b]
			Aggregate	High	2.9E05	3.1E05	3.8E05	4.7E05	2.2E04	2.5E04	2.4E04
		Chronic	–	–	–	–	–	–	–	–	–
Packaging, paper, plastic, toys, hobby products: Toys, playground, and sporting equipment	Children's toys (legacy)	Acute	Dermal	High	750	870	1,000	1,300	1,600	1,700	–
			Ingestion [c]	High	57	200	340	4,100	7,300	9,200	2.0E04
			Inhalation [c]	High	83	88	110	150	220	260	320
			Aggregate	High	32	57	76	130	190	220	310
		Intermediate	–	–	–	–	–	–	–	–	–
		Chronic	Dermal	High	750	870	1,000	1,300	1,600	1,700	–
			Ingestion [c]	High	57	200	340	4,100	7,300	9,200	2.0E04
			Inhalation [c]	High	86	92	110	160	230	270	330
			Aggregate	High	33	58	78	140	200	230	330
	Children's toys (new)	Acute	Dermal	High	750	870	1,000	1,300	1,600	1,700	–
			Ingestion [c]	High	59	220	440	1.3E07	2.4E07	3.0E07	6.8E07
			Inhalation [c]	High	2.7E05	2.9E05	3.6E05	5.1E05	7.2E05	8.5E05	1.1E06
			Aggregate	High	54	180	310	1,200	1,600	1,700	1.0E06
		Intermediate	–	–	–	–	–	–	–	–	–

Consumer Condition of Use Category: Subcategory	Product or Article	Exposure Duration	Exposure Route	Exposure Scenario [a]	Life stage (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)	Adults (21+ years)
		Chronic	Dermal	High	750	870	1,000	1,300	1,600	1,700	–
			Ingestion [c]	High	59	220	440	1.3E07	2.4E07	3.0E07	6.7E07
			Inhalation [c]	High	2.9E05	3.0E05	3.7E05	5.3E05	7.6E05	8.9E05	1.1E06
			Aggregate	High	53	160	250	960	1,300	1,500	2.0E04
	Tire crumb, artificial turf	Acute	Dermal	High	–	–	1.7E04	1.8E04	2.4E04	2.7E04	2.6E04
			Ingestion	High	–	–	5.1E06	1.2E07	2.1E07	5.3E07	5.9E07
			Inhalation	High	–	–	1.7E08	2.6E08	1.3E08	2.5E08	2.7E08
			Aggregate	High	–	–	1.7E04	1.8E04	2.4E04	2.7E04	2.6E04
		Intermediate	–	–	–	–	–	–	–	–	–
		Chronic	Dermal	High	–	–	8.1E04	8.6E04	6.2E04	7.1E04	1.2E05
			Ingestion	High	–	–	2.4E07	5.5E07	5.5E07	1.4E08	2.7E08
			Inhalation	High	–	–	8.0E08	1.2E09	3.5E08	6.6E08	1.3E09
			Aggregate	High	–	–	8.1E04	8.6E04	6.2E04	7.1E04	1.2E05
	Small articles with the potential for semi-routine contact: Fitness balls, jump rope, yoga mat, football, and diving goggles	Acute	Dermal	High	1,700	2,000	2,300	2,900	3,600	4,000	3,700
			Ingestion	–	–	–	–	–	–	–	–
			Inhalation	–	–	–	–	–	–	–	–
		Intermediate	–	–	–	–	–	–	–	–	–
		Chronic	Dermal	High	1,700	2,000	2,300	2,900	3,600	4,000	3,700
			Ingestion	–	–	–	–	–	–	–	–
			Inhalation	–	–	–	–	–	–	–	–

[a] Exposure scenario intensities include high, medium, and low.
[b] MOE for bystander scenario. These individuals may inhale DEHP away (*i.e.*, in far-field within the room or outside room of use) from where the product or article is being used or emitted. Therefore, bystander exposures are lower than that of an active user or a do-it-your-self/hobbyist who may use or install a product or an article (*i.e.*, flooring adhesive application).
[c] Exposure routes evaluated for indoor environments in which dust containing DEHP may be inhaled via indoor air or ingested from suspended dust, mouthing of articles, or settled dust on various residential surfaces. For a detailed description of the sources, routes and pathways of consumer and bystander exposures to DEHP, see the *Consumer and Indoor Exposure Assessment for DEHP* (U.S. EPA, 2025c).
[d] Scenario was deemed to be unlikely either due to a lack of adequate input parameters, input parameters may not reflect actual use scenarios, or calculated estimates may not effectively represent actual exposures and risks, see *Consumer and Indoor Exposure Assessment for DEHP* (U.S. EPA, 2025c).

Of note, the risk summary below is based on the most sensitive non-cancer endpoint for all relevant duration scenarios (*i.e.*, effects on the developing male reproductive system for acute, intermediate, and chronic durations). MOEs for all high-, medium- and low-intensity exposure scenarios for all COUs are described in the *Consumer Risk Calculator for DEHP* (U.S. EPA, 2025f).

COUs with MOEs for High-Intensity Use Exposure Scenarios Above Benchmark

The screening level assessment for consumers considers high-intensity exposure scenario risk estimates (MOEs) and relies on conservative assumptions to assess exposures that would be expected to be on the high end of the expected exposure distribution. If MOEs are above the benchmark of 30 for the high-intensity use scenario then any exposures with lower intensity use inputs would result in larger MOEs and, thus, be of less concern. Consumer COUs that resulted in MOEs for high-intensity exposure scenarios above the benchmark of 30 for acute, chronic and intermediate exposures are summarized in Table 4-18 and in the following list:

- Automotive, fuel, agriculture, outdoor use products: Lawn and garden care products;
- Construction, paint, electrical, and metal products: Adhesives and sealants;
- Construction, paint, electrical, and metal products: floor coverings; construction and building materials covering large surface areas including stone, plaster, cement, glass and ceramic articles; fabrics, textiles, and apparel;
- Construction, paint, electrical, and metal products: machinery, mechanical appliances, electrical/electronic articles;
- Construction, paint, electrical, and metal products: paints and coatings;
- Other uses: automotive articles;
- Other uses: novelty articles;
- Packaging, paper, plastic, toys, hobby products: packaging (excluding food packaging), including paper articles;
- Packaging, paper, plastic, toys, hobby products; packaging (excluding food packaging) and other articles with routine direct contact during normal use, including rubber articles; plastic articles (hard); plastic articles (soft); and
- Packaging, paper, plastic, toys, hobby products; Toys, playground, and sporting equipment

Variability in MOEs for these high-intensity exposure scenarios results from use of different exposure factors for each COU and product/article examples that led to different estimates of exposure to DEHP. As described in the *Consumer and Indoor Exposure Assessment for DEHP* (U.S. EPA, 2025c) and *Non-cancer Human Health Hazard Assessment for DEHP* (U.S. EPA, 2025aa), 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. EPA is confident that the high-intensity use scenarios used in the screening approach represent a plausible upper bound estimate and provide a health protective estimate for consumer exposures.

COUs with MOEs for High-Intensity Exposure Scenarios Below Benchmark

The screening level assessment for consumers considered high-intensity exposure scenario risk estimates (MOEs) and relied on conservative assumptions to assess exposures that would be expected to be on the high end of the expected exposure distribution. If MOEs were below the benchmark of 30 for the high-intensity use scenario, EPA reevaluated the approaches and inputs used and determined if refinement of those was needed. In addition, EPA considered the medium-intensity use scenario as either a possible upper bound estimate by reevaluating inputs and approaches or endeavors in the refinement of approaches by using other modeling tools or other input parameters within the same modeling tools. See Section 2 in *Consumer and Indoor Exposure Assessment for DEHP* (U.S. EPA, 2025c) for details about the consumer modeling approaches, sources of data, model parameterization, and assumptions. After reevaluating approaches and input parameters for each consumer COU with MOEs below the benchmark EPA concluded that further refinement of input parameters was not possible or would not result in different MOEs for those already presented in Table 4-18. The consumer COU that resulted in MOEs for high-intensity exposure scenarios below the benchmark of 30 for acute, chronic, and intermediate exposures is summarized in Table 4-18 and in the following:

- Furnishing, Cleaning, Treatment Care Products: Fabric, Textile, and Leather Products; Furniture and Furnishings

The consumer COU that resulted in MOEs for high-intensity exposure scenarios below the benchmark of 30 for acute, chronic and intermediate exposures is discussed in further detail in the subsection below which expands on the aspects driving the MOEs below the benchmark.

Furnishing, Cleaning, Treatment Care Products: Fabric, Textile, and Leather Products; Furniture and Furnishings

This section summarizes the risk estimates (MOEs) below the benchmark of 30 for the Furnishing, cleaning, treatment care products; fabric, textile, and leather products; furniture and furnishing COU. Two different scenarios were assessed under this COU for articles with differing use patterns: synthetic leather clothing and synthetic leather furniture. The two scenarios capture the variability from manufacturing formulation in the high, medium, and low-intensity use estimates and the weight fraction ranges reported. Indoor synthetic furniture articles were assessed for all exposure routes as part of the indoor exposure assessment (*i.e.*, inhalation, ingestion (suspended and settled dust, and mouthing), and dermal), while synthetic clothing was only assessed for dermal contact since the articles were too small to result in significant inhalation and ingestion exposures.

Aggregate risk estimates across all evaluated exposure routes (dermal, ingestion, and inhalation) for synthetic leather furniture were considered, with the exception of the high-intensity use scenario. The aggregate high-intensity use scenario only considered inhalation and ingestion because the high-intensity use dermal scenario was found to have high uncertainties for the skin contact area input. While dermal contact with synthetic leather furniture may be possible for infants and toddlers, it is expected to be minimal. Infants are not likely to be set on furniture for extended periods of time (*i.e.*, 2–8 hours) for safety reasons, and toddlers are unlikely to stay seated for the 4-hour exposure duration used in the medium-intensity use dermal assessment. The acute high-intensity use aggregate exposure scenario MOE for infants was 29.8 (usually rounded to 30). Inhalation and ingestion MOEs have similar contributions to the overall aggregate MOE value (MOE = 86 for ingestion and MOE = 46 for inhalation). The ingestion exposure value for infants also includes mouthing. Direct dermal contact is unlikely for infants for extended periods of time (8, 4, and 2 hours), but mouthing durations for the high intensity use exposure scenario was 10 min/day which can be representative of short periods of possible mouthing contact (*e.g.*, diaper changes, story time reading, "tummy time"). EPA has robust confidence in the inhalation and ingestion estimates for this COU.

Indoor Dust

Exposure to DEHP via ingestion of dust was assessed for all articles expected to contribute significantly to dust concentrations. See Section 4.1.2.3 for a brief discussion of the assumptions associated with DEHP migration from articles indoor dust. Articles evaluated were those with a surface area exceeding ~1 m^2 for a single article, or a collection of like articles with aggregate surface area exceeding ~1 m^2. Collections of like articles satisfying these conditions include car mats, vinyl flooring, wallpaper in-place, insulated cords, furniture components (textiles), air beds, shower curtains, and children's toys (legacy and new). In a screening assessment for indoor dust ingestion, EPA considered the aggregation of chronic dust ingestion doses (Section 4.1.2.3). However, the indoor assessment was further refined to only consider articles assumed to be present in residential indoor environments, such as vinyl flooring, wallpaper in-place, insulated cords, furniture components (textiles), shower curtains, and children's toys (new and legacy). Car mats and air beds were considered not to be continuously available in residential indoor environments, as car mats are present in vehicles, and air beds are often kept in storage as they're expected to be used sporadically for overnight trips or camping a few nights per month throughout the year. The highest aggregated dose from indoor scenario chronic ingestion of settled dust was for preschoolers, aged 3 to 5 years and resulted in an MOE of 306. See *Consumer Risk Calculator for DEHP* (U.S. EPA, 2025f). All other doses were lower and would have resulted in even larger MOEs.

Overall Confidence in Consumer Risks

As described in Section 4.1.2 and in more detail in the *Consumer and Indoor Exposure Assessment for DEHP* (U.S. EPA, 2025c), EPA has moderate to robust confidence in the assessed inhalation, ingestion, and dermal consumer exposure scenarios, and robust confidence in the non-cancer POD selected to characterize risk from acute, intermediate, and chronic duration exposures to DEHP (see Section 4.2 and (U.S. EPA, 2025aa)). The exposure doses used to estimate risk relied on conservative inputs and parameters that are considered representative of a wide selection of use patterns. Dermal risks estimates may be conservative for consumer exposure to articles, especially given that the dermal flux used to determine exposure was based on a study in rats, which have higher dermal absorption than humans. However, dermal exposure to liquid products was based on studies using metabolically active human skin and likely did not overestimate exposure. For inhalation and ingestion, EPA's overall confidence is based on consideration of multiple factors including strength in applied methods, refinements to best represent real-world scenarios, support from and consistency with literature data, and uncertainties on a scenario-by-scenario basis, as presented in Section 4.1.2.4. Overall, EPA has moderate to robust confidence in the risk estimates calculated for inhalation, ingestion, and dermal exposure scenarios for consumers. Sources of uncertainty associated with consumer COUs which had MOEs less than 30 are discussed above in Section 4.3.3.

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

EPA utilized previously peer reviewed methodologies to conduct screening level analyses of general population exposures to DEHP associated with TSCA COUs via the ambient air, ambient water, ambient land, and fish ingestion pathways/routes as described in the *Environmental Media and General Population and Environmental Exposure for DEHP* (U.S. EPA, 2025s) and Section 4.1.3. This assessment focuses on subsets of the general population in proximity to releasing facilities, including fenceline communities.

EPA evaluated surface water, drinking water, fish ingestion, ambient air, and soil via deposition from ambient air pathways quantitatively. Land pathways (*i.e.*, landfills and application of biosolids) were assessed qualitatively, and were inclusive of down-the-drain disposal of consumer products and landfill disposal of consumer articles (see Section 3.1.4 for details on the qualitative assessment of consumer disposal of DEHP-containing products and articles). For pathways assessed quantitatively, EPA used high-end estimates of DEHP concentration in the various environmental media for screening level purposes. EPA used an MOE approach using high-end exposure estimates with the human health POD 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 for a COU and given pathway of exposure, then EPA determined that the pathway was not a pathway of concern, and the pathway was not evaluated 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 if available, additional subpopulations and COUs. No MOEs were below the benchmark of 30 for the highest exposure scenarios for surface water, drinking water, ambient air and soil via deposition from ambient air. For fish ingestion, MOEs were below the benchmark only for the Use of automotive care products OES which discharges to multiple media types. EPA has only slight confidence in risk estimates for the multimedia OESs in the absence of information to proportion what fraction is released to water, as described further in Section 4.1.3.1. Without further information, EPA is unable to refine its analysis specifically for multimedia releases because of the resultant slight confidence and high uncertainty in assuming what fraction may be released to water. However, EPA did use monitoring studies to determine that no fish tissue concentration as high as those associated with Use of automotive care products OES have been measured. EPA relied on the Plastic compounding OES, which had the highest reported release to water, for its fish ingestion assessment and found that there were no MOEs below the benchmark. Therefore, using a screening level approach with additional refinements as needed described for all pathways in Section 4.1.3, exposure to DEHP through biosolids, landfills, surface water, drinking water, fish ingestion, and ambient air were not determined to be pathways of concern for any COU listed in Table 3-1.

4.3.4.1 Overall Confidence in General Population Risk

As described in Section 3.3.1 and 4.1.3.3 and in more technical details in the *Environmental Media and General Population and Environmental Exposure for DEHP* (U.S. EPA, 2025s), EPA has robust confidence that modeled releases used are appropriately conservative for a screening level analysis. Therefore, EPA has robust confidence that no general population exposure scenarios via the air, land, or surface water pathways will lead to greater exposures than presented in this evaluation. Despite slight to moderate confidence in the estimated values themselves, confidence in exposure estimates capturing high-end exposure scenarios was robust given the conservative assumptions used for the estimates. Along with EPA's robust confidence in the non-cancer POD selected to characterize risk from acute, intermediate, and chronic duration exposures to DEHP (see Section 4.2 and (U.S. EPA, 2025aa)), EPA has robust confidence that the risk estimates calculated for the general population were conservative and appropriate for a screening level analysis.

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 DEHP risk evaluation.

Some population group life stages may be more susceptible to the health effects of DEHP exposure. As discussed in Section 4.2 and in EPA's *Non-cancer Human Health Hazard Assessment for DEHP* (U.S. EPA, 2025aa) and *Technical Support Document for the Cumulative Risk Analysis of DEHP, DBP, BBP, DIBP, DCHP, and DINP Under TSCA* (U.S. EPA, 2025al), exposure to DEHP causes adverse effects on the developing male reproductive system consistent with a disruption of androgen action and phthalate syndrome in experimental animal models. Therefore, females of reproductive age, pregnant women, male infants, male children, and male adolescents are considered to be susceptible subpopulations. These susceptible life stages were considered throughout the risk evaluation. For example, females of reproductive age were evaluated for occupational exposures to DEHP 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 DEHP 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 life stages have greater exposure to DEHP. This includes people exposed to DEHP at work, those who frequently use consumer products and/or articles containing high concentrations of DEHP, and those who may have a greater intake of DEHP per body weight (*e.g.*, infants, children, adolescents) leading to greater exposure. EPA accounted for these populations with greater exposure in the DEHP risk evaluation as follows:

- EPA evaluated a range of OESs for workers and ONUs, including high-end exposure scenarios for females 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 and exposure due to age-specific behaviors (*e.g.*, mouthing of toys, wires, and erasers by infants and children).
- 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 of children to DEHP through use of legacy and new toys.
- EPA evaluated exposure to DEHP through fish ingestion for subsistence fishers and Tribal populations.
- EPA aggregated occupational inhalation and dermal exposures for each COU for females 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 females of reproductive age (16–49 years) and male children (3–5, 6–11, and 12–15 years of age).
- For females of reproductive age, black non-Hispanic women had slightly 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 Cumulative Risk Considerations

EPA developed a *Technical Support Document for the Cumulative Risk Analysis of DEHP, DBP, BBP, DIBP, DCHP, and DINP Under TSCA* (U.S. EPA, 2025al) (CRA TSD) for the CRA of six toxicologically similar phthalates being evaluated under section 6 of the Toxic Substances Control Act (TSCA): DEHP, BBP, DBP, DCHP, DIBP, and 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, 2023d). EPA's proposal was subsequently peer-reviewed by the SACC in May 2023 (U.S. EPA, 2023f), while EPA's CRA TSD (U.S. EPA, 2025al) was peer-reviewed by the SACC in August 2025 (U.S. EPA, 2025ag). 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 females 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, 2025aa), DBP (U.S. EPA, 2025y), DIBP (U.S. EPA, 2025ab), BBP (U.S. EPA, 2025x), DCHP (U.S. EPA, 2025z), and DINP (U.S. EPA, 2025ac), including hepatic, kidney, and other developmental and reproductive toxicity.

EPA's approach for assessing cumulative risk is described in detail in the CRA TSD (U.S. EPA, 2025al) and incorporates feedback from the SACC (U.S. EPA, 2023f) on EPA's 2023 draft proposal (U.S. EPA, 2023d), as well as feedback from the SACC received during the August 2025 peer-review meeting of phthalates (U.S. EPA, 2025ag). EPA is focusing its CRA on acute duration exposures of females 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, 2025al) 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 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 Section 4.4 of 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 this human health CRA section is organized as follows:

- Section 4.4.1 – Describes the approach used by EPA to derive RPFs 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. Section 2 of EPA's CRA TSD (U.S. EPA, 2025al) 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 CRA TSD (U.S. EPA, 2025al) provides additional details.
- Section 4.4.3 – Describes two approaches considered by EPA to combine exposures to DEHP from individual consumer and occupational COUs/OES with cumulative non-attributable phthalate exposures from NHANES to estimate cumulative risk. Section 5 of EPA's CRA TSD (U.S. EPA, 2025al) provides additional details.

- Sections 4.4.4 through 4.4.6 – Summarizes cumulative risk estimates for workers, consumers, and the general population.

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

- *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, 2025al);
- *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, 2025w);
- *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, 2023d);
- *Draft Proposed Principles of Cumulative Risk Assessment under the Toxic Substances Control Act* (U.S. EPA, 2023e);
- *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); and
- *Science Advisory Committee on Chemicals (SACC) meeting minutes and final report - Peer Review of the Draft Risk Evaluations of Dibutyl phthalate (DBP), Di(2-ethylhexyl) phthalate (DEHP), and Dicyclohexyl phthalate (DCHP), and the Technical Support Documents for Butylbenzyl phthalate (BBP) and Diisobutyl phthalate (DIBP)* (U.S. EPA, 2025ag).

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 RPFs derived by EPA for DEHP, DBP, BBP, DIBP, DCHP, and DINP based on decreased fetal testicular testosterone. Further details regarding the analysis conducted by EPA are provided in the following two TSDs:

- *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, 2025al); and
- *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, 2025w).

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, 2023b, 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 a 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 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 *Meta-Analysis and Benchmark Dose Modeling of Fetal Testicular Testosterone for DEHP, DBP, BBP, DIBP, and DCHP* (U.S. EPA, 2025w), the Agency evaluated benchmark responses (BMRs) of 5, 10, and 40 percent using Metafor Version 4.6.0 and 2.0.0. However, RPFs could not be estimated for BBP at the 5 or 10 percent response levels or for DIBP at the 5 percent response level because BMDs could not be estimated for BBP or DIBP at these response levels due to lack of data at the low-end range of the dose-response curve using Metafor Version 4.6.0. Therefore, for input into the CRA of phthalates, EPA has derived RPFs using BMD_{40} estimates, as this was the only response level in which a full set of RPFs could be derived for all phthalates being evaluated (Table 4-19). There is some uncertainty in the applicability of the selected RPFs for DIBP and BBP at the low response levels (*i.e.*, 5 and 10% changes). However, the lack of variability in calculated

RPFs for DEHP (RPFs ranged from 0.82–0.84), DCHP (RPFs ranged from 1.66–1.71), and DINP (RPFs ranged from 0.19–0.21) across response levels, and the fact that the RPF for DIBP was 0.53 at both the 10 and 40 percent response levels, increases EPA's confidence in the selected RPFs for BBP and DIBP. Further, during the August 2025 phthalate peer-review meeting (U.S. EPA, 2025ag), the SACC recommended that EPA consider use of the older Metafor Version 2.0.0 BMD modeling results as an alternative to calculate RPFs based on decreased fetal testicular testosterone because Metafor Version 2.0.0 allowed BMD_5, BMD_{10}, and BMD_{40} estimates to be derive for DEHP, DBP, BBP, DIBP, DCHP, and DINP. As described in Section 2.4 of the CRA TSD (U.S. EPA, 2025al), RPFs calculated using BMD_5 estimates from Metafor Version 2.0.0 were similar (within 5–10% for DEHP, BBP, DCHP, DINP; 20% for DIBP) to the selected RPFs calculated using BMD_{40} estimates from Metafor Version 4.6.0, which further increases EPA's confidence in the selected RPFs.

For input into the CRA of phthalates under TSCA, EPA is using RPFs calculated using BMD_{40} estimates using Metafor Version 4.6.0 shown in Table 4-19.

For further details regarding RPFs derivation, see Section 2 of EPA's *Technical Support Document for the Cumulative Risk Analysis of DEHP, DBP, BBP, DIBP, DCHP, and DINP Under TSCA* (U.S. EPA, 2025al).

Table 4-19. 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**

Selection of the Index Chemical

As described further in Section 2 of EPA's *Technical Support Document for the Cumulative Risk Analysis of DEHP, DBP, BBP, DIBP, DCHP, and DINP under TSCA* (U.S. EPA, 2025al), *EPA has selected DBP as the index chemical*. Notably, the SACC agreed with EPA's selection of DBP as the index chemical during the August 2025 phthalate peer-review meeting (U.S. EPA, 2025ag). 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.

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 hazard assessments of DEHP (U.S. EPA, 2025aa), DBP (U.S. EPA, 2025y), BBP (U.S. EPA, 2025x), DIBP (U.S. EPA, 2025ab), DCHP (U.S. EPA, 2025z), and DINP

(U.S. EPA, 2025ac) (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. This is because, for some phthalates (*e.g.*, DEHP), a BMR of 10 percent is not protective of downstream apical outcomes on the developing male reproductive system consistent with phthalate syndrome. 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, 2022f, 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 for 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 an interspecies uncertainty factor [UF_A] of 3 and an intraspecies uncertainty factor [UF_H] of 10).

Weight of Scientific Evidence

EPA has 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 data from eight studies of rats gestationally exposed to DBP. EPA has also derived 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 selected POD for the index chemical (*i.e.*, DBP) and the derived RPFs.

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 *Technical Support Document for the Cumulative Risk Analysis of DEHP, DBP, BBP, DIBP, DCHP, and DINP Under TSCA* (U.S. EPA, 2025al) 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 COUs or other sources. Given the short half-lives of phthalates, NHANES also cannot 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.

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[8] intake of each phthalate through reverse dosimetry for

- Females 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).

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 females 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 females of reproductive age was selected for use in the CRA of DEHP (Table 4-20).

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

- Females 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 females 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 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. 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

[8] 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).

EPA has been used extensively in the literature and has been used by U.S. CPSC (2014) and Health Canada (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.

Table 4-20. Cumulative Phthalate Daily Intake (µg/kg-day) Estimates for Females 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; 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			
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			
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			

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 (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.

4.4.3 Estimation of Cumulative Risk

As described in the *Technical Support Document for the Cumulative Risk Analysis of DEHP, DBP, BBP, DIBP, DCHP, and DINP under TSCA* (U.S. EPA, 2025al), EPA is focusing its exposure assessment for the CRA for DEHP on evaluation of exposures through individual TSCA consumer and occupational DEHP COUs as well as non-attributable cumulative exposure to DEHP, DBP, BBP, DIBP, and DINP using NHANES urinary biomonitoring data and reverse dosimetry.

As described in the *Technical Support Document for the Cumulative Risk Analysis of DEHP, DBP, BBP, DIBP, DCHP, and DINP under TSCA* (U.S. EPA, 2025al), EPA considered two approaches for characterizing cumulative risk. During the 2025 peer-review meeting of phthalates, the SACC concluded that both approaches have strengths and uncertainties, but that the two approaches can complement one another and that EPA should present both approaches and select the most scientifically defensible approach for the final individual risk characterization and decision making process (U.S. EPA, 2025ag).

For the first approach, all phthalate exposures are scaled 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 DEHP consumer or worker COUs/OES were then combined with non-attributable cumulative exposure (from NHANES) to estimate cumulative exposure and cumulative risk using the index chemical (DBP) POD. Cumulative risk for the first approach was estimated using the four-step process outlined in Section 5.1 of the CRA TSD (U.S. EPA, 2025al), along with two empirical examples of how EPA calculated cumulative risk using Approach 1. For the second approach, individual phthalate exposures for consumer and occupational COUs are not scaled by RPFs but use the individual phthalate hazard values and are combined with non-attributable cumulative exposures estimated using NHANES. Cumulative risk for the second approach was estimated using the four-step process outlined in Section 5.1 of the CRA TSD (U.S. EPA, 2025al), along with two empirical examples of how EPA calculated cumulative risk using Approach 2.

Table 4-21 provides a comparison of similarity and differences between Approaches 1 and 2, while Section 4.4.3.1 below provides an overview of the similarities and differences between the two approaches, as well as a discussion of the strengths, limitations, and uncertainties associated with both approaches, and the approach selected by EPA for estimating cumulative risk in the final risk characterization and for use in decision making.

Table 4-21. Comparison of CRA Approaches 1 and 2

Steps for Calculating the Cumulative Risk	Approach 1	Approach 2
Step 1: Exposure estimates for the individual phthalates individual TSCA COUs	Individual exposures scaled by relative potency and expressed in index chemical (DBP) equivalents	Individual exposures not scaled by relative potency
Step 2: Estimate non-attributable cumulative exposure	No differences between approaches	
Step 3: Calculate the MOEs for each exposure to the individual phthalate	Individual MOEs calculated using the index chemical (DBP) POD	Individual MOEs calculated using the individual phthalate POD
Step 4: Calculate the cumulative MOE	No differences between approaches	

4.4.3.1 Comparison of Two Approaches for Estimating Cumulative Risk

To determine which approach is most scientifically defensible for use in the final risk characterization and decision making for each individual phthalate, EPA considered the strengths, limitations, and uncertainties of underlying dose-response data supporting both approaches for each phthalate included in the CRA. To support transparent and consistent decision making, EPA developed a framework that outlines key considerations used by EPA to determine the most scientifically defensible approach for the contribution of cumulative risk to the individual risk characterization for each phthalate (Table 4-22). Because non-attributable cumulative exposure and risk from NHANES biomonitoring data is factored into Approaches 1 and 2 in the same manner, non-attributable cumulative exposure and risk from NHANES is not a factor that contributes to differences in cumulative risk estimates between the two approaches. Instead, differences between the two approaches stem from how exposure estimates from each individual phthalate COU are handled. For Approach 1, exposure estimates from individual consumer or occupational COUs are scaled by relative potency, expressed in index chemical equivalents, and the index chemical POD is used to calculate risk. For Approach 2, exposure estimates from individual consumer or occupational COUs are not scaled by relative potency, and the individual phthalate POD is used to calculate risk for each individual COU, resulting in risk estimates identical to those calculated in the individual phthalate risk assessment. Therefore, there are two primary factors that contribute to how closely cumulative risk estimates align between Approaches 1 and 2: the RPF for each phthalate and the POD selected for each individual phthalate, see Table 4-22.

Table 4-22. Considerations for Determining Confidence in Cumulative Risk Estimates For CRA Approaches 1 and 2

Factor	Consideration
Dose-Response Data Supporting RPF Derivation	• Quantity and quality of fetal testicular testosterone dose-response data • Availability of dose-response data in the low-end range of the dose-response curve (*i.e.*, doses below those eliciting a 40% response) • Similarity of candidate RPFs across 5, 10, and 40% response levels (*i.e.*, consideration of the parallelism) • Similarity of BMD results obtained via different approaches (*i.e.*, meta-analysis and/or BMD modeling of individual data sets using EPA's BMDS)
Dose-Response Data Supporting the Individual Phthalate POD	• Quantity and quality of dose-response data supporting the POD, whether it be a NOAEL (*i.e.*, for DEHP, BBP, DCHP) or $BMDL_5$ (*i.e.*, for DBP, DIBP, DINP) • For DEHP, BBP, and DCHP, the dose-range between the NOAEL and LOAEL • Comparison of BMD modeling and NOAEL/LOAEL approaches

As discussed in Section 5 of the CRA TSD (U.S. EPA, 2025al), application of Approach 1 for DEHP leads to cumulative risk estimates that are less sensitive than risk estimates in the individual DEHP risk evaluation, while application of Approach 2 leads to risk estimates that are approximately 1.1× to 1.2× more sensitive than in the individual DEHP risk evaluation. The reason for the difference in cumulative risk estimates between the two approaches is because the DEHP RPF of 0.84 based on reduced fetal testicular testosterone content (used in Approach 1) indicates DEHP is 16 percent less potent than DBP, while the difference between the index chemical (DBP) POD of 2.1 mg/kg-day (used in Approach 1) and DEHP POD of 1.1 mg/kg-day (used in Approach 2) indicates DEHP is 91 percent more potent than the index chemical (DBP). A discussion of the strengths, limitations, and uncertainties of the dose-response data supporting derivation of the DEHP RPF and the DEHP POD is provided below.

Dose-Response Data Supporting RPF Derivation

- *Quantity and quality of fetal testicular testosterone dose-response data*. EPA calculated an RPF of 0.84 for DEHP. The DEHP RPF of 0.84 is derived from the ratio of the DBP BMD_{40} to the DEHP BMD_{40} for reduced fetal testicular testosterone (*i.e.*, 149÷178 mg/kg-day = 0.84). The DEHP RPF was estimated via meta-analysis and BMD analysis of a large and robust dataset of fetal testicular testosterone data from 8 studies (4 high- and 4 medium-quality) (Gray et al., 2021; Furr et al., 2014; Saillenfait et al., 2013; Hannas et al., 2011; Culty et al., 2008; Howdeshell et al., 2008; Lin et al., 2008; Martino-Andrade et al., 2008).
- *Availability of dose-response data in the low-end range of the dose-response curve (i.e., doses below those eliciting a 40% response).* One source of uncertainty associated with the meta-analysis and BMD analysis of DEHP is that there are limited testosterone data available for DEHP in the low-end range of the dose response curve where the BMD_5 and $BMDL_5$ and BMD_{10} and $BMDL_{10}$ estimates are derived. For example, the BMD_5/$BMDL_5$ and BMD_{10}/$BMDL_{10}$ estimates for DEHP are 17/11 and 35/24 mg/kg-day, respectively, while one study of DEHP provides fetal testicular testosterone data at a dose of 10 mg/kg-day (Lin et al., 2008), one study of provides data at a dose of 50 mg/kg-day (Saillenfait et al., 2013), and all other studies provide testosterone data at doses of 100 mg/kg-day or higher.
- *Similarity of candidate RPFs across 5, 10, 40 percent response levels (i.e., consideration of the parallelism).* Candidate RPFs for DEHP did not vary significantly at the 5, 10, and 40 percent response levels (*i.e.,* RPFs ranged from 0.82 to 0.84). This indicates that the selected RPF of 0.84 derived from the 40 percent response level is expected to provide a reasonable estimate of potency at the 5 and 10 percent response levels, indicating parallel dose-response curves. This increases EPA's confidence in the selected RPF for DEHP.
- *Similarity of BMD results obtained via different approaches***.** EPA did not conduct BMD modeling of individual fetal testicular testosterone datasets using EPA's BMDS for comparison to the meta-analysis results for DEHP. This analysis was not conducted because both approaches (*i.e.*, meta-analysis and BMDS of individual data sets) provided similar results for DBP, DCHP, DIBP, and BBP.

Dose-Response Data Supporting the Individual Phthalate POD

- *Quantity and quality of dose-response data supporting the POD*. The DEHP POD is an HED of 1.1 mg/kg-day and is derived from a NOAEL of 4.8 mg/kg-day based on a spectrum of effects on the developing male reproductive system consistent with phthalate syndrome, including male reproductive tract malformations (U.S. EPA, 2025aa). Notably, the same NOAEL of 4.8 mg/kg-day has also been selected by U.S. CPSC (2014), Health Canada (2020), ECHA (2017a), NICNAS (2010), and EFSA (2019) for use for human health risk characterization of DEHP. The DEHP POD is supported by four studies of rats, including one high-quality multi-generation study of reproduction (TherImmune Research Corporation, 2004), and three medium-quality gestational exposure studies of rats (Andrade et al., 2006b; Andrade et al., 2006a; Grande et al., 2006).
- *Dose-range between the NOAEL and LOAEL***.** In addition to the four studies supporting the selected NOAEL of 4.8 mg/kg-day, an additional 13 studies reporting effects on the developing male reproductive system consistent with disrupted androgen action and phthalate syndrome

support NOAEL and LOAEL values in a narrow dose-range of 1 to 5 and 10 to 15 mg/kg-day, respectively, (1 high-, 10 medium-, 2 low-quality) (Rajagopal et al., 2019; Guo et al., 2013; Kitaoka et al., 2013; Christiansen et al., 2010; Gray et al., 2009; Lin et al., 2009; Vo et al., 2009b; Vo et al., 2009a; Lin et al., 2008; Ge et al., 2007; Akingbemi et al., 2004; Akingbemi et al., 2001; Ganning et al., 1990). The narrow dose-range between the NOAELs of 1–5 mg/kg-day and LOAELs of 10–15 mg/kg-day for effects consistent with phthalate syndrome increases EPA's confidence in the selected POD for DEHP.

- *Comparison of BMD modeling and NOAEL/LOAEL approaches.* Available studies of DEHP support NOAELs of 1–5 mg/kg-day and LOAELs of 10–15 mg/kg-day for effects consistent with phthalate syndrome. Comparatively, meta-analysis and BMD modeling of decreased fetal testicular testosterone data from 8 studies (4 high- and 4-medium quality) supports a BMD_5/$BMDL_5$ of 17/11 mg/kg-day. The $BMDL_5$ of 11 mg/kg-day is higher than the highest NOAEL of 4.8–5 mg/kg-day and is comparable to the lowest LOAEL of 10 mg/kg-day. This indicates that the $BMDL_5$ for reduced fetal testicular testosterone is not health protective or appropriate for use in risk assessment, and was therefore not selected for use as the POD in the individual chemical assessment.

Based on the weight of scientific evidence considerations outlined in the developed framework (Table 4-22), EPA has weighed the strengths and uncertainties associated with the DEHP RPF (Approach 1) and the DEHP POD (Approach 2 and individual BBP risk assessment). Given the strengths and uncertainties associated with the DEHP RPF and the DEHP POD, EPA has more confidence in the DEHP POD compared to the DEHP RPF and has concluded that Approach 2 is more appropriate for use in risk characterization for DEHP. This conclusion is based on the following:

- EPA has confidence in the DEHP POD used in the individual DEHP risk assessment and as part of CRA Approach 2 because it is supported by 17 studies that support a narrow range of NOAEL (1–5 mg/kg-day) and LOAEL (10–15 mg/kg-day) values.
- Meta-analysis and BMD analysis of fetal testicular testosterone data from 8 studies supports a $BMDL_5$ of 11 mg/kg-day, which is comparable to the lowest LOAEL of 10 mg/kg-day, which indicates the $BMDL_5$ for reduced fetal testicular testosterone is not health protective or appropriate for use in risk characterization.

4.4.4 Cumulative Risk Estimates for Workers

This section summarizes cumulative risk estimates for female workers of reproductive age from acute duration exposures to DEHP. EPA focused its occupational cumulative risk assessment on this population and exposure duration because as described in Section 4.4 and (U.S. EPA, 2025al), this population and exposure duration is considered most directly applicable to the common hazard outcome that serves as the basis for the cumulative analysis (*i.e.*, phthalate syndrome).

To evaluate cumulative risk to female workers of reproductive age, EPA combined inhalation and dermal exposures to DEHP 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 4.4.3.1, EPA calculated cumulative risk using Approach 2. For Approach 2 (described further in Section 4.4.3 and Section 5 of the CRA TSD (U.S. EPA, 2025al)), exposures from individual DEHP OES were not scaled by RPFs, but instead remained in units of exposure of mg/kg-day DEHP. MOEs were then calculated using exposures from individual DEHP OES and the DEHP POD and combined with the non-attributable cumulative MOE (from NHANES, with all exposures expressed in index chemical (DBP) equivalents).

As discussed previously in Section 4.3.2.20, OSHA and NIOSH both recommend a hierarchy of controls to address hazardous exposures in the workplace. OSHA and NIOSH recommend the use of PPE (*e.g.*, respirators, gloves) as the last means of control, when the other control measures cannot reduce workplace exposure to an acceptable level. Cumulative MOEs for female workers of reproductive age are presented in Table 4-23 and the *Occupational and Consumer Cumulative Risk Calculator for DEHP* (U.S. EPA, 2025ad) assume no PPE use. For COUs with acute cumulative MOEs below the cumulative benchmark of 30, corresponding PPE required to raise the cumulative MOE above the benchmark are also presented. Since inhalation exposure from individual DEHP OES is the primary contributor to risk, Table 4-23 presents only the minimum respirator APF value necessary to bring the cumulative MOE above the benchmark MOE of 30.

4.4.4.1 Cumulative Risk Characterization – Approach 2

As discussed in Section 4.4.3.1, EPA has concluded that Approach 2 is the most scientifically-supportable approach for characterizing cumulative risk for DEHP. As can be seen from Table 4-23, high-end and/or central tendency cumulative MOEs ranged from 0.4 to 15 (benchmark MOE = 30) for 7 of the 17 OES evaluated for DEHP using Approach 2. However, all 7 of the OES with cumulative MOEs less than 30 also had MOEs below the benchmark of 30 in the individual DEHP worker risk assessment (Table 4-17). For these 7 OES (listed below), the addition of cumulative risk using Approach 2 has no impact on risk conclusions.

- Import and repackaging (high-end and central tendency cumulative MOEs = 15 and 50);
- Rubber product manufacturing (high-end and central tendency cumulative MOEs = 1.0 and 4.7);
- Spray application of paints, coatings, adhesives, and sealants (high-end and central tendency cumulative MOEs = 0.4 and 24);
- Non-spray application of paints, coatings, adhesives, and sealants (high-end and central tendency cumulative MOEs = 1.0 and 4.7);
- Uses of dyes, pigments, and fixing agents (high-end and central tendency cumulative MOEs = 1.0 and 4.7);
- Formulation for diffusion bonding (high-end and central tendency cumulative MOEs = 1.0 and 22);
- Waste handling, treatment, and disposal (high-end and central tendency cumulative MOEs = 5.0 and 56).

The remaining 10 OES (listed below) have high-end cumulative MOEs ranging from 49 to 187 (cumulative benchmark = 30) (Table 4-23). For these 10 OES, the addition of cumulative risk using Approach 2 has no impact on risk conclusions.

- Manufacturing (high-end cumulative MOE = 187);
- Plastic compounding (high-end cumulative MOEs = 57);
- Plastic converting (high-end cumulative MOEs = 76);
- Incorporation into formulation, mixture, or reaction product (high-end cumulative MOE = 187);
- Use of automatic care products (high-end cumulative MOE = 54);
- Textile finishing (high-end cumulative MOE = 148);
- Use in hydraulic fracturing (high-end cumulative MOE = 134);
- Use of laboratory chemicals (high-end cumulative MOE = 52);
- Recycling (high-end cumulative MOEs = 76); and
- Fabrication or use of final products and articles (high-end cumulative MOE = 49).

For Approach 2, only one factor contributes to slightly lower cumulative MOEs compared to the individual DEHP risk assessment. Since DEHP inhalation and dermal exposures are not scaled by RPFs for Approach 2, the only factor contributing to slightly lower cumulative MOEs is the addition of non-attributable cumulative exposure from NHANES. 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 dataset available) and reverse dosimetry (see Section 4.4.2 and (U.S. EPA, 2025al) 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. 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 females of reproductive age (16–49 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 dataset, 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.

4.4.4.2 Overall Confidence in Cumulative Worker Risk Estimates

As described in Section 4.1.1.5 and the *Environmental Release and Occupational Exposure Assessment for DEHP* (U.S. EPA, 2025u), EPA has slight to robust confidence in the assessed inhalation and dermal exposure assessments for the assessed OESs. As discussed above in Section 4.4.3.1, EPA has weighed the strengths and uncertainties associated with the DEHP RPF (Approach 1) and the DEHP POD (Approach 2 and individual DEHP risk evaluation). EPA has concluded that Approach 2 is more appropriate for use in risk characterization and decision-making for DEHP.

Table 4-23. Acute Cumulative MOE Summary Table for Female Workers of Reproductive Age Using CRA Approach 2

Life Cycle Stage/ Category	Subcategory	OES	Exposure Level	Acute Cumulative MOE (Dermal Exposure from COU + Inhalation Exposure from COU + Non-Attributable Cumulative Exposure from NHANES)[a] (Benchmark = 30)	Respirator APF to get Cumulative MOE Above the Benchmark of 30
Manufacturing – Domestic manufacturing	Domestic manufacturing	Manufacturing	HE	187	–
			CT	249	–
Manufacturing – Importing	Importing	Import and repackaging	HE	**15**	APF = 5
Processing – Repacking	Repackaging in wholesale and retail trade and in paint and coating manufacturing		CT	50	–
Processing – Incorporation into formulation, mixture, or reaction product	Plasticizer in basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint and coating manufacturing; adhesive manufacturing; plastic material and resin manufacturing; synthetic rubber manufacturing; all other basic inorganic chemical manufacturing; wholesale and retail trade; services; ink, toner and colorant manufacturing	Incorporation into formulation, mixture, or reaction product	HE	187	–
Processing – Other uses	Miscellaneous processing (cyclic crude and intermediate manufacturing; processing aid specific to hydraulic fracturing)		CT	249	–
Processing – incorporation into formulation, mixture, or reaction product	Plasticizer in basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint and coating manufacturing; adhesive manufacturing; plastic material and resin manufacturing; synthetic rubber manufacturing; all other basic inorganic chemical manufacturing; wholesale and retail trade; services; ink, toner and colorant manufacturing	Plastic compounding	HE	57	–
			CT	65	–

Life Cycle Stage/ Category	Subcategory	OES	Exposure Level	Acute Cumulative MOE (Dermal Exposure from COU + Inhalation Exposure from COU + Non-Attributable Cumulative Exposure from NHANES)[a] (Benchmark = 30)	Respirator APF to get Cumulative MOE Above the Benchmark of 30
Processing – Incorporation into article	Plasticizer in basic organic chemical manufacturing; plastics product manufacturing; rubber product manufacturing; miscellaneous manufacturing; PVC extruding	Plastic converting	HE	76	–
Industrial Use – Other uses	Solid rocket motor insulation and other aerospace applications				
	Automotive articles, other than fluids		CT	91	–
Processing – Incorporation into article	Plasticizer in basic organic chemical manufacturing; plastics product manufacturing; rubber product manufacturing; miscellaneous manufacturing; PVC extruding	Rubber product manufacturing	HE	**1.0**	APF = 50
Processing – Incorporation into formulation, mixture, or reaction product	Plasticizer in basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint and coating manufacturing; adhesive manufacturing; plastic material and resin manufacturing; synthetic rubber manufacturing; all other basic inorganic chemical manufacturing; wholesale and retail trade; services; ink, toner and colorant manufacturing		CT	**4.7**	APF = 10
Industrial Use – Other uses	Paints and coatings	Spray application of paints, coatings, adhesives, and sealants	HE	**0.4**	APF = 1,000
Industrial Use – Construction, paint, electrical, and metal products	Paints and coatings				
Commercial Use – Construction, paint, electrical, and metal products	Adhesives and sealants				

Life Cycle Stage/ Category	Subcategory	OES	Exposure Level	Acute Cumulative MOE (Dermal Exposure from COU + Inhalation Exposure from COU + Non-Attributable Cumulative Exposure from NHANES)[a] (Benchmark = 30)	Respirator APF to get Cumulative MOE Above the Benchmark of 30
Commercial Use – Furnishing, cleaning, and treatment care products	All-purpose waxes and polishes		CT	**24**	APF = 5
Industrial Use – Other uses	Paints and coatings	Non-spray application of paints, coatings, adhesives, and sealants			
Industrial Use – Construction, paint, electrical, and metal products	Paints and coatings		HE	**1.0**	APF = 50
Commercial Use – Construction, paint, electrical, and metal products	Adhesives and sealants		CT	**4.7**	APF = 10
Commercial Use – Packaging, paper, plastic, toys, hobby products	Ink, toner and colorants	Use of dyes, pigments, and fixing agents	HE	**1.0**	APF = 50
			CT	**4.7**	APF = 10
Commercial Use – Other uses	Automotive articles	Use of automotive care products	HE	54	–
			CT	95	–
Commercial Use – Furnishing, cleaning, and treatment care products	Fabric, textile, and leather products; furniture and furnishings	Textile finishing	HE	148	–
	Fabric enhancer		CT	217	–
Industrial Use – Construction, paint, electrical, and metal products	Adhesives and sealants	Formulation for diffusion bonding	HE	**1.0**	APF = 50
			CT	**22**	APF = 5
Industrial Use – Other uses	Hydraulic fracturing	Use in Hydraulic fracturing	HE	134	–
			CT	197	–
Commercial Use – Other uses	Laboratory chemicals	Use of laboratory chemicals	HE	52	–
			CT	171	–
Processing – Recycling	Recycling	Recycling	HE	76	–
			CT	91	–

Life Cycle Stage/ Category	Subcategory	OES	Exposure Level	Acute Cumulative MOE (Dermal Exposure from COU + Inhalation Exposure from COU + Non-Attributable Cumulative Exposure from NHANES)[a] (Benchmark = 30)	Respirator APF to get Cumulative MOE Above the Benchmark of 30
Commercial Use – Construction, paint, electrical, and metal products	Batteries and capacitors	Fabrication or use of final products and articles	HE	49	–
	Construction and building materials covering large surface areas, including paper articles; metal articles; stone, plaster, cement, glass and ceramic articles				
	Machinery, mechanical appliances, electrical/electronic articles				
Commercial Use – Automotive, fuel, agriculture, and outdoor use products	Lawn and garden care products				
Commercial Use – Packaging, paper, plastic, toys, hobby products	Packaging (excluding food packaging) and other articles with routine direct contact during normal use, including paper articles; rubber articles; plastic articles (hard); plastic articles (soft)				
	Packaging (excluding food packaging), including paper articles				
	Toys, playground, and sporting equipment				
Commercial Use – Furnishing, cleaning, and treatment care products	Floor coverings; construction and building materials covering large surface areas including stone, plaster, cement, glass and ceramic articles fabrics, textiles, and apparel				
			CT	104	–
Disposal – Disposal	Disposal	Waste handling, treatment and disposal	HE	**5.0**	APF = 10
			CT	56	–

[a] The acute cumulative MOEs for Approach 2 are derived by summing inhalation exposure from each individual DEHP COU with dermal exposure from the same DEHP COU and the cumulative non–attributable exposure to DEHP, DBP, BBP, DIBP, and DINP as described in Section 4.4.3. Non-attributable cumulative exposure was estimated from NHANES urinary biomonitoring data using reverse dosimetry.
Bold text in a gray shaded cell indicates an MOE is below the benchmark value of 30.

4.4.5 Cumulative Risk Estimates for Consumers

This section summarizes cumulative risk estimates for consumers from acute duration exposures to DEHP. EPA focused its CRA on females 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 4.4 and (U.S. EPA, 2025al), 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 females of reproductive age or male infants and children; however, consumer exposures of teenagers (16–20 years) and adults (21+ years) were considered to be a proxy for females 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.

To evaluate cumulative risk to consumers, EPA combined inhalation, dermal, and ingestion exposures to DIBP from each individual consumer COU and product/article exposure scenario 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, EPA calculated cumulative risk for DEHP using Approach 2. For the Approach 2 (described further in Section 4.4.3 and Section 5 of the CRA TSD (U.S. EPA, 2025al)), exposures from individual DEHP OES were not scaled by RPFs, but instead remained in units of exposure of mg/kg-day DEHP. MOEs were then calculated using exposures from individual DEHP OES and the DEHP POD and combined with the non-attributable cumulative MOE (from NHANES, with all exposures expressed in index chemical (DBP) equivalents).

Cumulative MOEs calculated using Approaches 2 are shown in Table 4-24 and the *Occupational and Consumer Cumulative Risk Calculator for DEHP* (U.S. EPA, 2025ad).

4.4.5.1 Cumulative Risk Characterization – Approach 2

As discussed in Section 4.4.3.1, EPA had concluded that Approach 2 is the most scientifically-supportable approach for characterizing cumulative risk for DEHP. Cumulative MOEs for high-intensity exposure scenarios were greater than 30 (ranging from 41 to 472) for 24 of the 26 evaluated product and/or article exposure scenarios (cumulative benchmark = 30) (Table 4-24; (U.S. EPA, 2025ad)). For these 24 consumer product or article example scenarios, the addition of cumulative risk using Approach 2 does not lead to any changes in risk conclusions.

For two consumer product or article exposure scenarios, cumulative MOEs were less than the benchmark of 30, including for Furniture Components (Textile) and Children's Toys (Legacy), but only for high-intensity acute aggregate exposure, and only when added to cumulative background exposure considering NHANES data. These two exposure scenarios are discussed further below.

Furniture Components (Textile).
Acute, high-intensity cumulative MOEs were 26 and 30 for infants (<1 year) and toddlers (1–2 years) (cumulative benchmark = 30), respectively, and ranged from 37 to 122 for all other age groups (Table 4-24), while acute medium-intensity cumulative MOEs were 88 and 93 for infants (<1 year) and toddlers (1–2 years), respectively (Table 4-24). Comparatively, acute aggregate MOEs were 30 and 36 for infants (<1 year) and toddlers (1–2 years) (benchmark = 30), respectively, in the individual consumer DEHP risk assessment (Section 4.3.3). For infants (<1 year) and toddlers (1–2 years), the addition of cumulative non-attributable phthalate exposure from NHANES is the only factor leading to the lower cumulative MOEs compared to the aggregate MOEs in the individual assessment and contributes 15.5 percent to the risk cup. 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 NHANES biomonitoring data from male children (3 to <6 years) as a proxy for male infants and toddlers. The inputs and assumptions underlying the furniture components (textile) exposure scenario were characterized previously in Section 4.3.3.

Children's Toys (Legacy).
The acute, high-intensity cumulative MOE was 28 (cumulative benchmark = 30) for infants (<1 year), and ranged from 44 to 177 for all other age groups, while the acute medium-intensity MOE for infants (<1 year) is 122 (Table 4-24). Comparatively, the acute aggregate MOE was 32 for infants (<1 year) (benchmark = 30) in the individual consumer DEHP risk assessment (Section 4.3.3). For infants (<1 year), the addition of cumulative non-attributable phthalate exposure from NHANES is the only factor leading to the lower cumulative MOEs compared to the aggregate MOEs in the individual assessment, and contributes 15.5 percent to the risk cup. Since NHANES does not include urinary biomonitoring for infants (<1 year), and other national data sets are not available, EPA used NHANES biomonitoring data from male children (3 to <6 years) as a proxy for male infants. The children's toys (legacy) exposure scenario from the individual DEHP assessment is characterized further below.

Children's toys were assessed for DEHP exposure by inhalation, dust ingestion, dermal and mouthing routes. Under the Consumer Product Safety Improvement Act (CPSIA) of 2008 (CPSIA section 108(a), 15 U.S.C. section 2057c(a);16 CFR section 1307.3(a)), Congress permanently prohibited the sale of children's toys or childcare articles containing concentrations of more than 0.1 percent DEHP. However, it is possible that some individuals may still have children's toys in the home that were produced before statutory and regulatory limitations. Among the data for children's items from the Washington State database (WSDE, 2020), a total of 19 toy items had measurable DEHP content. In the U.S. market, the High Priority Chemicals Data System (HPCDS) database contained data for DEHP measurements in toy/game items with reporting dates from 2017 to 2024. While there is some uncertainty about the materials these items are manufactured from, based on the limited descriptions in the database, EPA determined that these items are likely composed primarily of plastic and rubber components. Among all 19 items, the minimum, average, and maximum weight fractions reported were 8.3×10^{-6}, 0.023, and 0.33 w/w. respectively. Five new toys in the Washington State database tested 8 or more years after the CPSIA had components with DEHP content above the statutory and regulatory limit of 0.1 percent (WSDE, 2020). The legacy toys scenario is more representative of any new toys with weight fractions above the CPSIA statutory and regulatory limit.

Children's toys generally have a small surface area for an individual item, but consumers may have many of the same type of item in a home. As phthalates are ubiquitous in PVC materials, it is reasonable to assume that, in a collection of toys, all of the items may have DEHP content. As such, surface area for these items was estimated by assuming that a home has several of these items rather than one. The surface area of new and legacy toys was varied for the low-, medium-, and high-intensity use exposure scenarios based on EPA's professional judgment of the number and size of toys present in a bedroom. The low intensity use scenario was based on 5 small toys measuring 15 cm × 10 cm × 5 cm, the medium-intensity use scenario was based on 20 medium toys measuring 20 cm × 15 cm × 8 cm, and the high-intensity use scenario was based on 30 large toys measuring 30 cm × 25 cm × 15 cm. EPA used the stay-at-home 20 hour exposure duration and bedroom for location of articles CEM inputs for inhalation and dust ingestion exposure estimates. The overall confidence in this COU's inhalation and dust ingestion exposure estimate is robust because of a good understanding of the CEM model parameter inputs and representativeness of actual use patterns and location of use.

For mouthing exposure, key parameters include the rate of chemical migration from the article to saliva (µg/cm^2/h), surface area mouthed (cm^2), and duration of mouthing (min/day). The mouthing parameters used, such as duration of use (16.1 min/day Greene (2002) and surface area for infants (standardized value of 10 cm² (Danish EPA, 2010; Niino et al., 2003; Niino et al., 2001)) are very well understood. The chemical migration value is DEHP specific, empirically derived, and the main sources of uncertainty are related to a large variability in empirical migration rate data for harsh, medium, and mild mouthing approaches. Additionally, there are uncertainties from the unknown correlation between chemical concentration in articles and chemical migration rates, and no data were reasonably available to compare and confirm selected rate parameters to better understand uncertainties.

Infants skin contact duration for the high-intensity use scenario was 137 minutes and the skin contact area was inside of two hands including palms and fingers (Section 2.3.3 in U.S. EPA (2025c)). The DEHP dermal exposure to solid articles used the Chemical Manufacturers Association (1991) dermal absorption study. This study conducted an *in vivo* dermal experiment using male rats. There have been additional studies conducted to determine the difference in dermal absorption between rat skin and human skin. Specifically, Scott et al. (1987) examined the difference in dermal absorption between rat skin and human skin for four different phthalates (*i.e.,* DMP, DEP, DBP, and DEHP) using *in vitro* dermal absorption testing. Results from those experiments showed that rat skin was more permeable than human skin for all four phthalates examined. For example, rat skin was up to 4 times more permeable than human skin for DEHP. Although there is uncertainty regarding the magnitude of difference between dermal absorption through rat skin vs. human skin for DEHP, EPA is confident that the *in vivo* dermal absorption data using male rats provides an upper-bound of dermal absorption of DEHP based on the findings of Scott et al. (1987). EPA has moderate confidence in the dermal exposure to solid articles modeling approach.

For Approach 2, only one factor contributes to slightly lower cumulative MOEs compared to the individual DEHP risk assessment. Since DEHP inhalation, dermal, and ingestion exposures are not scaled by RPFs for Approach 2, the only factor contributing to slightly lower cumulative MOEs is the addition of non-attributable cumulative exposure from NHANES. 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 dataset available) and reverse dosimetry (see Section 4.4.2 and (U.S. EPA, 2025al) for further details), representing exposure to a national population. As discussed in Section 4.4.2, the addition of non-attributable cumulative exposure contributes 15.5 percent to the risk cup for infants (<1 year) and toddlers (1–2 years). Overall, EPA has robust confidence in the non-attributable cumulative exposure estimate since it was calculated from CDC's NHANES biomonitoring dataset, 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.

Conclusions on Furniture Components (Textile) and Children's Toys (Legacy).
EPA identified two consumer uses (legacy toys and synthetic leather furniture) that result in MOEs below the benchmark of 30, but only for high-end acute aggregate exposure, and only when added to cumulative background exposure considering NHANES data. Specifically, for use of legacy toys, the MOE from exposure to DEHP alone is 32, and the MOE considering cumulative exposure is marginally lower at 28. For furniture components/textile, the MOE for DEHP alone is 30, and the MOE considering cumulative exposure is 26.

Concentrations for inhalation exposure were calculated using CEM modeling of emissions from the article and are driven by the surface area of the articles in the room (considering the size and number of articles). Oral exposure was determined considering mouthing, incidental ingestion of dust contaminated with DEHP, and ingestion following inhalation. Factors that were consistent across varying intensity use scenarios included the mouthing surface area (10 cm^2) for children from the *Exposure Factors Handbook* (U.S. EPA, 2011a) and mouthing duration (16 minutes/day) specifically relevant to the products (soft plastic) and to the age group (*e.g.*, 6–9 months). Several factors varied across the different intensity use scenarios (*e.g.*, low, medium, high), including: the surface area of the articles (considering the number and size), the weight fraction of DEHP in the article; and the mouthing intensity. The high-intensity use scenario for each of these consumer uses, is a product of considering the high-end value for each of these parameters as follows:

- The *high-intensity use scenario for legacy toys* comprises: high surface area of toys with a larger size and higher number of toys (30 large toys measuring 30 × 25 × 15 cm for high-end) compared to medium exposure (20 medium toys measuring 20×15×8 cm); highest weight fraction in toys from the WSDE database (33%) compared to the medium intensity use represented by the mean value (2%); and harsh mouthing intensity (54.9 µg/cm^2/hour) compared to 10.7 µg/cm^2/h for medium mouthing and 0.27 µg/cm^2/h for mild mouthing.
- The *high-intensity use scenario for synthetic leather furniture* comprises: high surface area of furniture, including a large couch (100” × 42” × 35”) plus a large loveseat (72” × 42” × 35”) compared to a medium exposure from a medium-sized couch (80” × 36” × 30”) and medium-sized loveseat (60” × 36” × 30”); highest weight fraction from the Danish marketplace survey (39%) compared to the medium weight fraction (mean of 12%); and, again, harsh mouthing intensity (54.9 µg/cm^2/hour) compared to 10.7 µg/cm^2/h for medium mouthing and 0.27 µg/cm^2/h for mild mouthing.

While EPA has high confidence in the data underlying each of the values representing these different exposure parameters, as they are based on extensive empirical evidence (*e.g.*, experiments and marketplace monitoring), EPA considers the confluence of factors that contribute to these high-intensity use scenarios (*e.g.*, high number, size, and weight fraction of DEHP in the article and harsh mouthing intensity) to be unlikely. Furthermore, regarding the mouthing intensity, the Danish Environmental Protection Agency’s report on *Determination of Migration Rates for Certain Phthalates* (Danish EPA, 2016) stated that the “mild conditions result generally in lower migration rates compared with the in vivo adult migration rates for the simulation of children’s sucking and chewing of soft PVC products”. Therefore, it is possible that the use of harsh mouthing intensity overestimates exposure for infants. Given that, and the fact that the resulting MOEs from exposure to DEHP alone were at or slightly above the benchmark from high-intensity use for these two COUs, EPA expects that the cumulative MOEs for the high-intensity scenario, which are marginally below the benchmark, likewise overestimate exposure.

4.4.5.2 Overall Confidence in Cumulative Consumer Risks

As described in Section 4.1.2 and in more technical details in the *Consumer and Indoor Exposure Assessment for DEHP* (U.S. EPA, 2025c), EPA has moderate or robust confidence in the inhalation, ingestion, and dermal consumer exposure estimates for the evaluated consumer product and article exposure scenarios. As discussed above in Section 4.4.3.1, EPA has weighed the strengths and uncertainties associated with the DEHP RPF (Approach 1) and the DEHP POD (Approach 2 and individual DEHP risk evaluation). EPA has concluded that Approach 2 is more appropriate for use in risk characterization and decision-making for DEHP. For Approach 2, the addition of cumulative non-attributable phthalate exposure from NHANES is the only factor leading to the lower cumulative MOEs compared to the aggregate MOEs in the individual assessment and contributes 6.2 to 15.5 percent to the risk cup. Since NHANES does not include urinary biomonitoring for infants (<1 year), and other national data sets are not available, EPA used NHANES biomonitoring data from male children (3 to <6 years) as a proxy for male infants.

Table 4-24. Consumer Acute Cumulative MOE Summary Table for CRA Approach 2

Life Cycle Stage: COU: Subcategory	Product or Article	Exposure Scenario (H, M, L) [a]	Life stage (Years) Acute Cumulative MOE (Dermal exposure from COU + Inhalation exposure from COU + ingestion exposure from COU + Non-Attributable Cumulative Exposure from NHANES) (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)
Construction, paint, electrical, and metal products: Adhesives and sealants	Auto repair putty	H	–	–	–	–	469	398	398
	Flooring adhesive	H	174	175	179	259	387	347	348
	Inductance loop sealant	H	–	–	–	–	310	285	279
Other Automotive Articles	Car mats	H	179	180	182	268	436	378	382
	Tire replacement	H	175	177	179	260	425	369	367
Furnishing, cleaning, treatment care products: Fabric, textile, and leather products; furniture and furnishings	Clothing	M[b]	–	–	–	–	203	198	192
	Furniture components (textile)	H	**26**	30	37	64	95	103	122
		M	88	93	69	102	147	151	155
Furnishing, cleaning, treatment care products: Fabric, textile, and leather products; furniture and furnishings	Small articles with the potential for semi-routine contact: Outdoor furniture, children's bags, wallets, footwear, interior and exterior components of jackets, handbags	H	175	177	179	260	425	369	367
Construction, paint, electrical, and metal products: Floor coverings; construction and building materials covering large surface areas including stone, plaster, cement, glass and ceramic articles; Fabrics, textiles, and apparel Furnishing, cleaning, treatment care products: Floor coverings; construction and building materials covering large surface areas including stone, plaster, cement, glass and ceramic articles; Fabrics, textiles, and apparel	Vinyl flooring	H	86	90	97	141	213	210	220
	Wallpaper (in place)	H	184	185	186	272	451	387	407
	Wallpaper (installation)	H	–	–	–	–	233	223	216
Automotive, fuel, agriculture, outdoor use products: Lawn and garden care products	Small articles with the potential for semi-routine contact: garden hose	H	175	177	179	260	425	369	367
Construction, paint, electrical, and metal products: Machinery, mechanical appliances, electrical/electronic articles	Insulated cords	H	61	85	105	265	440	380	384
	Small articles with the potential for semi-routine contact: phone charge, wireless earbuds, electrical tape	H	175	177	179	260	425	369	367
Other: Novelty Products	Adult toys	H	–	–	–	–	–	369	367
Packaging, paper, plastic, toys, hobby products: Packaging (excluding food packaging) and other	Air beds (article concentration and barrier refinement)	H	41	70	81	113	162	163	161

Life Cycle Stage: COU: Subcategory	Product or Article	Exposure Scenario (H, M, L) [a]	Life stage (Years) Acute Cumulative MOE (Dermal exposure from COU + Inhalation exposure from COU + ingestion exposure from COU + Non-Attributable Cumulative Exposure from NHANES) (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)
articles with routine direct contact during normal use, including rubber articles; Plastic articles (hard); plastic articles (soft)	Erasers	H	190	191	109	170	469	399	398
	Mobile phone covers	H	145	150	155	220	344	311	306
	Shower curtains	H	45	47	54	80	119	127	147
	Small articles with the potential for semi-routine contact: packaging, paper, plastic, toys, hobby products: cutting board, pencils, pouches, bags, hose, labels, covers, chewy toys, jewelry, gloves, packaging, mats, lampshade, vinyl floor runner, diving goggles, silly straws, stickers, diving goggles	H	175	177	179	260	425	369	367
Packaging, paper, plastic, toys, hobby products: Packaging (Excluding Food Packaging), Including Paper Articles	Small articles with the potential for semi-routine contact: packaging, paper, hobby products: pencils, labels, covers, lampshade, stickers	H	175	177	179	260	425	369	367
Construction, paint, electrical, and metal products: Paints and coatings	Auto Coatings	H	177	178	181	264	425	371	375
	Concrete sealant	H	191	191	192	281	292	274	269
Packaging, paper, plastic, toys, hobby products: Toys, playground, and sporting equipment	Children's toys (legacy)	H	**28**	44	54	91	135	142	177
		M	122	146	161	242	390	345	398
	Children's toys (new)	H	43	93	119	233	369	329	407
	Tire crumb, artificial turf	H	–	–	192	281	472	401	401

[a] Exposure scenario intensities include high (H), medium (M), and low (L).
[b] High-intensity dermal scenario was deemed to be unlikely due to high uncertainties, see *Consumer and Indoor Exposure Assessment for DEHP* (U.S. EPA, 2025c).
[c] High-intensity aggregate scenario includes ingestion and inhalation exposure routes, while the medium-intensity aggregate scenario includes dermal, ingestion, and inhalation exposure routes for all populations except infants, which does not include the dermal route. The high-intensity dermal scenario was deemed to be unlikely due to high uncertainties, see *Consumer and Indoor Exposure Assessment for DEHP* (U.S. EPA, 2025c).
Bold text in a gray shaded cell indicates an MOE is below the benchmark value of 30.

4.4.6 Cumulative Risk Estimates for the General Population

For DEHP, 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 DEHP 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. However, as discussed in Section 4.4.2, EPA did evaluate cumulative exposure and risk from exposure to DEHP, DBP, BBP, DIBP, and DINP using NHANES urinary biomonitoring data. The NHANES biomonitoring data set is a national, statistical representation of the general, non-institutionalized, civilian U.S. population and provides estimates of average aggregate exposure to individual phthalates for the U.S. population. As can be seen from Table 4-20, and as discussed in more detail in the *Technical Support Document for the Cumulative Risk Analysis of DEHP, DBP, BBP, DIBP, DCHP, and DINP Under TSCA* (U.S. EPA, 2025al), 95th percentile cumulative MOEs ranged from 194 to 592 (cumulative benchmark = 30) for females of reproductive age and male children. These MOEs indicate that the risk cup is 6.2 to 15.5 percent full and indicate that cumulative exposure to DEHP, DBP, DIBP, BBP, and DINP, based on the most recent NHANES survey data (2017 to 2018), does not currently pose a risk to most male children or pregnant women within the U.S. civilian population.

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, 2007a);
- *Pesticide Cumulative Risk Assessment: Framework for Screening Analysis Purpose* (U.S. EPA, 2016c);
- *Advances in Dose Addition For Chemical Mixtures: A White Paper* (U.S. EPA, 2023b);
- *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).

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 DEHP 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 DEHP assessment (Section 4.3) and the CRA (Section 4.4). As part of the individual DEHP assessment (Section 4.3), EPA considered all human health hazards of DEHP and selected a POD based on a NOAEL for phthalate syndrome-related effects to characterize risk from exposure to DEHP. As part of its exposure assessment in the individual DEHP assessment, EPA considered acute, intermediate, and chronic exposure durations for a broad range of populations—including female workers of reproductive age, average adult workers, ONUs, the general population, and consumers of various life stages (*e.g.*, infants, toddlers, children, adults). Furthermore, in the individual DEHP assessment, EPA evaluated inhalation and dermal exposures to workers, as well as consumer exposure to DEHP via the inhalation, dermal, and ingestion exposure routes. In contrast, the CRA is more focused in scope (Section 4.4). For example, the CRA is focused on acute duration exposures and the most sensitive populations (*i.e.*, females of reproductive age, male infants, male children) (Section 4.4). As discussed in Section 4.4.3.1, EPA had concluded that Approach 2 is the most scientifically-supportable approach for characterizing cumulative risk for DEHP. For Approach 2, DEHP exposures were not scaled by relative potency but instead use the individual DEHP POD and are combined with non-attributable cumulative exposures for each phthalate estimated using NHANES (Section 4.4.3).

CRA Approach 2 leads to cumulative risk estimates 1.1× to 1.2× more sensitive than in the individual DEHP risk assessment. For workers, CRA Approach 2 did not have any impact on risk conclusions compared to the individual DEHP worker risk assessment (Section 4.4.4.1). For consumers, CRA Approach 2 resulted in high-intensity (but not medium-intensity) cumulative MOEs below the benchmark of 30 for 2 product or article exposure scenarios for infants (<1 year) and toddlers (1–2 years), including for Furniture Components (Textile) and Children's Toys (Legacy) (Section 4.4.5.1). Overall, there is one factor that influenced differences in risk estimates between the individual DEHP assessment (Section 4.3) and the CRA using Approach 2 (Section 4.4.3). That is the addition of non-attributable cumulative exposure to DEHP, DBP, BBP, DIBP, and DIBP using NHANES urinary biomonitoring, which adds 6.2 to 15.5 percent to the risk cup, depending on the population and age group.

Ultimately, there is little additional cumulative risk by adding the simultaneous exposure of other phthalates to the single chemical risk estimates for DEHP using Approach 2 (*i.e.*, non-attributable cumulative exposure from NHANES adds 6.2–15.5% to the risk cup).

5 ENVIRONMENTAL RISK ASSESSMENT

DEHP – Environmental Risk Assessment (Section 5):
Key Points

EPA evaluated the reasonably available information for environmental exposures and hazard to ecological receptors following releases of DEHP to surface water, sediment, air deposition of DEHP to soil, and agricultural application of municipal biosolids. The following bullets summarize the key points.

Environmental Exposure Key Points

- Using TRI data, the highest surface water concentration resulted from the Plastic compounding (upper bound) OES with a 7Q10 value of 17.6 µg/L, and the lowest surface water concentration resulted from Plastic converting (lower-bound) OES 30Q5 value of 0.023 µg/L, which represent bounding estimates for this risk characterization.
- Fugitive/stack deposition to soil was calculated from the maximum single release out of all OESs resulting in a daily soil concentration of 8.29×10^{-6} mg/kg.

Hazard Key Points

- The chronic aquatic COC of 0.0032 µg/L was derived from a chronic value (ChV) of 0.032 µg/L from a study in Japanese medaka (*Oryzias latipes*) divided by an assessment factor (AF) of 10.
- The sediment-dwelling organism COC was 0.03 µg/L, derived from an unbounded LOAEC of 0.3 µg/L in pore water divided by an AF of 10.
- The hazard value for terrestrial mammals was 80.79 mg/kg-day, based on the geometric mean of a NOAEL of 46.58 mg/kg-day and LOAEL of 140.15 mg/kg-day via ingestion.
- The avian hazard threshold of 10 mg/kg egg was based on a geometric mean of the NOAEL of 5 mg/kg egg and a LOAEL of 20 mg/kg of egg via egg injection.
- The terrestrial plant hazard threshold was 10 mg/kg soil, based on the geometric mean of a NOAEC of 5.0 mg/kg soil and LOAEC of 20 mg/kg soil.
- No effects were observed in aquatic organisms on an acute exposure basis, or in aquatic plants and algae, or terrestrial invertebrates, thus hazard thresholds were not established for these organisms.

Risk Assessment Key Points

- Aquatic species
  - The COUs representing the highest (Plastic compounding) and lowest (Plastic converting) surface water concentrations from TRI releasers resulted in RQs greater than 1 for chronic exposure to aquatic vertebrates.
  - DEHP is unlikely to pose risk to aquatic vertebrates and invertebrates on an acute exposure basis and unlikely to pose risk to aquatic plants and algae.
- Benthic species
  - The COUs representing the highest (Plastic compounding) and second lowest (Manufacturing) pore water concentrations from TRI releasers resulted in RQs greater than 1 for chronic exposure to sediment-dwelling invertebrates.
  - RQs were less than 1 for chronic exposures to DEHP for sediment-dwelling invertebrates in the Plastic converting (lower-bound) OES.
- Terrestrial species
  - RQs were less than 1 for terrestrial plants exposed via air deposition (fugitive or stack release) or biosolid land application.
  - DEHP is unlikely to pose risk to mammals, birds, and terrestrial invertebrates.
  - Risk from DEHP exposure through trophic transfer is not expected.
- EPA has robust and moderate confidence in the risk characterization for the chronic aquatic and chronic benthic assessments, respectively, and robust and moderate confidence in the terrestrial plant assessments through air deposition to soil and biosolid land application, respectively.

5.1 Summary of Environmental Exposures

DEHP is expected to be released to the environment via air, water, and biosolids and landfills as detailed within the environmental release assessment presented in the *Environmental Release and Occupational Exposure Assessment for DEHP* (U.S. EPA, 2025u). Environmental media concentrations were estimated in ambient air, soil from ambient air deposition, biosolids, surface water, and sediment. Further details on the environmental partitioning and media assessment can be found in the *Chemistry, Fate, and Transport Assessment for DEHP* (U.S. EPA, 2025af).

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

For the water pathway, the EPA's VVWM-PSC tool (PSC) (U.S. EPA, 2019d) was used to estimate surface water and sediment concentrations of DEHP resulting from COU releases. Industrial releases of DEHP to surface waters were reported to EPA via TRI and DMR databases or estimated using generic scenarios (U.S. EPA, 2025u). PSC inputs include physical and chemical properties of DEHP (*i.e.*, K_{OW}, K_{OC}, water column half-life, photolysis half-life, hydrolysis half-life, and benthic half-life) and estimated DEHP releases to water (U.S. EPA, 2025u), which are used to predict receiving water column concentrations. PSC was also used to estimate DEHP concentrations in settled sediment in the benthic region of streams. Site-specific parameters including the concentration of suspended sediments, water depth, and weather patterns influence how partitioning occurs over time. However, physical and chemical properties of the chemical have a major influence on partitioning and half-lives in aqueous environments. DEHP has a log K_{OC} of 5.4 indicating a high potential to sorb to suspended particles in the water column and settled sediment in the benthic environment (U.S. EPA, 2017). Physical and chemical, and environmental fate properties selected by EPA for this assessment were used as inputs to the PSC model described in detail in the *Chemistry, Fate, and Transport Assessment for DEHP* (U.S. EPA, 2025af) and *Environmental Media and General Population and Environmental Exposure for DEHP*, (U.S. EPA, 2025s). Measured concentrations of DEHP ranged less than 280 ng/L to 940 µg/L in surface waters while ranging less than 165 to 699,000 µg/kg in the sediment (U.S. EPA, 2025s). Specific detailed review of measured concentrations of DEHP in surface water, sediment, and drinking water are presented in Section 4.2.1, 4.2.2, and 6.2 of the *Environmental Media and General Population and Environmental Exposure for DEHP*, respectively (U.S. EPA, 2025s).

Monitored surface water concentrations of DEHP (Table 5-1), when detected above the level of detection, fall within the ranges of DEHP concentrations modeled from TRI data Table 5-4. DEHP is monitored at drinking water facilities across the U.S. due to the designation of national maximum contaminant level (6 µg/L) for DEHP within drinking water by public water systems (U.S. EPA, 2025ah). The EPA's six-year review of drinking water standards data from 2012 to 2019 includes 202,420 sample records from over 36,400 public water systems, ranging up to 52.2 µg/L DEHP detected in finished drinking water at a Pennsylvania facility sourcing surface water, and up to 130 µg/L at a Massachusetts groundwater facility. The frequency of detection for surface water and groundwater samples from these sample records was 3.5 and 3.9 percent, respectively (U.S. EPA, 2025ah). The ability to detect DEHP in this large nationwide dataset would be independent from overall risk conclusions since they are not linked to COUs; but rather demonstrates the infrequent presence of DEHP within surface water and groundwater. Samples from EPA's six-year review of drinking water standards data from 2012-2019 were analyzed at multiple facilities potentially resulting in different detection limits among laboratories, however, the limit of detection for DEHP is typically less than 1 µg/L with many samples in this database near 0.05 µg/L (U.S. EPA, 2025ah). The EPA method for measuring phthalates in water is 8061A SW846, with a method detection limit (MDL) for DEHP of 0.27 µg/L (U.S. EPA, 1998b).Previous studies have used analytical methods to detect DEHP at concentration below the COC for chronic aquatics of 0.0032 µg/L, such as gas chromatography and gas chromatography-mass spectroscopy, to determine concentrations of DEHP within aquatic media at limits of detection of 2.0×10^{-4} µg/L and above (Wang and Kannan, 2023; Giam et al., 1978).

Elliott et al. (2017) reported concentrations of DEHP in freshwater samples collected from 12 tributaries to the Laurentian Great Lakes. Sample sites represented a mix of uses from watersheds with relatively little human disturbance to watersheds with urban and agricultural land uses. Within Elliot et al. (2017), DEHP was detected infrequently (1% of samples) from the total of 291 samples with a maximum concentration of 8.6 µg/L found in the Raquette River in a sample collected below the Potsdam WWTP in New York. Liu et al. (2013) assessed the spatial distribution of phthalates in Lake Pontchartrain, Louisiana, before, during, and after opening of the Bonnet Carré Spillway that occurred April to May 2008. Forty-two freshwater samples were collected from the Bonnet Carré Spillway at six sites located about 1 mile apart. DEHP was detected in 24 percent of these samples (pooled frequency of detection estimate for both the Bonnet Carre Spillway and the Lake Maurepas samples) with concentrations measured in the Bonnet Carre Spillway samples ranging from <0.4 to 12 µg/L. Fifty-four samples were also collected from the central lake area at six sites located near Lake Maurepas to the Causeway Bridge, with one site near the Manchac Pass. DEHP was detected in 32 percent of these central lake area samples with concentrations up to 18.2 µg/L (Table 5-1).

Table 5-1. DEHP Surface Water and Groundwater Concentrations from EPA's Six-Year Review of Drinking Water Standards and Peer Reviewed literature.

Drinking Water Sourcing Sample Type	Number of Detectable Samples, Frequency of Detection	Maximum DEHP (µg/l)	Mean (± SEM) DEHP Concentration (µg/l)	Reference
Surface water	1,223, 3.5%	52.2	1.34 ± 0.06	(U.S. EPA, 2025ah)
Groundwater	6,536, 3.9%	130	2.05 ± 0.05	
Freshwater samples from 12 tributaries to the Laurentian Great Lakes, 2013–2014	291, 1%	8.6	N/A	(Elliott et al., 2017)
Freshwater samples from Lake Pontchartrain, LA, before, during, and after opening of the Bonnet Carré Spillway that occurred April/May 2008, March 2008–June 2009	Bonnet Carré Spillway (6 locations; n = 42) Number of detectable samples: 24% <0.4–12 µg/L Central lake area (6 locations; n = 54) Number of detectable samples: 32% <0.4–18.2 µg/L	18.2	N/A	(Liu et al., 2013)

Although there is the possibility of environmental releases from consumer uses containing DEHP, EPA was unable to quantify the environmental releases for the following COUs:

- Consumer use – automotive, fuel, agriculture, outdoor use products – lawn and garden care products
- Consumer use – construction, paint, electrical, and metal products – batteries

- Consumer use – construction, paint, electrical, and metal products – construction and building materials covering large surface areas, including paper articles; metal articles; stone, plaster, cement, glass and ceramic articles
- Consumer use – construction, paint, electrical, and metal products – machinery, mechanical appliances, electrical/electronic articles
- Consumer use – construction, paint, electrical, and metal products – paints and coatings
- Consumer use – furnishing, cleaning, treatment care products – floor coverings; construction and building materials covering large surface areas including stone, plaster, cement, glass and ceramic articles; fabrics, textiles, and apparel
- Consumer use – packaging, paper, plastic, toys, hobby products – ink, toner, and colorants
- Consumer use – packaging, paper, plastic, toys, hobby products – packaging (excluding food packaging) and other articles with routine direct contact during normal use, including rubber articles; plastic articles (hard); plastic articles (soft)
- Consumer use – packaging, paper, plastic, toys, hobby products – packaging (excluding food packaging), including paper articles
- Consumer use – packaging, paper, plastic, toys, hobby products – toys, playground, and sporting equipment

EPA did not quantify these end-of-life and down-the-drain exposures due to limited information on source attribution of the consumer COUs. Section 3.1.4 provides further details on the information on consumer disposal of DEHP-containing products and articles. Although EPA acknowledges that there may be DEHP releases to the environment, the Agency did not quantitatively assess these scenarios due to limited information, monitoring data, or modeling tools. Consumer releases to the environment are anticipated to be more dispersed and less direct than DEHP releases from COUs/OESs quantified for risk estimates for aquatic and terrestrial receptors detailed within Table 5-10. However, EPA believes that many of the scenarios here are captured by the disposal COU which is assessed separately.

For the land pathway, 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 DEHP 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 are discussed qualitatively. Modeled soil DEHP concentrations from air deposition to soil and modeled DEHP in biosolids-amended soils from OESs with the resulting highest concentrations to soil were assessed quantitatively with hazard thresholds (U.S. EPA, 2025r) for relevant soil dwelling organisms and plants within the *Environmental Hazard Assessment for DEHP* (U.S. EPA, 2025r). The complete review of exposure pathways can be found in the *Environmental Media and General Population and Environmental Exposure for DEHP* (U.S. EPA, 2025s). DEHP concentrations in topsoil were estimated to range from 0.003 to 6.25 mg/kg (U.S. EPA, 2025s).

EPA conducted qualitative assessments of DEHP trophic transfer, as the physical properties, fate, and exposure of the chemical determined that it does not biomagnify and is characterized as demonstrating trophic dilution. The Agency has robust confidence that DEHP has limited bioaccumulation and bioconcentration potential based on physical and chemical and fate properties, biotransformation, and empirical metrics of bioaccumulation metrics presented in Section 2. A summary of relevant exposure pathways to receptors and resulting risk characterization summaries are presented in Table 5-2.

DEHP releases to water are represented with data from TRI releases. Environmental releases were characterized with TRI, NEI, DMR data for 13 OESs, while three OESs were modeled with generic

Table 5-2. Relevant Exposure Pathway to Receptors and Corresponding Risk Assessment for the DEHP Environmental Risk Characterization

Exposure Pathway		Receptor	Risk Assessment
Aquatic environment	Surface water	Acute exposure to aquatic vertebrates or invertebrates[a]	Qualitative; Unlikely to result in risk
	Surface water	Chronic exposure to aquatic vertebrates, Reduced growth/development of Japanese medaka (*Oryzias latipes*)	Quantitative; risk quotients are calculated later in Section 5 to assess impacts for this pathway and receptor[d]
	Sediment	Chronic exposure to invertebrates, Reduced growth of the midge (*Chironomus riparius*)[b]	Quantitative; risk quotients are calculated later in Section 5 to assess impacts for this pathway and receptor[d]
	Surface water	Aquatic plants and algae[a]	Qualitative; Unlikely to result in risk
Terrestrial environment	Soil	Terrestrial invertebrates[a,c]	Qualitative; Unlikely to result in risk
	Soil (air to soil)	Terrestrial plants	Quantitative; risk quotients are calculated in Section 5 to assess impacts for this pathway and receptor
	Soil (biosolids)		
	Atmospheric deposition/Soil (biosolids)	Birds	Qualitative; Unlikely to result in risk
	Trophic transfer	Terrestrial mammal	Qualitative; Unlikely to result in risk

[a] No hazard threshold identified up to the limit of solubility.
[b] No hazard threshold identified from chronic DEHP exposure for aquatic invertebrates in the water column as no studies below the limit of water solubility were available (see Section 5.3.6).
[c] No hazard threshold identified up to and exceeding 5,000 mg/kg after 50 days (Jensen et al., 2001).
[d] Table 5-4 and Table 5-5 detail the risk estimates calculated from hazard thresholds and site-specific TRI data representing the DEHP COU/OESs within surface water and pore water from the maximum number of release days and 7Q10, harmonic mean, and 30Q5 flow rate.

scenarios because TRI, NEI, DMR data for these releases were not available (Table 3-5). Direct releases to surface water reported via TRI and DMR were applied as the actual loading to surface water, including any onsite treatment prior to discharge. Specifically for TRI-reported COU/OES, reported surface water releases are based on monitoring at the outfall to surface water and already reflect any applicable pretreatment and wastewater treatment, and no additional wastewater treatment removal was applied (See Section 2.3.3.1 of the *Environmental Release and Occupational Exposure Assessment for DEHP* (U.S. EPA, 2025u)). As described within Section 3.3, the TRI release with the highest resulting environmental concentrations for surface and pore water indicated that RQs were above one for these aquatic compartments. As a refinement from this initial approach, TRI data from the COU/OESs with the highest and lowest resulting concentrations within surface water and pore water were used to represent bounds with water releases of DEHP. For the COU/OESs with TRI release information, the highest surface water concentration was from the Plastic compounding (upper bound) OES with a 7Q10 value of 17.6 µg/L, and the lowest surface water concentration was from Plastic converting (lower bound) 30Q5 value of 0.023 µg/L. As a result, DEHP concentrations from TRI data represent both the highest and lowest in stream concentrations as bounds for this risk characterization. Risk estimates from calculated hazard thresholds and TRI data representing the COU/OES with the highest and lowest surface and pore water concentrations can be found in Table 5-4 and Table 5-5.

5.2 Summary of Environmental Hazards

EPA evaluated the reasonably available information for environmental hazard endpoints associated with DEHP exposure to ecological receptors in aquatic and terrestrial ecosystems. EPA reviewed a total of 82 high/medium quality ranked aquatic studies with 103 endpoints for toxicity to aquatic organisms. Of the 82 studies, 73 studies either demonstrated no acute or chronic effects at any concentration tested, or the reported hazard values exceeded the limit of solubility of 3.0 µg/L selected by EPA to be representative of non-colloidal water solubility (U.S. EPA, 2025af). These included 32 acute hazard studies that showed no effects ranging from greater than 100 to greater than 770,000 µg/L, and 11 that showed effects greater than 3.0 µg/L ranging from 50 to 37.950 µg/L. There were six non-dietary chronic fish studies that showed no effects ranging from 12 to 5,000 µg/L, five that showed effects greater than 3.0 µg/L with NOAECs and LOAECs ranging from 1 and 10 µg/L to 100 and 500 µg/L, respectively, and four that showed effects at the lowest test concertation but greater than 3.0 µg/L resulting in an unbounded LOAEC ranging from less than 0.5 to less than 20 µg/L.

Six chronic aquatic invertebrate studies showed no effects ranging from 107 to 60,000 µg/L, five showed effects greater than 3.0 µg/L with NOAECs and LOAECs ranging from 10 and 30 µg/L to 390 and 510 µg/L, and one study had a NOAEC less than 3.0 µg/L at 2 µg/L while the LOAEC was above it at 10 µg/L. Four sediment-dwelling organism studies showed no effects ranging from 47 to 382 µg/L, and one study showed effects at the lowest concertation tested but greater than greater than 3.0 µg/L resulting in an unbound NOAEC of less than 10 µg/L.

Of the aquatic studies that were considered for quantitative assessment, one acute study was considered but ruled out due to potential contamination issues while four chronic studies showed effects at the lowest test concertation resulting in an unbounded NOAEC of 0.001 µg/L, including a sediment-dwelling organism study (Heindler et al., 2017; Corradetti et al., 2013; Kwak and Lee, 2005; Mayer Jr et al., 1973). The remaining four studies reported definitive endpoints and had NOAECs/LOAECs of 1.0/10 µg/L, 0.1/1.0 µg/L, 0.01/0.1 µg/L, and 0.01/0.1 µg/L (Golshan et al., 2015; Zanotelli et al., 2010; Chikae et al., 2004a; Chikae et al., 2004b). The sediment-dwelling organism study reported a NOAEC and LOAEC of less than 0.3 and 0.3 µg/L (Kwak and Lee, 2005).

Environmental monitoring of DEHP indicates that it can be present at concentrations greater than 3.0 µg/L based on samples reported within peer-reviewed literature (Elliott et al., 2017; Liu et al., 2013) and EPA's Six-Year Review of Drinking Water Standards (U.S. EPA, 2025ah). Because negative data indicating no effects is just as important as data showing effects, these 73 studies were considered qualitatively in the weight of evidence as they relate to exposure, although EPA was unable to use these studies quantitatively to develop hazard thresholds. For an overview of the studies considered and environmental hazards, refer to the *Environmental Hazard Assessment for DEHP* (U.S. EPA, 2025r).

EPA has robust confidence that DEHP poses low hazard potential to aquatic vertebrates and invertebrates from acute exposure durations. This is supported by reasonably available data which consistently found that acute DEHP exposure poses no hazard up to and exceeding the limit of water solubility.

Conversely, EPA has robust confidence that DEHP does pose potential hazard to aquatic vertebrates and invertebrates from chronic exposure durations at concentrations below the limit of water solubility (3.0 µg/L). This is supported by eight chronic aquatic studies with reported endpoints less than 3.0 µg/L across taxa including two studies selected based on the most conservative value in which effects on mortality, growth, and development were observed in Japanese medaka exposed to 0.1 µg/L DEHP for 21-days and followed for an additional 5 months. These studies reported effects on mortality, growth, reproduction, and development at NOAECs and LOAEC values ranging from 0.01 and 0.1 to 0.1 and 1.0 µg/L, respectively. The COC of 0.0032 µg/L was calculated from the chronic value (ChV) of 0.032 µg/L, which is the geometric mean of the NOAEC of 0.01 µg/L and the LOAEC of 0.1 µg/L divided by an assessment factor (AF) of 10 (Chikae et al., 2004a; Chikae et al., 2004b). There is uncertainty in much of the chronic aquatic data since most studies either show no effect at the concentrations tested or used DEHP concentrations above the limit of water solubility where colloidal suspensions may form; however, these studies were not included in the development of the RQ. Additionally, selecting the most conservative value as the hazard threshold along with the inclusion of an AF of 10 may result in an overly protective COC. A complete listing of studies and endpoints can be found in the *Environmental Hazard Assessment for DEHP* (U.S. EPA, 2025r).

EPA has moderate confidence that DEHP has effects on growth and development to sediment dwelling invertebrate species at concentrations below the limit of water solubility. This moderate confidence is supported by one study in which effects on growth were observed in the midge (*Chironomus riparius*). The COC of 0.03 µg/L was derived from an unbounded LOAEC of 0.3 µg/L, based on significant effects in body volume in *C. riparius* at every concentration tested, divided by an AF of 10 (Kwak and Lee, 2005). There is uncertainty, however, regarding the hazard threshold for this species since an unbounded LOAEC was used to derive the COC because the study authors did not test lower concentrations where a NOAEC could be established.

EPA has robust confidence that DEHP poses low hazard potential to aquatic plants and algae. This robust confidence is supported by reasonably available data indicating DEHP poses no hazard to aquatic plants and algae below the limit of water solubility. EPA acknowledges the aquatic hazard conclusions are limited by studies that assessed hazard above the solubility limit or by the low number of studies available to assess hazard to aquatic plants and algae.

In the terrestrial environment, EPA has robust confidence that DEHP poses potential hazard to mammals and terrestrial plants, and moderate confidence that DEHP poses potential hazard to birds.
The conclusion that DEHP poses hazard to terrestrial mammals is supported by evidence obtained from 26 laboratory rodent studies conducted for use as human health models. EPA used studies from the human health animal model data set (terrestrial mammals) and considered only studies with ecologically-relevant hazard endpoints (*e.g.*, survival, growth, development, and reproduction). Studies with LOAELs based on reproductive endpoints were further considered for selection of hazard value for terrestrial species, over that of survival/mortality, given that these endpoints were more sensitive. EPA acknowledges that human health rodent models may not be fully representative of effects in a more diverse array of wild animal populations; however, it is important to note that hazard value was derived from the most sensitive ecologically-relevant endpoint from the data set. The terrestrial mammalian hazard threshold of 80.79 mg/kg-day is the geometric mean of the NOAEL of 48.58 mg/kg-day and LOAEL of 140.15 mg/kg-day based on a decrease in pup survival during lactation (Tanaka, 2002). Nearly all other rodent studies considered for hazard threshold determination were within an order of magnitude of the selected value.

The conclusion that DEHP poses hazard to terrestrial plants is supported by two terrestrial plant studies that identified effects of DEHP on plant growth in six plant species (U.S. EPA, 2025r). The terrestrial plant hazard threshold was 10 mg/kg soil, derived from a geometric mean of a NOAEC/LOAEC of 5.0/20 mg/kg soil for the growth of perennial ryegrass (*Lolium perenne*).

The avian threshold was 10 mg DEHP/kg of egg via egg injection, derived from a single-dose pre-hatch egg injection study that resulted in developmental defects (gastroschisis and omphalocele). For avian taxa, EPA has uncertainty in the hazard characterization that the dose reached by the embryo is representative of concentrations that would be depurated to the embryo in the egg development process.

No studies were available to quantitatively assess the hazard of DEHP to terrestrial invertebrates as the studies identified through systematic review showed no effects of DEHP. Other studies administered DEHP as an aqueous test solution that exceeded the limit of solubility, or the amount of DEHP administered to test organisms was unclear. Therefore, a hazard threshold could not be established for terrestrial invertebrates. Based on the absence of studies with measurable effects in studies that have been reviewed, EPA has determined that DEHP is not hazardous to terrestrial invertebrates up to the exposures tested.

5.3 Environmental Risk Characterization

5.3.1 Risk Assessment Approach

EPA characterized the environmental risk of DEHP using risk quotients (RQs) (U.S. EPA, 1998a; Barnthouse et al., 1982). The RQ is defined in Equation 5-1. Risk was also characterized qualitatively using a weight of evidence approach to support conclusions (Table 5-9).

Equation 5-1. Calculating the Risk Quotient

$$RQ = Predicted\ Environmental\ Concentration / Hazard\ Threshold$$

Environmental exposure concentrations for each compartment (*i.e.*, surface water, pore water, sediment, and soil) were based on measured (*i.e.*, monitoring data and/or values from available literature) and/or modeled (*i.e.*, E-FAST 2014, VVMW-PSC, AERMOD, IIOAC) concentrations of DEHP from Section 3. EPA calculates hazard thresholds to identify potential concerns to aquatic and terrestrial species. These terms describe how the values are derived and can encompass multiple taxa or ecologically relevant groups of taxa as the environmental risk characterization serves populations of organisms within a wide diversity of environments. For hazard thresholds, EPA used the COCs calculated for aquatic organisms, and the hazard values calculated for terrestrial organisms as detailed within the *Environmental Hazard Assessment for DEHP* (U.S. EPA, 2025r).

RQs equal to 1 indicate that environmental exposures are the same as the hazard threshold. If the RQ is above 1, the exposure is greater than the hazard threshold. If the RQ is below 1, the exposure is less than the hazard threshold. Risk is indicated when the RQ is greater than or equal to 1. RQs derived from modeled data for DEHP are described in Section 5.3.2 for aquatic organisms and Section 5.3.3 for terrestrial organisms. RQs derived from measured data for DEHP are presented within the *Environmental Hazard Assessment for DEHP* (U.S. EPA, 2025r), in Table 3-1 for aquatic organisms and Table 4-1 for terrestrial organisms. For aquatic species, acute risk is generally indicated when the RQ is greater than or equal to 1 for acute exposures. Chronic risk is generally indicated when the RQ is greater than or equal to 1, which results from water concentrations being above the CoC for a similar duration as the study from which the hazard value was derived. The number of days out of the year during which the average concentration exceeds the chronic COC is calculated in the PSC model and referred to as the days of exceedance. The chronic COC for DEHP was derived from a 21-day exposure; therefore, the days of exceedance to demonstrate risk reflects the exposure period for that hazard value and RQ values presented in the current risk characterization reflect that these durations were exceeded. For terrestrial species, RQ values are calculated from the hazard value for mammals, avian species, and plants.

Monitoring data and published literature, when available, were used for comparison if modeled concentrations in the ambient environment exceeded the identified hazard benchmarks for aquatic and terrestrial receptors while also providing support for, or in concurrence with, modeled concentrations.

5.3.2 Risk Characterization for Aquatic Receptors

Fish and Aquatic Invertebrates (Acute Exposure)

EPA did not identify any reasonably available data for the derivation of a hazard threshold for acute aquatic species, including sediment-dwelling organisms, therefore, RQs were not calculated for acute aquatic exposures. The data suggest that DEHP has low acute toxicity as no definitive effects were observed below the limit of water solubility (3 µg/L), and thus EPA has determined that DEHP is unlikely to result in risk for acute exposure to aquatic species.

Aquatic Plants and Algae

No studies with definitive values below the limit of solubility were available to assess the hazard of DEHP to aquatic plants or algae. Therefore, a hazard threshold could not be established, and RQs were not calculated. EPA has determined that DEHP is unlikely to result in risk for aquatic plants or algae.

Fish and Sediment-Dwelling Organisms (Chronic Exposure)

Releases of DEHP to surface water and sediment were identified for 31 COUs (Life cycle stage/Category/ Sub-category) represented by 16 OESs. The OESs with the highest and lowest DEHP surface water releases and corresponding flow rates were Plastic compounding (upper-bound) and Plastic converting (lower-bound), respectively (Table 5-3). Calculated RQs for chronic aquatic vertebrates and chronic aquatic sediment-dwelling invertebrates can be found in Table 5-4 and Table 5-5, respectively, and were represented by the concentrations from TRI release data and hazard thresholds for aquatic organisms. The maximum daily average value for surface water and sediment pore water (in µg/L) was based on 21- and 32-day average release scenario for calculating RQs, respectively, modeled by VVWM-PSC. The release scenario duration was selected based on the study duration for those receptors. All days of exceedance were greater than the hazard threshold value study duration for each release scenario. Based on model estimates, release for the Plastic compounding OESs for surface water exceeded the EPA-determined DEHP limit of solubility (3.0 µg/L). Environmental monitoring in surface water has indicated that DEHP can occur above this concentration (Section 5.1), however, EPA used the DEHP limit of solubility 3.0 µg/L in calculations for quantitative risk assessment for surface water and sediment pore water.

Because this analysis is using TRI site data and not modeled data (*i.e.*, P50, P75, P90), only one release value is reported for each 7Q10, 30Q5, and harmonic mean flow scenario. Inputs for the TRI OESs are in Table 5-3. The flow data were represented by self-reported hydrologic reach codes on NPDES permits and represents the best available flow estimation from Enhanced Run Off Method (EROM) flow data. Surface water and sediment pore water RQs can be found in Table 5-4 and Table 5-5, respectively. Three different flow rates were considered to further refine risk under varying flow scenarios. 7Q10 is defined as seven consecutive days of lowest flow over a 10-year period used to calculate estimates of chronic surface water concentrations to compare with the COCs for aquatic life (Versar, 2014). The 30Q5 is defined as 30 consecutive days of lowest flow over a 5-year period. Harmonic mean is defined as the inverse mean of reciprocal daily arithmetic mean flow values. The presented low end for an OES (identified as lower bound in Table 5-3 and throughout the risk evaluation) is calculated from the median reported release amounts whereas high-end (identified as upper bound in Table 5-3 and throughout the risk evaluation) is reported from maximum release amounts. The specific upper bound and lower bound values presented depend on the number of sites with programmatic data. Direct releases to surface water reported via TRI and DMR were applied as the actual loading to surface water, including any onsite treatment prior to discharge.

Table 5-3. Releases to Water Based on Data from TRI and Resulting Water Concentrations Modeled Using PSC and Different Flow Conditions

OES (Release Distribution)	Annual Release (kg/year)	Maximum Number of Release Days[a]	Daily Release (kg/site-day)	Flow Rate 7Q10[b] (m^3/day)	Flow Rate HM[c] (m^3/day)	Flow Rate 30Q5[d] (m^3/day)
Plastic compounding (upper bound)	3.63	246	0.015	558.48	3,171.51	1,046.46
Plastic converting (lower bound)	0.0045	253	1.79E−5	131.7	499.9	259.17

[a] Max days of release based on total number of operating days.
[b] 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).
[c] Harmonic mean (HM) 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 environmental exposures via releases to surface water.

Plastic Compounding – Upper Bound

Surface Water: Surface water chronic RQ values for the Plastic compounding OES exceed 1 (Table 5-4). Surface water concentrations were 17.6, 4.31, and 11.2 µg/L for the 7Q10, harmonic mean, and 30Q5 flow scenarios, respectively. Since the limit of solubility for DEHP is 3.0 µg/L, the value used for surface water concentration in the calculation of RQs was 3.0 µg/L.

Benthic Pore Water: Benthic pore water chronic RQ values for the Plastic compounding OES exceeded 1 (Table 5-5). Pore water concentrations were 9.0, 2.25, and 5.74 µg/L for the 7Q10, harmonic mean, and 30Q5 flow scenarios, respectively. Because the limit of solubility for DEHP is 3.0 µg/L, the value used in the calculation of RQs was 3.0 µg/L for the 7Q10 and 30Q5 release scenarios.

Plastic Converting – Lower Bound

Surface Water: Surface water chronic RQ values for the plastic converting OES all exceeded 1 (Table 5-4). Pore water concentrations were 0.045, 0.023, and 0.034 µg/L for the 7Q10, harmonic mean, and 30Q5 flow scenarios, respectively.

Benthic Pore Water: Benthic pore water chronic RQ values for the plastic converting OES were less than 1 for the 7Q10, 30Q5, and harmonic mean release scenarios (Table 5-5). Pore water concentrations were 0.023, 0.012, and 0.017 µg/L for the 7Q10, harmonic mean, and 30Q5 flow scenarios, respectively. The second lowest resulting pore water concentration from a known TRI release represents the manufacturing OES with a pore water concentration of 0.391 µg/L for the 7Q10 flow scenario. This results in a RQ of 13 when using the COC for sediment invertebrates of 0.03 µg/L.

Table 5-4. Chronic Aquatic Environmental Risk Quotients (RQs) by DEHP TRI Release Surface Water Concentrations (µg/L) Modeled by VVWM-PSC

COU (Life Cycle Stage: Category: Subcategory)	OES [a]	Flow Scenario (Flow Rate)	Surface Water Concentration (µg/L) (Limit of Water Solubility) [b]	Risk Quotient (RQ) [c]
Processing; Incorporation into formulation, mixture, or reaction product; Plasticizer in basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint and coating manufacturing	Plastic compounding (upper bound)	7Q10	17.6 [3.0]	>937.5
Processing; Incorporation into formulation, mixture, or reaction product; Adhesive manufacturing; plastic material and resin manufacturing; synthetic rubber manufacturing		Harmonic mean	4.31 [3.0]	>937.5
Processing; Incorporation into formulation, mixture, or reaction product; All other basic inorganic chemical manufacturing				
Processing; Incorporation into formulation, mixture, or reaction product; Wholesale and retail trade; services; ink, toner and colorant manufacturing		30Q5	11.2 [3.0]	>937.5
Processing; Incorporation into article; Plasticizer in basic organic chemical manufacturing; plastics product manufacturing; rubber product manufacturing; miscellaneous manufacturing; PVC extruding	Plastic converting (lower bound)	7Q10	0.045	14.1
		Harmonic mean	0.023	7.2
Industrial use; Other uses; Solid rocket motor insulation and other aerospace applications; Automotive articles		30Q5	0.034	10.6

[a] The OESs with the highest and lowest DEHP surface water releases were Plastic compounding and Plastic converting and are referred to here at the upper bound and lower bound, respectively.
[b] The limit of solubility for DEHP is 3 µg/L. For cases in which the calculated surface water concentration exceeded the limit of water solubility, EPA used the water solubility limit of 3 µg/L as the exposure concentration and denoted the RQ as greater than the calculated value.
[c] RQ = exposure water concentration for each OES divided by the chronic COC of 0.0032 µg/L derived from a 21-day study in Japanese medaka (*O. latipes*).

Table 5-5. Chronic Environmental Risk Quotients (RQs) by DEHP TRI Release Sediment Pore Water Concentrations (µg/L) Modeled by VVWM-PSC

COU (Life Cycle Stage/Category/Subcategory)	OES [a]	Flow Scenario (Flow Rate)	Sediment Pore Water Concentration (µg/L) (limit of water solubility)] [b]	Risk Quotient (RQ)[c]
Processing; Incorporation into formulation, mixture, or reaction product; Plasticizer in basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint and coating manufacturing	Plastic compounding (upper bound)	7Q10	9.0 [3.0]	>100
Processing; Incorporation into formulation, mixture, or reaction product; Adhesive manufacturing; plastic material and resin manufacturing; synthetic rubber manufacturing		Harmonic mean	2.25	75
Processing; Incorporation into formulation, mixture, or reaction product; All other basic inorganic chemical manufacturing				
Processing; Incorporation into formulation, mixture, or reaction product; Wholesale and retail trade; services; ink, toner and colorant manufacturing		30Q5	5.74 [3.0]	>100
Processing; Incorporation into article; Plasticizer in basic organic chemical manufacturing; plastics product manufacturing; rubber product manufacturing; miscellaneous manufacturing; PVC extruding	Plastic converting (lower bound)	7Q10	0.023	0.77
		Harmonic mean	0.012	0.4
Industrial use; Other uses; Solid rocket motor insulation and other aerospace applications; Automotive articles		30Q5	0.017	0.57

[a] The OESs with the highest and lowest DEHP surface water releases were Plastic compounding (upper bound) and Plastic converting (lower bound), respectively.
[b] The limited of solubility for DEHP is 3 ug/L. The risk quotient presented represents the limit of solubility for DEHP.
[c] Based on midge (*C. riparius*) 32-day hazard data exposed to DEHP resulting in a COC of 0.03 µg/L.

Modeled Generic Scenarios

For OESs for which TRI data are not available, EPA used generic release scenarios and assumed that these modeled release scenarios would result in similar, or possibly more conservative, surface water concentrations, especially for untreated, low-flow aquatic releases. The use of Hydraulic fracturing OES is a generic scenario with a surface water release, while two other OESs (Use of laboratory chemicals [liquid], and Use of automative care products) detail environmental releases that discharge to a combination of surface water, incineration, and/or landfill. Although OESs modeled from generic scenarios result in lower confidence in exposure estimates compared to those using release data from TRI, the chronic COCs for aquatic species indicate a high degree of hazard potential. Specifically, the Use of Automotive Care Products OES results in the highest environmental concentrations within surface and pore water with results presented with and without treatment removal efficiency with potential discharge to POTW (Table 5-6). For this scenario, EPA included the resulting concentrations in the high-end screening analysis, with slight confidence in any subsequent risk identified, but robust confidence in the value being representative of an upper bound of potential exposure from these releases. The risk estimates for these OESs based on generic scenarios would also result in deleterious effects to aquatic organisms, despite the lower confidence in the exposure level, given the sensitive hazard values for aquatic organisms.

Table 5-6. Chronic Environmental Risk Quotients (RQs) Use of Automotive Care Products GS for Surface and Pore Water Modeled with VVWM-PSC

COU (Life Cycle Stage; Category; Subcategory)	Days of Release	Media	DEHP Concentration (µg/L) (limit of water solubility)] [a]	Flow Scenario (Flow Rate)	COC Type	RQ [c]
OES: Use of Automotive Care Products (no treatment removal)						
Commercial use; Other uses; Automotive articles and products	260	Surface Water	217 [3.0]	P50 7Q10	Chronic	>937.5
		Pore Water	112 [3.0]	P50 7Q10	Chronic Benthic	>100
		Surface Water	93 [3.0]	Harmonic mean	Chronic	>937.5
		Surface Water	140 [3.0]	30Q5	Chronic	>937.5
OES: Use of Automotive Care Products (treatment removal) [b]						
Commercial use; Other uses; Automotive articles and products	260	Surface Water	78 [3.0]	P50 7Q10	Chronic	>937.5
		Pore Water	40 [3.0]	P50 7Q10	Chronic Benthic	>100
		Surface Water	33 [3.0]	Harmonic mean	Chronic	>937.5
		Surface Water	50 [3.0]	30Q5	Chronic	>937.5

COU (Life Cycle Stage; Category; Subcategory)	Days of Release	Media	DEHP Concentration (µg/L) (limit of water solubility)] [a]	Flow Scenario (Flow Rate)	COC Type	RQ[c]
[a] The water solubility limit for DEHP is 3 µg/L. The RQ presented represents the limit of solubility for DEHP. [b] Use of Automotive Care Products is represented with a treatment removal due to environmental release to POTW. WWTP efficiency is represented with a 64% removal from a comprehensive USPOTW survey (U.S. EPA, 1982). [c] RQ = Exposure surface water concentration for each OES divided by the chronic COC of 0.0032 µg/L derived from a 21-day study in Japanese medaka (*O. latipes*); Pore water RQ based on midge (*C. riparius*) 32-day hazard data exposed to DEHP resulting in a COC of 0.03 µg/L.						

5.3.3 Risk Characterization for Terrestrial Receptors

EPA conducted an assessment for DEHP release to the terrestrial environment by performing quantitative risk characterization using the OES/COU with the highest values of fugitive release or stack atmospheric deposition to soil. The OES with the highest fugitive and stack air release, selected using all TRI, NEI and/or generic scenario data, was application of paints, coatings, adhesives, and sealants (Section 8.1 of the *Environmental Media and General Population and Environmental Exposure for DEHP*, (U.S. EPA, 2025s)). Soil concentrations were calculated from estimated soil catchment concentrations that could be in soil via maximum daily air deposition (95th percentile) of DEHP at a distance of 100m from a facility based on releases reported to TRI, resulting in a daily soil concentration of 8.29×10^{-6} mg/kg. RQs were less than 1 for exposure scenarios using the highest IIOAC predictions for annual air deposition to soil at 100 m with an annual soil concentration of 3.0×10^{-3} mg/kg.

No studies were identified reporting the concentration of DEHP in cultivated or non-cultivated soils following the application and incorporation of biosolids containing DEHP. Nor were any studies identified measuring the concentration of DEHP in final stabilized biosolids which may be applied to cultivated land as fertilizer. As such, concentrations of DEHP in biosolids-amended soils were estimated using data collected from the EPA's 2006 Targeted National Sewage Sludge Survey (U.S. EPA, 2009). Using sludge concentration from the 2006, final biosolids and amended soil concentration, conservative estimates were calculated assuming a liquid slurry application of biosolids was applied to agricultural fields with minimal reduction in concentration due to biological stabilization or biodegradation (*Environmental Media and General Population and Environmental Exposure for DEHP* (U.S. EPA, 2025s)). Annual application rates of biosolids ranged per application and frequency. Abiotic and biodegradation were assumed to be negligible following biosolids applications. The surface loading rate for spray or near surface injection applications range from 0.33 to 1,557 mg/m^2 while mixing applications ranged from 0.0013 to 6.25 mg/kg (1.86 – 8,755 mg/m^3) depending on the application rate, frequency, and applied biosolids concentration.

Terrestrial Vertebrates (Mammals)

Based on environmental monitoring and measured DEHP concentrations in soil, achieving a dose rate representative of the mammalian hazard threshold would be unlikely. Specifically, EPA conducted an assessment of risk to short-tailed shrew consuming earthworms from soil following biosolids application. Using the highest calculated topsoil concentration of 6.25 mg/kg following an agricultural application of biosolids on soybeans, EPA assumed 100 percent uptake by a worm, so that the concentration of DEHP in the earthworm is equivalent to the soil concentration. Comparing the resulting dose to a shrew with a food intake rate of 55 percent earthworms, to the hazard threshold of 80.79 mg/kg-day from a study of mice, the resulting RQ is less than 1 (4.43×10^{-2}). Furthermore, mean whole body earthworm samples from hayfields and pastures with a history of biosolid amendment ranged from approximately 0.15 to 0.29 mg/kg dw (Kinney et al., 2010), which is an order of magnitude lower than the calculated maximum of 6.25 mg/kg. Therefore, based on assumptions of environmental topsoil concentrations and food consumption, EPA has determined that DEHP is unlikely to result in risk for terrestrial mammals.

Terrestrial Invertebrates

Available terrestrial invertebrate studies identified through systematic review showed no effects of DEHP. Since no studies were available to quantitatively assess the hazard of DEHP to terrestrial invertebrates, a COC could not be calculated. Other studies either administered DEHP as an aqueous test solution that exceeded the limit of solubility, or the amount of DEHP administered to test organisms was unclear. Therefore, a hazard threshold could not be established for terrestrial invertebrates because of the uncertainty regarding exposure concentrations.

For terrestrial invertebrate exposure, EPA notes that mean whole body earthworm samples from hayfields and pastures with a history of biosolid amendment samples ranged from approximately 0.15 to 0.29 mg/kg dw (Kinney et al., 2010). Again, no hazard to terrestrial invertebrates was identified, as studies that assessed DEHP in invertebrates did not see effects up to and exceeding 5,000 mg/kg after 50 days (Jensen et al., 2001). Based on the absence of measurable effects in studies of terrestrial invertebrates exposed to soil concentrations approximately five orders of magnitude higher than soil concentrations from monitoring studies of soils with a history of biosoilds application, EPA has determined that DEHP is unlikely to result in risk for terrestrial invertebrates.

Birds

The avian hazard threshold was derived from pre-hatch DEHP egg injections in the chicken (*Gallus gallus domesticus*) which resulted in developmental malformations including gastroschisis and omphalocele in the hatched chicks resulting in a NOAEL/LOAEL of 5/20 mg DEHP/kg of egg (Abdul-Ghani et al., 2012). EPA derived an avian hazard threshold of 10 mg/kg of egg from egg injection using the geometric mean of the NOAEL (5 mg/kg of egg) and LOAEL (20 mg/kg of egg).. The study authors indicated that doses resulting in effects were extremely high and not expected in the natural environment, and the elevated levels of alkaline phosphatase noted during the biochemical evaluation reflected non-specific toxicity resulting from the high dose of DEHP. Behavioral effects at 100 mg/kg of egg were observed on chick imprinting behavior (Abdul-Ghani et al., 2012).

In addition to the avian hazard identified from the egg injection study (Abdul-Ghani et al., 2012), EPA identified hazards to birds via oral exposure. Although an oral avian hazard threshold has not been derived by EPA within the *Environmental Hazard Assessment for DEHP* (U.S. EPA, 2025r), two 45-day duration studies from literature reported effects from DEHP via oral gavage on the male and female Japanese quail (*Coturnix japonica*). In the first study, the effects of DEHP on cardiac histology, heat shock proteins, and heat shock transcription factors of juvenile male quail were investigated at 0, 250, 500, and 750 mg/kg-day via gavage for 45-days (Wang et al., 2019). At the end of the treatment period, histology indicated cardiac muscle fiber dilation (expansion) and cell necrosis which was accompanied by myocardial disorganization at the 500 and 700 mg/kg-day treatment groups. Abnormal myocardial cells were seen in the 500 mg/kg-day group, with authors indicating severe myocardial injury induced from DEHP exposure at this dose. The 250 mg/kg-day treatment resulted in histological observations of swelling of cells, dilation of muscle fibers, and pale staining in addition to significant increases in heat-shock factor and heat-shock protein expression within the heart (Wang et al., 2019). Heat shock protein and transcription factor expression were significantly affected for different types (increased or decreased expression) (Wang et al., 2019). The second study by the same authors evaluated the effects of DEHP nephrotoxicity on juvenile female Japanese quail at concentrations of 0, 250, 500, and 750 mg/kg-day via gavage for 45 days. At the end of the treatment period, histological changes occurred at all concentrations including a disorganized renal structure, a partially dilated glomerulus, renal interstitial congestion, and an atrophied Bowman's space. Renal tubular epithelial cells were unclear, and the study authors observed swelling of columnar epithelial cells. CYP450 activity was significantly affected for different types (increased or decreased expression) (Wang et al., 2020). These studies on Japanese quail indicate an unbounded LOAEL of 250 mg/kg, but given the effects are subapical, the NOAEL is likely not much lower.

An additional study on oral DEHP in birds was conducted in which chickens (*Gallus gallus domesticus*) were fed diets containing either 1 percent DEHP or 1 percent DEHP plus 5 percent tallow compared to control diets for 28 days (Wood and Bitman, 1980). The investigators did not report achieved dose; therefore, EPA estimated a mean achieved dose of approximately 578 mg/kg-day in the treated groups using the mean body weight data presented in a table and an interpolated estimate of the feed consumption presented in a graph from the publication (Wood and Bitman, 1980). However, the DEHP incorporated into the feed apparently altered palatability, with feed consumption significantly decreased by 10 percent compared to controls over the 4-week period. Egg production in the DEHP-treated group was not significantly different but decreased by 5 percent compared to controls over the 4-week period with no differences in body weight, egg weight, percent shell, white or yolk. Although there was an increase in liver lipids and cholesterol in the DEHP-treated group compared to controls, no significant effects were observed in chicken growth. This study was excluded from quantitative use in hazard determination due to significant apparent food aversion occurring in chicken exposed to DEHP in feed at this concentration, and some uncertainty around the estimation of the achieved dose of approximately 578 mg/kg-day.

Biota monitoring values of DEHP from both urban and remote sampling regions have reported concentrations orders of magnitude lower than concentrations used in the aforementioned avian hazard studies. Mackintosh et al. (2004) reported DEHP concentrations within liver tissue of a marine avian species, surf scoter (*Melanitta perspicillata*), from the urban False Creek Harbor in Vancouver, British Columbia, Canada, at a mean of 0.005 mg/kg ww. A comprehensive study on environmental pollutants within egg samples was conducted on seabird species within coastal Norway (Huber et al., 2015). Concentrations of DEHP recorded within pooled eggs of the European herring gull (*Larus argentatus*) ranged from 0.011 to 0.024 mg/kg of egg and 0.003 to 0.042 mg/kg of egg for European shag eggs (*Phalacrocorax aristotelis*) (Huber et al., 2015). DEHP concentrations in eggs from captive and free-ranging chickens were examined within Turkey's second-largest city, Ankara (Kuzukiran et al., 2018). Three different types of farm hen production practices; caged, free-range, and organic resulted in mean DEHP egg concentrations of 0.010, 0.003, and 0.008 mg/kg of egg, respectively, with a maximum concentration within the egg of 0.020 mg/kg of egg in both caged and organic eggs. Another study collected samples from failed peregrine falcon (*Falco peregrinus*) eggs within Germany as part of a large survey of pollutants and reported "traces of DEHP" with no concentration reported within the study (LOD = 0.001 mg/kg of egg (dry weight); (Schwarz et al., 2016)). Concentrations of DEHP have also been detected within tissues of birds collected from remote regions; the common eider (*Somateria mollissima*) collected from Kongsfjorden and the kittiwakes (*Rissa tridactyla*) from Kongsfjorden and Liefdefjorden had similar geometric means in their liver at 0.10 and approximately 0.11 mg/kg ww, respectively (Evenset et al., 2009).

Aquatic avian species are part of the upper trophic level in aquatic ecosystems with biomonitoring of this group and DEHP within components of eggs in oviparous aquatic animals playing an important role in understanding the landscape of this chemical in the environment. DEHP was measured in thirty sea turtle (*Caretta caretta*) eggs (shell, yolk, and albumin) from the Marine Protected Area of the Pelagie Islands in the Mediterranean Sea (Savoca et al., 2021). The eggs were collected from four different nests around the islands. The maximum eggshell, yolk, and albumen content of DEHP was 0.206, 0.276, and 0.052 mg/kg, respectively. Another study examined DEHP in Audouin's gull eggs (*Larus audouinia*) from four breeding colonies in coastal Spain (Oró-Nolla et al., 2024). In this study, DEHP was not detected in the eggs and the study authors suggested it may be because the minimum detection limit (MDL) was high (reported as 0.72 mg/kg of egg [wet weight] within table 2 of the publication) due to blank contribution from background sources of DEHP. Concentrations of various phthalates were measured in 13 European herring gull (*Larus argentatus*) eggs collected from seven nests at 3 semi-urban sites in Cornwall, UK (Allen et al., 2021). According to the report, only one of the 13 eggs from three different sample locations contained measurable amounts of DEHP at approximately 0.416 mg/kg of yolk. The DEHP metabolite, MEHP, was only detected in one egg sample but was reported at a concentration below the MDL, which was not reported or available within supplementary information. Another DEHP metabolite, MEOHP, was either not detected or was also detected within eggs at concentrations below the MDL. The authors indicated that phthalate ingestion and subsequent deposition in gull eggs may be variable over macro- and micro-geographic scales possibly due to local differences in exposure and foraging preferences (Allen et al., 2021). In summary, the measured phthalate concentrations found in eggs are two to four orders of magnitude lower than the avian hazard threshold 10 mg DEHP/kg of egg derived from the laboratory administered injection treatments of from Abdul-Ghani et al. (2012).

Section 12 of the *Environmental Media and General Population and Environmental Exposure Assessment for DEHP* details aquatic and terrestrial environmental biomonitoring, ADME, and trophic transfer potential which demonstrates that DEHP does not biomagnify and is characterized as demonstrating trophic dilution (U.S. EPA, 2025s). Exposure estimates can be derived for terrestrial invertebrates (earthworms [*Eisenia fetida*]) to oral DEHP uptake to an invertebrate eating bird (American woodcock [*Scolopax minor*]) using DEHP measured in biosolids during the 2008 EPA National Sewage Survey (U.S. EPA, 2009).ed in a maximum daily concentration for oral uptake of DEHP of 6.22 mg/kg-day. This DEHP from soil and prey for the insectivorous bird is two orders of magnitude (~40 times) lower than concentrations resulting in subapical effects (250 mg/kg-day) from chronic feeding studies in Japanese quail (Wang et al., 2020; Wang et al., 2019). Based on the weight of evidence, EPA has determined that exposure to DEHP is unlikely to result in risk for birds.

Terrestrial Plants

Two studies in terrestrial plant species were identified by EPA as relevant for quantitative assessment for the highest DEHP OES release to air (application of paints, coatings, adhesives, and sealants). The terrestrial plant hazard threshold of 10 mg/kg soil was the geometric mean of the NOAEC of 5.0 mg/kg soil and the LOAEC of 20 mg/kg soil based on effects on the growth of perennial ryegrass (*Lolium perenne*) after 72-hour exposure (Ma et al., 2015) (Table 5-7). The RQ was less than 1 for terrestrial plants exposed via air deposition (fugitive or stack release). Therefore, EPA has determined that DEHP is unlikely to result in risk for terrestrial plants.

Biosolids

Soil surface concentrations for biosolids were calculated from the minimum and maximum recommended application rates for each agricultural crop cover (in the *Environmental Media and General Population and Environmental Exposure for DEHP* (U.S. EPA, 2025s)). Concentrations of DEHP in biosolids were selected from the observed concentrations in biosolids measured during the 2008 EPA National Sewage Survey (U.S. EPA, 2009). Using the generic application scenarios and biosolids concentrations collected from the national survey, the maximum concentration of DEHP within topsoil resulted in an RQ of 0.62 for terrestrial plants (Table 5-8). Therefore, EPA has determined that DEHP is unlikely to result in risk for terrestrial plants.

Table 5-7. Risk Quotients (RQs) For Terrestrial Plants Based on Modeled Air Deposition of DEHP to Soil from Reported or Modeled Fugitive Emissions.

COU (Life Cycle Stage; Category; Subcategory)	OES	Annual Soil Concentration (mg/kg)	Hazard Value (mg/kg)	RQ
Commercial use; Furnishing, cleaning, and treatment care products; All-purpose waxes and polishes	Application of paints, coatings, adhesives, and sealants	3.0E−03	10	3.0E−04
Industrial Use; construction, paint, electrical, and metal products; Paints and coatings				
Commercial use; Construction, paint, electrical, and metal products; Adhesives and sealants				
Commercial use; Construction, paint, electrical, and metal products; Paints and coatings				
Commercial use; Furnishing, cleaning, and treatment care products; All-purpose waxes and polishes				

Table 5-8. Risk Quotients (RQs) For Terrestrial Plants Based on Biosolids Calculated Using Modeled Biosolid Land Application Data

Maximum Monitored Biosolid Concentration (mg/kg) from the 2008 EPA National Sewage Survey	Topsoil Concentration (mg/kg)	Hazard Value (mg/kg)	RQ
310	6.15	10	0.62

5.3.4 Risk Characterization Based on Trophic Transfer

DEHP 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. In the atmosphere, DEHP is unlikely to remain for long periods of time as it is expected to undergo photolytic degradation through reaction with atmospheric hydroxyl radicals, with estimated half-lives of 5.5 hours. DEHP is predicted to hydrolyze slowly at ambient temperature but is not expected to persist in aquatic media as it undergoes rapid aerobic biodegradation (see Section 2.2). DEHP has the potential to remain for longer periods of time in soil and sediments, but due to the inherent hydrophobicity (log K_{OW} = 7.60) and sorption potential (log K_{OC} = 5.51), DEHP is not expected to be bioavailable for uptake. Using the Level III Fugacity model in EPI Suite™ (LEV3EPI™) (see Section 2), DEHP's overall environmental half-life was estimated to be on the order of days to weeks (U.S. EPA, 2017). Therefore, DEHP is not expected to be persistent in the atmosphere, aquatic or terrestrial environments.

EPA did not conduct a quantitative analysis of DEHP food chain trophic transfer. Due to the physical and chemical properties, environmental fate, and exposure parameters of the chemical, DEHP is not expected to persist in surface water, groundwater, or air. Based on the log K_{OC} of 5.41 to 5.95 and low reported BCF values of 0.05 to 114, DEHP is expected to have low bioaccumulation potential, no apparent biomagnification potential, and low potential for uptake overall. DEHP is expected to degrade rapidly via direct and indirect photolysis and has an environmental biodegradation half-life in aerobic environments on the order of days to weeks. Further, DEHP is not subject to long range transport and transforms in the environment via biotic and abiotic processes to form monoisononyl phthalate, isononanol, and phthalic acid. DEHP shows strong affinity and sorption potential for organic carbon in soil and sediment. Approximately 64 percent of the DEHP present in wastewater is expected to be accumulated in sewage sludge and released with biosolids disposal or application, and the remaining fraction is sorbed to suspended solids in wastewater treatment effluent and discharged with surface water (U.S. EPA, 1982). DEHP may persist in sediment, soil, biosolids, or landfills after release to these environments, but bioavailability is expected to be limited. The estimated BCF/BAF suggest DEHP does not meet the criteria to be considered bioaccumulative (BCF/BAF > 1,000), and bioaccumulation and bioconcentration in aquatic and terrestrial organisms are not expected to be important environmental processes (U.S. EPA, 2012c).

Concentrations of DEHP in soil following agricultural application of municipal biosolids were not identified from TRI or the NEI release data nor were any monitoring studies identified during systematic review. As such, DEHP concentrations in soil were estimated using the concentrations identified in sludge, ranging from 0.657 to 0.31 mg/kg (U.S. EPA, 2009). The maximum biosolid topsoil concentration was estimated at 6.15 mg/kg based on application to soybeans (*Environmental Media and General Population and Environmental Exposure for DEHP* (U.S. EPA, 2025s)). The mammalian hazard threshold was 80.79 mg/kg-day in the *Environmental Hazard Assessment for DEHP* (U.S. EPA, 2025r). Terrestrial organisms, such as mammals, would need to consume a considerable over 13 kg of DEHP-tainted soil or prey items to reach the threshold for toxicity.

Given the reasonably available data, EPA has robust confidence that that DEHP is not readily found, or if found, is in relatively low concentrations in organism tissues, and that DEHP has low bioaccumulation and biomagnification potential in aquatic and terrestrial organisms, and thus low potential for trophic transfer through food webs. The conclusion that DEHP does not biomagnify is supported by the estimated BCF, BAF, BSAF, and TMF values and studies specifically centered on the characteristics of trophic transfer of DEHP and other phthalates. This conclusion is consistent with observations made for other phthalates with measured BCF/BAFs such as DIDP, DINP, DBP, DIBP, and DCHP.

5.3.5 Overall Confidence and Remaining Uncertainties in Environmental Risk Characterization

5.3.5.1 Risk Characterization Confidence

The overall confidence in the risk characterization combines the confidence from the environmental exposure, hazard threshold, and trophic transfer sections. This approach aligns with *Draft Systematic Review Protocol Supporting TSCA Risk Evaluations for Chemical Substances* (U.S. EPA, 2021a) and *Systematic Review Protocol for DEHP* (U.S. EPA, 2025ak). Confidence was evaluated from environmental exposures and environmental hazards. Hazard confidence was represented by evidence type as reported previously in the *Environmental Hazard Assessment for DEHP* (U.S. EPA, 2025r). Exposure confidence has been synthesized from Section 3 and is further detailed within Section 5.1. All studies that factored into the environmental hazard and environmental media section received an overall quality determination of high or medium. Synthesis of confidence for exposure and hazard resulted in the following confidence for risk characterization:

- chronic aquatic risk characterization – robust confidence that EPAs assessment is protective; there is uncertainty with regards to the magnitude of overestimation;

- chronic benthic risk characterization – moderate confidence due to only one study with a hazard threshold below 3 ug/L;
- terrestrial plant risk characterization evidence based on air deposition – robust confidence based on IIOAC-modeled results, assumptions and number of terrestrial plant hazard studies; and,
- terrestrial plant risk characterization evidence based on biosolid land application – moderate confidence based on calculated values from 2008 EPA National Sewage Survey (U.S. EPA, 2009).

RQ Inputs for Aquatic and Benthic Assessments

Combining the robust confidence for the TRI-modeled surface water and benthic pore water sediment DEHP concentrations with robust hazard confidences for aquatic and benthic assessments (robust and robust, respectively) resulted in robust confidence that EPAs assessment is protective, however, there is uncertainty with regards to the magnitude of overestimation for chronic aquatic and benthic assessments (see Table 5-4 and Table 5-5).

This is supported by seven chronic pelagic aquatic studies demonstrating effects of DEHP on growth, development, mortality, and reproduction at concentrations less than the limit of solubility of 3.0 µg/L to be representative of non-colloidal water solubility. Two studies in which effects on mortality, growth, and development were observed in Japanese medaka exposed to 0.1 µg/L DEHP for 21-day (Chikae et al., 2004a; Chikae et al., 2004b) were chosen as the critical studies to base the COC derivation on. These studies were further supported with chronic hazard studies conducted by Golshan et al. (2015), Corradetti et al. (2013), and Zanotelli et al. (2010) since these additional studies also evaluated effects on mortality, growth, reproduction, and development although these studies showed effects at sometimes higher concentrations ranging from 0.01 to 10 µg/L and exposure durations ranging from 21 to 91 days. An additional study identified effects on reproduction including at the lowest test concentration resulting in a NOAEC and LOAEC of less than 3.0 and 3.0 µg/L, respectively (Mayer Jr et al., 1973).

For sediment-dwelling invertebrates, EPA has moderate confidence based on effects observed on growth and development. This confidence is supported by one study in which effects on growth were observed in midge exposed to 0.3 µg/L DEHP (Kwak and Lee, 2005). However, since a LOAEC was used in the COC, there is uncertainty regarding the actual hazard value for this group. Although not used for COC determination, a pelagic invertebrate study with the marine copepod (*Parvocalanus crassirostris*) also showed effects around a similar threshold of less than 0.3 µg/L (Heindler et al., 2017). This study was not considered for COC calculations due to analytical measurement concerns and background concentrations of DEHP. Previous studies have used analytical methods, such as gas chromatography and gas chromatography-mass spectroscopy, to determine concentrations of DEHP within aquatic media at limits of detection of 2.0×10^{-4} µg/L and above (Wang and Kannan, 2023; Giam et al., 1978). The EPA method for measuring phthalates in water is 8061A SW846, with a method detection limit (MDL) for DEHP of 0.27 µg/L (U.S. EPA, 1998b).

The different PSC release scenarios (described in Section 5.3.2) were used to estimate and quantify concentrations of DEHP within surface water and sediment. PSC considers model inputs of physical and chemical properties of DEHP (*i.e.*, K_{OW}, K_{OC}, water column half-life, photolysis half-life, hydrolysis half-life, and benthic half-life) and allows EPA to estimate sediment concentrations. The use of vetted physical and chemical properties of DEHP increases confidence in the application of the PSC model. Only the chemical release amount, days-on of chemical release, and the receiving water body hydrologic flow were changed for each COU/OES. EPA used TRI-reported releases for estimating surface water concentrations and resulting environmental risk for OES when available as shown in Table 5-4 and

Table 5-5. When TRI-reported releases were not available for an OES, EPA modeled releases using generic scenarios which were used to estimated surface water concentrations and resulting risk as shown in Table 5-6. As presented in Section 3.3.1.1, the application of TRI-reported release data from actual facilities provides high confidence in the annual release estimates. Facility releases are paired with receiving waterbodies reported through NPDES permits, and flow statistics are calculated from the NHDPlus V2.1 EROM flow database, based on gage-adjusted modeled hydrologic flows. TRI-reported releases are based on releases to surface water at the external outfall of a releasing facility and therefore include any treatment or removal from onsite wastewater processes. TRI data were used to model DEHP concentrations (Table 5-3). These concentrations tend to fall within the high-end or maximum monitored water concentrations of DEHP from different monitoring programs shown in Table 5-1 and Table 5-3. It should be noted that DEHP was monitored relatively infrequently in surface and groundwater in three of the four monitoring studies shown in Table 5-1 and because summary statistics were not provided for the various monitoring studies, it makes relating modeled concentrations against monitoring data a very general comparison. Overall confidence in the estimated environmental concentrations modeled from these reported releases is moderate.

For OES that did not have reported releases, EPA modeled releases using generic scenarios. For the PSC release scenarios modeled using generic scenarios, in lieu of facility-specific receiving water body information for DEHP, flow statistics were drawn from a generic distribution of receiving water body flow rates derived from receiving water bodies listed on NPDES permits for facilities with relevant NAICS codes. The modeled distribution of hydrological flow data is specific to an industry sector rather than a single facility but provides a reasonable estimate of the distribution of location-specific values. The complete methods for retrieving and processing flow data by NAICS code are detailed in Appendix B of the *Environmental Media and General Population and Environmental Exposure for DEHP* (U.S. EPA, 2025s). Releases modeled using generic scenarios were paired with the generic receiving water body flow rate to model DEHP concentrations (Table 5-6). These concentrations are higher than any monitored water concentrations of DEHP from different monitoring programs shown in Table 5-1. EPA has slight confidence in the environmental concentration and resulting RQs modeled using generic scenarios, but moderate confidence that it is an upper bound estimate as the concentrations are higher than any monitored value and concentrations resulting from actual reported releases.

Concentrations of DEHP within the surface and pore water were estimated using the highest 2015 to 2020 annual releases and estimates of 7Q10 hydrologic flow data for the receiving water body that were derived from NHD-modeled EROM flow data. The 7Q10 flow represents the lowest 7-day flow in a 10-year period for examining a condition where a potential contaminant may be predicted to be elevated due to periodic low-flow conditions.

EPA acknowledges there are remaining uncertainties with regards to the aquatic assessment. There is minimal risk to aquatic organisms on an acute exposure basis. On a chronic exposure basis above the limit of solubility (3.0 µg/L) where colloidal suspensions may form, studies both showed effects and no effects. These studies, however, were not included in the development of the RQ given the testing above water solubility introduces uncertainties in the testing and does not follow standard toxicity testing guidance (OECD, 2019; U.S. EPA, 2016a). Additionally, selecting the most conservative value as the hazard threshold along with the inclusion of an AF of 10 may result in an overly-protective COC.

RQ Inputs for Terrestrial Plant Assessments

EPA has robust confidence in the terrestrial plants hazard value due to the number of terrestrial plant endpoints with ecologically relevant endpoints and well-represented terrestrial plant data (two terrestrial plant studies that identified effects of DEHP on plant growth in six plant species; (Gao et al., 2018; Ma et al., 2015)). In perennial ryegrass, root elongation and seedling growth significantly decreased by 9 and 22 percent, respectively, at 20 mg/kg DEHP resulting in 72-hour NOAEC/LOAEC of 5.0/20 mg/kg soil (dry weight). However, both root elongation and seedling growth increased at higher concentrations of DEHP (100 and 500 mg/kg DEHP). In the radish, root elongation and seedling growth were found to be significantly increased, compared to controls, at all tested concentrations. In alfalfa, root elongation and seedling growth were both significantly decreased at all treated concentrations (5 mg/kg soil and above). In wheat, root elongation was decreased in all treated groups (5 mg/kg soil and above), but seedling growth was only decreased at the low concentration (5 mg/kg soil). At 5.0 mg/kg soil DEHP, alfalfa root length and seedling growth decreased by 25 and 7 percent, respectively, and by 10 and 6 percent, respectively, in bread wheat (Ma et al., 2014).

EPA has moderate confidence in the IIOAC-modeled results used to characterize exposures and deposition rates. Inputs (*e.g.*, maximum estimated ambient air release) and assumptions (*e.g.*, 100 m from a facility with no annual degradation) were included in modeling parameters. Soil concentrations of DEHP from land application of biosolids were not quantitatively assessed as DEHP was expected to have limited persistence potential and mobility in soils receiving biosolids. Concentrations of DEHP in soil following agricultural application of municipal biosolids were not identified from TRI or NEI release data nor were any monitoring studies identified during systematic review. As such, DEHP concentrations in soil were estimated using the concentrations identified in sludge concentrations in accordance with 40 CFC Part 503, *Standards for the Use of Disposal of Sewage Sludge.* Uncertainties in the soil concentration resulting from land application of biosolids containing DEHP result in slight confidence for exposure estimates of DEHP from soil.

Combining the moderate exposure confidence for the calculated soil based on IIOAC modeling of DEHP air deposition from TRI-reported fugitive emissions with the robust hazard confidence for hazard to terrestrial plants resulted in overall confidences of robust and moderate in the RQ inputs for the terrestrial plant exposed via air deposition and biosolid application, respectively (Table 5-7 and Table 5-8). Confidence and uncertainties in environmental hazard and environmental exposure estimates from PSC have been described in Section 5 of the *Environmental Hazard Assessment for DEHP* (U.S. EPA, 2025r) and Section 4.3.1 of the *Environmental Media and General Population and Environmental Exposure for DEHP* (U.S. EPA, 2025s), respectively.

Table 5-9 represents receptors for which qualitative risk characterization was performed. Within the aquatic environment a qualitative assessment was performed with the exposure pathway for surface water including receptors for acute exposure to aquatic organisms, aquatic plants, and algae. A qualitative assessment of soil includes terrestrial invertebrates for which exposure studies did not determine a hazard value for these taxa within a soil medium. Risk to avian species and mammals was assessed qualitatively.

Table 5-9. Evidence Table for Qualitative Risk Characterization to Specific Receptor Groups

Receptors	Exposure	Hazard[a]	Trophic Transfer[b]	Qualitative Assessment
Acute aquatic assessment	EPA has high confidence in quantifying a high-end estimated concentration at the point of release as reporting data for actual facilities were used and many conservative assumptions, such as the assumption that there is no removal of DEHP prior to release in surface water, was applied to the modeling. TRI data from the COU/OESs with the highest and lowest resulting concentrations within surface water and pore water were used to represent upper and lower bounds with water releases of DEHP.	EPA has robust confidence that acute DEHP exposure poses no hazard up to and exceeding the limit of water solubility.	Investigations on DEHP consistently present evidence that DEHP has low bioaccumulation potential and exhibits trophic dilution within aquatic ecosystems (Burkhard et al., 2012). The case study presented within Burkhart et al. (2012) further supports the weight of evidence that DEHP does not biomagnify, partially due to the crucial role of biotransformation resulting in trophic dilution across trophic levels. EPA has robust confidence that DEHP has limited bioaccumulation and bioconcentration potential based on its physical, chemical, and fate properties, biotransformation, and biomonitoring data.	Hazard thresholds from acute DEHP exposures were not identified within invertebrates or vertebrates nor were hazard thresholds identified for aquatic plants or algae. EPA has robust confidence in the acute aquatic assessment and moderate confidence in the algal and aquatic plants assessment. Unlike chronic exposures, DEHP is not likely to pose risk to aquatic vertebrates and invertebrates on an acute exposure basis and aquatic plants and algae.
Algal and aquatic plants assessment		EPA has robust confidence that DEHP exhibits low hazard potential to aquatic plants and algae. Available aquatic plant and algae hazard studies were not able to identify acute hazard thresholds for DEHP below the limit of solubility.		
Terrestrial invertebrate assessment	EPA has moderate confidence in the IIOAC-modeled results used to characterize exposures and deposition rates. DEHP present in soil through the application of biosolids or otherwise introduced to topsoil has limited mobility within the soil column. High-quality biodegradation rates and physical and chemical properties suggest that DEHP will have limited persistence potential and mobility in soils receiving biosolids.	Studies that assessed DEHP in soil invertebrates (springtails) did not see effects up to and exceeding 5000 mg/kg after 50 days (Jensen et al., 2001). Other studies performed on nematodes administered DEHP as an aqueous test solution that exceeded the limit of solubility, or the amount of DEHP administered to test organisms was unclear.	Investigations on DEHP consistently present evidence that DEHP has low bioaccumulation potential and exhibits trophic dilution within aquatic ecosystems (Burkhard et al., 2012). The case study presented within Burkhart et al. (2012) further supports the weight of evidence that DEHP does not biomagnify, partially	EPA has moderate confidence that reasonably available information on DEHP in soil concentrations from air deposition and environmental monitoring; in combination with the absence of hazard studies with measurable effects from chronic DEHP exposure provide evidence that DEHP is unlikely to pose risk to terrestrial invertebrates.
Avian assessment	DEHP concentrations found in eggs of wild bird populations are two to	The avian hazard threshold was derived from pre-hatch DEHP		EPA has moderate confidence that the

Receptors	Exposure	Hazard[a]	Trophic Transfer[b]	Qualitative Assessment
	four orders of magnitude lower than NOAEL/LOAEL observed in the laboratory administered egg injection DEHP treatments of 5/20 mg/kg of egg in chicken eggs by Abdul-Ghani (2012). Due to the high confidence in the biodegradation rates and physical and chemical data, there is robust confidence that DEHP in soils will not be mobile and will have low persistence potential. The existing literature suggests that DEHP present in biosolid amended soils will likely not be absorbed by any plants or crops growing in the soil.	egg injections, resulted in a 10 mg DEHP/kg of egg avian hazard threshold from developmental effects in chicks (*Gallus gallus domesticus*) (Abdul-Ghani et al., 2012). Two chronic oral studies in quail have indicated hazards to cardiac and kidney tissue with NOAEL and LOAEL at less than 250 and 250 mg/kg-day, respectively (Wang et al., 2020; Wang et al., 2019).	due to the crucial role of biotransformation resulting in trophic dilution across trophic levels. EPA has robust confidence that DEHP has limited bioaccumulation and bioconcentration potential based on its physical, chemical, and fate properties, biotransformation, and biomonitoring data.	qualitative assessment presented within Section 5.3.3 of the current environmental risk characterization and reasonably available information indicates that DEHP is unlikely to pose risk to birds based on concentrations via biomonitoring, limited trophic transfer, and measured DEHP concentrations within the environment compared to the avian hazard values from reasonable available literature
Mammalian assessment	Oral intake of DEHP would be the expected route of exposure for mammals. Using the highest estimated topsoil concentration of 6.15 mg/kg following an agricultural application of biosolids on soybeans, assuming a 100% uptake by a worm (food source) then ingested by a short-tailed shrew with a food intake rate of 55%, and a TRV of 80.79 mg/kg-bw/d, the resulting RQ is less than 1 (4.32E−02).	Twenty-six laboratory rat and mouse studies were assessed with the most sensitive (lowest LOAEL) ecologically-relevant endpoint chosen to represent the terrestrial mammalian hazard threshold. The terrestrial mammalian COC that was determined was 80.79 mg/kg-bw/d based on decreased pup survival during lactation (Tanaka, 2002).		EPA has robust confidence that reasonably available information indicates that DEHP would not be present within biota, prey, or environmental media at concentrations that produce hazard within mammals and is unlikely to pose risk to mammals.
[a] Overall confidence for each receptor as presented within Apx B-2 from the *Environmental Hazard Assessment for DEHP* (U.S. EPA, 2025r). [b] Robust overall confidence that DEHP has limited bioaccumulation and bioconcentration potential as presented within Section 12 of the *Environmental Media and General Population and Environmental Exposure for DEHP* (U.S. EPA, 2025s).				

5.3.6 Summary of Environmental Risk Characterization

Aquatic Organisms - Chronic

TRI data from the COU/OESs with the highest and lowest resulting concentrations within surface water and pore water were used to represent bounds that encompass all COU/OESs with water releases of DEHP. Direct releases to surface water reported via TRI and DMR were applied as the actual loading to surface water, including any onsite treatment prior to discharge. The higher bound release included the OES of Plastic compounding and resulted in the highest environmental concentration for the aquatic environment (Table 3-7). The OES of Plastic converting resulted in the lowest environmental concentration for the aquatic environment and thus served as a lower bound of the assessment for TRI based releases (Table 5-4). Surface water concentrations were modeled using the TRI/DMR data for loading to surface water and several different flow estimates as described previously.

DEHP concentrations modeled with generic scenarios or for discharges to multiple media in the same OES (*i.e.*, surface water, non-POTW, indirect discharge to POTW, emissions via fugitive or stack air, treatment via incinerations) were assessed qualitatively. The use of hydraulic fracturing OES is a generic scenario with a surface water release while two other OESs (use of laboratory chemicals [liquid], use of laboratory chemicals [solid], and use of automative care products) detail environmental releases that discharge to a combination of surface water, incineration, or landfill. For chronic exposure to DEHP with aquatic organisms, surface and pore water concentrations of DEHP modeled for the Use of Automotive Care Products OES resulted in concentrations within the bounds of the lowest and highest DEHP concentrations from TRI releases and also result in RQs greater than 1 without and with treatment removal efficiencies from POTWs (Table 5-6).

Risk quotients were calculated for chronic aquatic exposures based on COCs for aquatic organisms described within Section 0. For the aquatic assessment, all RQs calculated from site-specific TRI surface water releases previously detailed as resulting in the highest and lowest DEHP concentrations were greater than one (Table 5-4). For the benthic assessment, the OES resulting in the highest concentrations of DEHP in pore water (Plastic compounding) resulted in RQs greater than one, while the OES resulting in the lowest concentration of DEHP in pore water resulted in an RQ of 0.77 when using the 7Q10 flow rate (Table 5-5). Furthermore, for the benthic assessment, all other facilities reporting releases results in pore water concentrations above the COC for sediment invertebrates, thus resulting in RQs greater than 1.

EPAs aquatic risk assessment includes multiple inputs that align with long standing EPA practices (*i.e.*, use of 7Q10 from EPA Office of Water's Water Quality Standards Handbook). However, EPA recognizes the combination of these inputs may lead to RQs which are potentially overestimates for some scenarios. Table 5-4 provides alternative inputs from TRI based COUs resulting in upper and lower bounds of DEHP concentrations at varying flow conditions while Table 5-6 provides resulting RQs with alternative inputs from Generic Scenario releases. Table 3-1 in the *Environmental Hazard Assessment for DEHP* (U.S. EPA, 2025r) provides hazard values based on NOAEC and LOAEC concentrations from chronic exposures of DEHP to aquatic vertebrates and invertebrates at or below 3 µg/L (guideline measured study represented within the *Physical and Chemical Property Assessment and Fate and Transport Assessment for DEHP* (U.S. EPA, 2025af)). Appendix A presents hazard studies above 3 µg/L with review of these results presented within Section 0 of the current DEHP Environmental Risk Assessment. The following numbered bullets identify specific scientific areas impacting the interpretation of the RQs:

1) TRI releases are site specific as detailed within Section 3.3.1.1 of the current DEHP Risk Assessment. Since TRI data from the COU/OESs with the highest and lowest resulting

concentrations within surface water and pore water were used to represent bounds that encompass all COU/OESs with water releases of DEHP; these results indicate that all COUs result in DEHP concentrations greater than COCs for chronic exposures to aquatic organisms.

2) Flow data are geospatially linked to TRI data. The 7Q10 (Table 5-1 of the EPA's Water Quality Standards Handbook) is standard practice for aquatic life, however, EPA acknowledges that it represents a conservative low flow condition. The DEHP concentration for plastic compounding OES 7Q10 and 30Q5 are 17.6 and 11.2 µg/l, respectively, with the harmonic mean of 4.3 µg/L. The DEHP concentration for plastic converting OES, which represent the lower bound of all COU/OESs resulted in 7Q10 and 30Q5 of 0.045 and 0.034 µg/l, respectively, with a harmonic mean of 0.023 µg/L.

3) EPA investigated the removal efficiencies of priority pollutants within 50 wastewater treatment facilities in the U.S. The study reported a median DEHP removal of 64 percent in WWTPs employing activated sludge systems (U.S. EPA, 1982). DEHP removals of 61.7, 75, and 93 percent have been reported in WWTPs employing activated sludge systems in Canada, Hong Kong, and Denmark, respectively (Wu et al., 2017; Osachoff et al., 2014; Roslev et al., 2007). EPA acknowledges that treatment removal of DEHP are represented across a range of wastewater removal efficiencies within the literature, the value of 64 percent removal was selected as a conservative removal value for U.S. WWTPs based on the discussion and confidence presented in the *Physical and Chemical Property Assessment and Fate and Transport Assessment for DEHP* (U.S. EPA, 2025af). RQs were derived with and without removal efficiency.

4) Derivation of a Concentration for Concern for chronic aquatic vertebrates used a geometric mean of the most sensitive studies NOAEC and LOAEC values (Chikae et al., 2004a; Chikae et al., 2004b). In total, eight chronic aquatic studies have reported endpoints less than 3.0 µg/L with organism level effects on growth, reproduction, and development. As shown in Appendix A of the *Environmental Hazard Assessment for DEHP* (U.S. EPA, 2025r) and summarized within Section 0 of the current Environmental Risk Assessment, there are several chronic exposure studies with concentrations above 3 µg/L that show impacts on apical level endpoints such as but not limited to survival, growth, reproduction, and development. For example, six non-dietary chronic fish studies that showed no effects ranging from 12 to 5,000 µg/L, five studies demonstrated effects at greater than 3.0 µg/L with NOAECs and LOAECs ranging from 1 and 10 µg/L to 100 and 500 µg/L, respectively, and four with effects at the lowest test concertation but greater than 3.0 µg/L resulting in an unbounded LOAEC ranging from less than 0.5 to less than 20 µg/L.

5) Published values for DEHP water solubility vary greatly within published literature and the relationship between hazard thresholds and solubility limits are often unclear. The EPA extracted and evaluated 44 data sources containing DEHP water solubility information. Twenty-one of these studies were identified and evaluated as overall high-quality data sources. The overall high-quality data sources identified water solubility values for DEHP ranging from 0.06 µg/L at 12 °C to 400 µg/L at 25 °C (Mitsunobu and Takahashi, 2006; Boese, 1984). The EPA selected a representative non-colloidal water solubility of 3 µg/L for DEHP (Elsevier, 2021) for use in the risk assessment. This value was chosen to represent the range of non-colloidal water solubilities extracted from numerous data sources and is also the most commonly cited representative value for the non-colloidal water solubility of DEHP in all of the extracted primary and secondary data sources. This water solubility was chosen to represent the distribution of DEHP in the environment and aqueous media.

These choices on the risk inputs and availability of information may account for the variability between the designated limits for DEHP derived by other regulatory agencies (for review see Section 6.2.2).

Aquatic Organisms – Acute

Hazard thresholds from acute DEHP exposures were not identified within aquatic invertebrates or vertebrates nor were hazard thresholds identified for aquatic plants or algae. EPA has robust confidence in the acute aquatic assessment and moderate confidence in the algal and aquatic plants assessment. DEHP is unlikely to pose risk to aquatic vertebrates and invertebrates on an acute exposure basis, and aquatic plants and algae.

Although there was no hazard threshold identified from chronic DEHP exposure for aquatic invertebrates in the water column, the results of quantified risk estimates using COCs representing chronic DEHP exposures to fish and sediment-dwelling invertebrates adds to the weight of scientific evidence supporting the identification of risk to the aquatic environment for this chemical. Based on surface water concentrations of DEHP and COCs for hazard to aquatic organisms, EPA expects that all COUs represented by analysis would result in DEHP concentrations that produce harm to fish and sediment-dwelling invertebrates (Table 5-10).

Terrestrial Plants

An assessment to examine air releases and subsequent air to soil deposition was employed to produce quantified risk estimates for terrestrial plants. The OES with the highest fugitive or stack air release, was application of paints, coatings, adhesives, and sealants and was used in the determination of risk of DEHP air deposition to soil. The RQ value from this assessment was less than one (Table 5-7). Using the generic application scenarios and biosolids concentrations collected from the national survey, the maximum concentration of DEHP within topsoil resulted in an RQ of 0.62 for terrestrial plants (Table 5-8). DEHP is expected to have limited persistence potential and mobility in soils receiving biosolids. EPA has robust and moderate confidence in the risk characterization RQ inputs for the terrestrial plant assessment for air deposition to soil and biosolid land application, respectively. EPA expects DEHP would not produce hazards within terrestrial plants from air to soil deposition or the application of biosolids.

Mammals

Risk to terrestrial mammals from DEHP exposure through ingestion of terrestrial invertebrates is expected to be limited and not approach the hazard threshold of 80.79 mg/kg-bw/d. Using the highest estimated topsoil concentration of 6.15 mg/kg following an agricultural application of biosolids on soybeans, assuming a 100 percent uptake by a worm (food source) then ingested by a short-tailed shrew with a food intake rate of 55 percent, and a TRV of 80.79 mg/kg-day, the resulting RQ is less than 1 (4.32×10^{-2}). EPA has robust confidence that DEHP has limited bioaccumulation and bioconcentration potential based on its physical, chemical, and fate properties, biotransformation, and the empirical metrics of bioaccumulation metrics. EPA has robust confidence that reasonably available information indicates that DEHP would not be present within biota, prey, or environmental media approaching concentrations that produce hazard within mammals and is unlikely to pose risk to mammals.

Birds

The avian hazard threshold was derived from developmental malformations including gastroschisis and omphalocele in chicks (*Gallus gallus domesticus*) hatched following DEHP injection into the albumen of an egg, resulting in a NOAEL/LOAEL of 5/20 mg/kg of egg (Abdul-Ghani et al., 2012). EPA is using the geometric mean of the NOAEL/LOAEL of 10 mg/kg of egg for the avian hazard threshold. However, this dosage exceeds environmentally relevant concentrations. The measured phthalate concentrations found in eggs of wild bird populations in monitoring studies are orders of magnitude lower than that used in the laboratory administered egg injection treatment. Furthermore, EPA has robust confidence that DEHP has limited bioaccumulation and bioconcentration potential based on empirical bioaccumulation data and on its biotransformation and physical, chemical, and fate properties. EPA has moderate confidence in the qualitative assessment presented within Section 5.3.3 of the current environmental risk characterization. Reasonably available information indicates that DEHP is unlikely to pose risk to birds based on low exposure levels indicated by biomonitoring, limited trophic transfer, and measured DEHP concentrations in the environment compared to the avian hazard value.

Terrestrial Invertebrates

No studies were available to quantitatively assess the hazard of DEHP to terrestrial invertebrates. Available invertebrate studies identified through systematic review showed no effects from DEHP exposure up to 5,000 mg/kg (Section 5.3.3), four orders of magnitude higher than concentrations detected in earthworms from soils amended with biosolids. EPA has moderate confidence that reasonably available information on DEHP in soil concentrations from air deposition and environmental monitoring; in combination with the absence of hazard studies with measurable effects from chronic DEHP exposure provide evidence that DEHP is unlikely to pose risk to terrestrial invertebrates.

Table 5-10. Environmental Risk Summary and Basis for Quantified Risk Characterization

COU (Life Cycle Stage; Category; Subcategory)	Occupational Exposure Scenario (OES)	Basis for Risk Characterization for Aquatic Receptors	Basis for Risk Characterization for Terrestrial Receptors (Air Deposition to Soil)
Manufacture; Domestic manufacturing; Domestic manufacturing	Manufacture	Concentration is within the highest and lowest bounded values from TRI releasers	Included in screening level assessment
Processing; Incorporation into article; Plasticizer in basic organic chemical manufacturing; plastics product manufacturing; rubber product manufacturing; miscellaneous manufacturing; PVC extruding	Rubber manufacturing	Concentration is within the highest and lowest bounded values from TRI releasers	Included in screening level assessment
Processing; Incorporation into formulation, mixture, or reaction product; Plasticizer in basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint and coating manufacturing; adhesive manufacturing; plastic material and resin manufacturing; synthetic rubber manufacturing; all other basic inorganic chemical manufacturing; wholesale and retail trade; services; ink, toner and colorant manufacturing			
Processing; Incorporation into article; Plasticizer in basic organic chemical manufacturing; plastics product manufacturing; rubber product manufacturing; miscellaneous manufacturing; PVC extruding	Plastic converting	COU resulting in the lowest concentrations and serves as the lowest bound for this assessment [a]; RQ >1	Included in screening level assessment
Industrial use; Other uses; Solid rocket motor insulation and other aerospace applications; Automotive articles			
Processing; Incorporation into formulation, mixture, or reaction product; Plasticizer in basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint and coating manufacturing; adhesive manufacturing; plastic material and resin manufacturing; synthetic rubber manufacturing; all other basic inorganic chemical manufacturing; wholesale and retail trade; services; ink, toner and colorant manufacturing	Plastic compounding	COU resulting in the highest environmental concentration and serves as the highest bound for this assessment[a]; RQ >1	Included in screening level assessment
Processing; Incorporation into formulation, mixture, or reaction product; Plasticizer in basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint and coating manufacturing; adhesive manufacturing; plastic material and resin manufacturing; synthetic rubber manufacturing; all other basic inorganic chemical manufacturing; wholesale and retail trade; services; ink, toner and colorant manufacturing	Incorporation into formulation, mixture, or reaction product	Concentration is within the highest and lowest bounded values from TRI releasers	Included in screening level assessment

COU (Life Cycle Stage; Category; Subcategory)	Occupational Exposure Scenario (OES)	Basis for Risk Characterization for Aquatic Receptors	Basis for Risk Characterization for Terrestrial Receptors (Air Deposition to Soil)
Processing; Other uses; Miscellaneous processing (cyclic crude and intermediate manufacturing; processing aid specific to hydraulic fracturing)			
Manufacture; Importing; Importing	Import and repackaging	Concentration is within the highest and lowest bounded values from TRI releasers	Included in screening level assessment
Processing; Repackaging; Repackaging in wholesale and retail trade and in paint and coating manufacturing			
Commercial use; Furnishing, cleaning, and treatment care products; All-purpose waxes and polishes	Application of paints, coatings, adhesives, and sealants	Concentration is within the highest and lowest bounded values from TRI releasers	COU resulting in highest environmental concentration for air to soil deposition and serving as a screening level assessment[b]; RQ <1
Industrial Use; Construction, Paint, Electrical, and Metal products; Paints and Coatings			
Commercial use; Construction, paint, electrical, and metal products; Adhesives and sealants			
Commercial use; Construction, paint, electrical, and metal products; Paints and coatings			
Commercial use; Furnishing, cleaning, and treatment care products; All-purpose waxes and polishes			
Commercial use; Furnishing, cleaning, and treatment care products; Fabric, textile, and leather products; furniture and furnishings	Textile finishing	Concentration is within the highest and lowest bounded values from TRI releasers	Included in screening level assessment
Commercial use; Furnishing, cleaning, and treatment care products; Fabric enhancer			
Commercial use; Construction, paint, electrical, and metal products; Batteries and capacitors	Fabrication or use of final product or articles	No water releases	Included in screening level assessment
Commercial use; Construction, paint, electrical, and metal products; Construction and building materials covering large surface areas, including paper articles; metal articles; stone, plaster, cement, glass and ceramic articles			
Commercial use; Construction, paint, electrical, and metal products; Machinery, mechanical appliances, electrical; electronic articles			
Commercial use; Automotive, fuel, agriculture, and outdoor use products; Lawn and garden care products			
Commercial use; Packaging, paper, plastic, toys, hobby products; Packaging (excluding food packaging) and other articles with routine direct contact during normal use, including paper articles; rubber articles;			

COU (Life Cycle Stage; Category; Subcategory)	Occupational Exposure Scenario (OES)	Basis for Risk Characterization for Aquatic Receptors	Basis for Risk Characterization for Terrestrial Receptors (Air Deposition to Soil)
plastic articles (hard); plastic articles (soft); Packaging (excluding food packaging), including paper articles	Fabrication or use of final product or articles	No water releases	Included in screening level assessment
Commercial use; Packaging, paper, plastic, toys, hobby products; Toys, playground, and sporting equipment			
Commercial use; Furnishing, cleaning, and treatment care products; Floor coverings; construction and building materials covering large surface areas including stone, plaster, cement, glass and ceramic articles fabrics, textiles, and apparel			
Commercial use; Other uses; Automotive articles and products			
Commercial use; Packaging, paper, plastic, toys, hobby products; Ink, toner, and colorants	Use of dyes and pigments, and fixing agents	Concentration is within the highest and lowest bounded values from TRI releasers	No air releases
Industrial use; Packaging, paper, plastic, toys, hobby products; Adhesives and sealants	Application of paints, coatings, adhesives, and sealants (formulations for diffusion bonding)	Concentration is within the highest and lowest bounded values from TRI releasers	Included in screening level assessment
Commercial use; Other uses; Laboratory chemicals	Use of laboratory chemicals (solid and liquid) [c]	Qualitatively assessed[d]	Included in screening level assessment
Commercial use; Other uses; Automotive articles and products	Use of automotive care products [c]	Quantitatively assessed[d]	Included in screening level assessment
Industrial use; Other uses; Hydraulic fracturing	Use in hydraulic fracturing [c]	Qualitatively assessed[d]	Included in screening level assessment
Processing; Recycling; Recycling	Recycling	No water releases	Included in screening level assessment
Disposal; Disposal; Disposal	Waste handling, treatment, and disposal	Concentration is within the highest and lowest bounded values from TRI releases	Included in screening level assessment

COU (Life Cycle Stage; Category; Subcategory)	Occupational Exposure Scenario (OES)	Basis for Risk Characterization for Aquatic Receptors	Basis for Risk Characterization for Terrestrial Receptors (Air Deposition to Soil)
[a] See Section 5.3.2; The COUs resulting in the highest and lowest environmental concentration of DEHP for the aquatic environment served as the bounding for quantified risk estimates. [b] See Section5.3.3; The COU resulting in the highest environmental concentration for air to soil deposition served as the bounding for quantified risk estimates [c] Table 3-5 provides details on these COUs represented with generic scenario releases. [d] Section 5.3.2 provides details on qualitative assessment of these COU.			

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 nonrisk factors, including an unreasonable risk to a PESS identified by EPA as relevant to this risk evaluation, under the COUs.

EPA is determining that DEHP presents unreasonable risk of injury to human health and the environment driven by: (1) identified significant contributions to unreasonable risk to workers, due to inhalation risks, from ten COUs, (2) identified significant contributes to unreasonable risk to ONUs due to inhalation risks from eight of the COUs that significantly contribute to unreasonable risk for workers; (3) identified significant contributions to unreasonable risk to aquatic vertebrates from chronic exposures to 20 COUs; and (4) identified significant contributions to unreasonable risk to sediment-dwelling organisms from chronic exposures to 18 of those 20 COUs. The inhalation exposure to workers is the primary route contributing to the aggregate and cumulative exposure for workers.[9] EPA did not identify significant contributions to unreasonable risk to human health to consumers, to the general population or from DEHP exposures via soil and air pathways to the environment. In total, 20 out of the 44 COUs significantly contribute to the unreasonable risk from DEHP.

This unreasonable risk determination is based on the information in previous sections of this risk evaluation, the appendices, and technical support documents of this risk evaluation in accordance with TSCA section 6(b). This unreasonable risk determination and the underlying evaluations are consistent with the best available science (TSCA section 26(h)) and based on the weight of scientific evidence (TSCA section 26(i)). EPA will initiate risk management for DEHP by applying one or more of the requirements under TSCA section 6(a) to the extent necessary so that DEHP no longer presents an unreasonable risk. The Agency expects risk management requirements to focus on those COUs that significantly contribute to the determination of unreasonable risk of DEHP. As inhalation risk presented in the single chemical analysis is the driver of unreasonable risk to human health, EPA's risk management will focus on the risk presented in the single chemical analysis of DEHP. EPA may select from among a suite of risk management options related to manufacture (including import), processing, distribution in commerce, commercial use, and disposal to address unreasonable risk. The Agency could also consider whether such risk may be prevented or reduced to a sufficient extent by action taken under another federal law, such that 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) may be appropriate.

As noted in the Executive Summary, DEHP 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. Workers may be exposed to DEHP when making these products or otherwise using DEHP in the workplace (Section 4.1.1). When it is manufactured or used to make products, DEHP can be released into water, where because of its properties, most will end up in the sediment at the bottom of lakes and rivers (Sections 3.2 and 3.3.1.1). If released into the air (Section 3.3.1.2), DEHP will attach to dust particles and be deposited on land or into water. Indoors, DEHP has the potential over time to be released from products and adhere to dust particles (Section 4.1.2) which could then be inhaled or ingested via dust that contains DEHP.

[9] The Agency conducted analyses on aggregate exposures and cumulative risks. Aggregate exposure analyses consider effects on populations that are exposed to DEHP via multiple routes (*e.g.*, dermal contact, ingestion, and inhalation). Cumulative risk refers to human health risks related to exposures to multiple chemicals with similar effects (*i.e.*, aggregate + NHANES = cumulative). See section 4.4 for more information.

EPA notes that uses that are not subject to TSCA (*e.g.*, cosmetics, medical devices, use of shells and cartridges as identified in 26 U.S.C. § 4181, and food additives such as food contact materials) resulting in human or environmental exposure to DEHP were not evaluated as COUs by the Agency because these uses are explicitly excluded from TSCA's definition of chemical substance. Thus, it is not appropriate to extrapolate from this risk determination to form conclusions about uses of DEHP that are not subject to TSCA and that EPA did not evaluate as COUs. Although certain uses are excluded and therefore not included in this assessment, EPA's cumulative analysis, which is used to characterize risk under the TSCA COUs by including background phthalate exposures, does consider non-attributable NHANES data which may be influenced by exposures due to non-TSCA uses.

Additionally, where relevant, the Agency analyzed aggregate exposures and cumulative risks. Aggregate exposure analyses consider effects on populations that are exposed to DEHP via multiple routes (*i.e.*, dermal contact, ingestion, and inhalation). Cumulative risk refers to human health risks related to exposures to multiple chemicals. Workers and consumers can be exposed to other phthalates that have the same toxicological endpoint (*i.e.*, decreased fetal testicular testosterone) as well as the exposure to DEHP, with greater risk in total. EPA has developed a CRA TSD of DEHP and five other toxicologically similar phthalates (*i.e.*, DCHP, DBP, DIBP, BBP, and DINP) that are also being evaluated under TSCA (U.S. EPA, 2025al). This analysis allows 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. For DEHP, the inhalation exposure to workers is the primary route contributing to the aggregate and cumulative exposure for workers (cumulative = aggregate + NHANES background), the Agency has considered the cumulative risk (*i.e.*, human health risks related to exposures to multiple phthalates). More information on the cumulative risk considerations is provided in Section 4.4.

The full list of COUs evaluated for DEHP are listed in Table 1-1. EPA has determined that a total of 20 COUs significantly contribute to the unreasonable risk of DEHP. Of the 20 total COUs, EPA has determined that the following 10 COUs significantly contribute to the unreasonable risk of DEHP to human health, due to inhalation risk to workers:

- Manufacturing – importing;
- Processing – incorporation into formulation, mixture, or reaction product – plasticizer in plastic material and resin manufacturing; synthetic rubber manufacturing; basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint and coating manufacturing; adhesive manufacturing; basic inorganic chemical manufacturing; wholesale and retail trade; services; and ink, toner, and colorant manufacturing (including risk to ONUs);
- Processing – incorporation into article – plasticizer in basic organic chemical manufacturing; plastics product manufacturing; rubber product manufacturing; miscellaneous manufacturing; and PVC extruding (including risk to ONUs);
- Processing – repackaging – repackaging in wholesale and retail trade and in paint and coating manufacturing;
- Industrial use – construction, paint, electrical, and metal products – paints and coatings (including risk to ONUs);
- Industrial use – construction, paint, electrical, and metal products – adhesives and sealants (including risk to ONUs);
- Commercial use – construction, paint, electrical, and metal products – adhesives and sealants (including risk to ONUs);

- Commercial use – construction, paint, electrical, and metal products – paints and coatings (including risk to ONUs);
- Commercial use – furnishing, cleaning, treatment care products – all-purpose waxes and polishes (including risk to ONUs); and
- Commercial use – packaging, paper, plastic, toys, hobby products – inks, toner, and colorants (including risk to ONUs).

EPA notes that, due to reasons discussed in Section 6.1.4, three COUs (Industrial use - other uses - solid rocket motor insulation and other aerospace applications; industrial use - other uses - automotive articles; and processing - recycling) preliminarily determined to significantly contribute to the unreasonable risk to workers in the *Draft Risk Evaluation for DEHP* (U.S. EPA, 2025q) are now determined to not significantly contribute to unreasonable risk to workers. See Section 6.1.4 for additional details.

EPA has determined that 20 COUs significantly contribute to unreasonable risk of DEHP to the environment. 18 of those 20 COUs significantly contribute to unreasonable risk of DEHP to both aquatic vertebrates and sediment-dwelling invertebrates through chronic exposure to DEHP in surface water and sediment pore water, respectively, while the remaining two COUs significantly contribute to the unreasonable risk of DEHP to aquatic vertebrates only through surface water. These 20 COUs are:

- Manufacturing – manufacturing (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);
- Manufacturing – importing (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);
- Processing – incorporation into formulation, mixture, or reaction product – plasticizer in plastic material and resin manufacturing; synthetic rubber manufacturing; basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint and coating manufacturing; adhesive manufacturing; basic inorganic chemical manufacturing; wholesale and retail trade; services; and ink, toner, and colorant manufacturing (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);
- Processing – incorporation into article – plasticizer in basic organic chemical manufacturing; plastics product manufacturing; rubber product manufacturing; miscellaneous manufacturing; and PVC extruding (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);
- Processing – repackaging – repackaging in wholesale and retail trade and in paint and coating manufacturing (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);
- Processing – other uses – miscellaneous processing (cyclic crude and intermediate manufacturing; processing aid specific to hydraulic fracturing) (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);
- Industrial use – construction, paint, electrical, and metal products – paints and coatings (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);
- Industrial use – construction, paint, electrical, and metal products – adhesives and sealants (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);
- Industrial use – other uses – hydraulic fracturing (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);
- Industrial use – other uses – solid rocket motor insulation and other aerospace applications (aquatic vertebrates through surface water only);
- Industrial use – other uses – automotive articles (aquatic vertebrates through surface water only);

- Commercial use – construction, paint, electrical, and metal products – adhesives and sealants (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);
- Commercial use – construction, paint, electrical, and metal products – paints and coatings (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);
- Commercial use – furnishing, cleaning, treatment care products – all-purpose waxes and polishes (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);
- Commercial use – furnishing, cleaning, treatment care products – fabric enhancer (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);
- Commercial use – furnishing, cleaning, treatment care products – fabric, textile, and leather products; furniture and furnishings (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);
- Commercial use – packaging, paper, plastic, toys, hobby products – ink, toner, and colorants (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);
- Commercial use – other uses – laboratory chemicals (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);
- Commercial use – other uses – automotive articles (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water); and
- Disposal (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water).

EPA did not identify significant contributions to unreasonable risk of injury to human health or the environment from the following 24 COUs:

- Distribution in commerce;
- Commercial use – automotive, fuel, agriculture, outdoor use products – lawn and garden care products;
- Commercial use – construction, paint, electrical, and metal products – batteries and capacitors;
- Commercial use – construction, paint, electrical, and metal products – construction and building materials covering large surface areas, including paper articles; metal articles; stone, plaster, cement, glass and ceramic articles;
- Commercial use – construction, paint, electrical, and metal products – machinery, mechanical appliances, electrical/electronic articles;
- Commercial use – furnishing, cleaning, treatment care products – floor coverings; construction and building materials covering large surface areas including stone, plaster, cement, glass and ceramic articles; fabrics, textiles, and apparel;
- Commercial use – packaging, paper, plastic, toys, hobby products – packaging (excluding food packaging) and other articles with routine direct contact during normal Use, including rubber articles; plastic articles (hard); plastic articles (soft);
- Commercial use – packaging, paper, plastic, toys, hobby products – packaging (excluding food packaging), including paper articles;
- Commercial use – packaging, paper, plastic, toys, hobby products – toys, playground, and sporting equipment;
- Consumer use – automotive, fuel, agriculture, outdoor use products – lawn and garden care products;
- Consumer use – construction, paint, electrical, and metal products – adhesives and sealants;
- Consumer use – construction, paint, electrical, and metal products – batteries;

- Consumer use – construction, paint, electrical, and metal products – construction, and building materials covering large surface areas, including paper articles; metal articles; stone, plaster, cement, glass and ceramic articles;
- Consumer use – construction, paint, electrical, and metal products – machinery, mechanical appliances, electrical/electronic articles;
- Consumer use – construction, paint, electrical, and metal products – paints and coatings;
- Consumer use – furnishing, cleaning, treatment care products – fabric, textile, and leather products; furniture and furnishings
- Consumer use – furnishing, cleaning, treatment care products – floor coverings; construction and building materials covering large surface areas including stone, plaster, cement, glass and ceramic articles; fabrics, textiles, and apparel;
- Consumer use – packaging, paper, plastic, toys, hobby products – ink, toner, and colorants;
- Consumer use – packaging, paper, plastic, toys, hobby products – packaging (excluding food packaging) and other articles with routine direct contact during normal use, including rubber articles; plastic articles (hard); plastic articles (soft);
- Consumer use – packaging, paper, plastic, toys, hobby products – packaging (excluding food packaging), including paper articles;
- Consumer use – packaging, paper, plastic, toys, hobby products – toys, playground, and sporting equipment;
- Consumer use – other uses – novelty articles;
- Consumer use – other uses – automotive articles; and
- Processing – recycling.

EPA did not identify significant contributions to unreasonable risk to human health to consumers or to the general population for any COU.

For some COUs the Agency has limited information to derive risk estimates (such as MOEs or RQs) to support a determination of whether the COU contributes to unreasonable risk of injury to human health or the environment. In such cases, EPA integrates reasonably available information *e.g.,* physical and chemistry properties, available monitoring data in a risk characterization using a weight of evidence approach and professional judgment to support conclusions. The risk characterizations of COUs that EPA evaluated qualitatively present what EPA expects given the weight of scientific evidence. These COUs include distribution in commerce and releases associated with consumer uses.

The unreasonable risk determination must be informed by science and in making a finding of "presents unreasonable risk," EPA considers risk-related factors beyond comparison to benchmarks. Risk-related factors include the type and severity of health effect under consideration, the reversibility of the health effects being evaluated, exposure-related considerations (*e.g.,* duration, magnitude, frequency of exposure), or population exposed—particularly populations with greater exposure or greater susceptibility (PESS), and the confidence in the information used to inform the hazard and exposure values. EPA also considered, where relevant and appropriate, the Agency's analyses on aggregate exposures and cumulative risk. For COUs evaluated quantitatively, as described in the risk characterization, EPA based the unreasonable risk determination on the risk estimate that best represented the COU. Additionally, in the risk evaluation, the Agency describes the strength of the scientific evidence supporting the human health and environmental assessments as robust, moderate to robust, moderate, slight to moderate, or slight.

Robust confidence suggests thorough understanding of the scientific evidence and uncertainties, and 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 estimates. 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 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. The designation of slight to moderate confidence suggests that some aspects of the analysis are reasonably adequate but that other aspects are not adequate or sufficiently understood to characterize the exposure. In general, EPA makes a determination of unreasonable risk based on risk estimates that have an overall confidence rating of slight to moderate, moderate, moderate to robust, or robust because those confidence ratings indicate the scientific evidence is adequate to characterize risk estimates despite uncertainties or is such that it is unlikely the uncertainties could have a significant effect on the risk estimates.

This 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 (Section 2.2); environmental release (Sections 3.2.2 and 3.2.3); environmental concentrations (Section 3.3.1); environmental exposures and hazards (Section 5.3.5); and human health exposures and hazards (Sections 4.1.1.5, 4.1.2.4, and 4.1.3.3). The risk evaluation also includes overall confidence and remaining uncertainties sections for human health (Sections 4.3.2, 4.3.3, and 4.3.4.1) and environmental risk characterizations (Sections 5.3.5 and 5.3.6).

6.1 Human Health

Calculated non-cancer risk estimates (margin of exposure [MOEs[10]]) can provide a risk profile of DEHP 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 in a manner that takes in consideration reasonably available information (*e.g.*, information submitted by manufacturers and processors of DEHP; representative site visits if relevant) regarding whether the use of respiratory protection or other PPE is standard practice at all sites.[11] This allows EPA to make unreasonable risk determinations based on the available information regarding workers where the Agency has confidence that the information is representative. In addition, the risk estimates are based on exposure scenarios with monitoring data that reflect existing requirements, such as those established by OSHA (*i.e.*, permissible exposure limit [PEL]), or industry or sector best practices. In this risk evaluation, the risk estimates calculated reflect both use with and without PPE, including information on PPE that could be used to reduce the exposures. EPA received some information from stakeholders during the public comment period for the draft risk evaluation and has incorporated this information into the analysis where possible. Because EPA does not currently have sufficient information regarding use of PPE under the COUs, the unreasonable risk determination is based on the risk estimates that do not reflect use of PPE.

To characterize risk from non-cancer endpoints, the estimated MOEs are compared to their respective benchmark MOE. The benchmark MOE accounts for the total uncertainty in a POD. The benchmark

[10] EPA derives non-cancer MOEs by dividing the non-cancer POD (HEC [mg/m^3] or HED [mg/kg-day]) by the exposure estimate (mg/m^3 or mg/kg-day). Section 4.3.1 has additional information on the risk assessment approach for human health.
[11] 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.

MOE is the total of several individual uncertainty factors relevant to a given POD with values usually of 1, 3 or 10. For DEHP, two uncertainty factors were used to derive a benchmark MOE, (1) UF_A of 3 for the uncertainty in extrapolating animal data to humans (*i.e.,* interspecies variability) and (2) UF_H of 10 for the variation in sensitivity among the members of the human population (*i.e.,* intrahuman/ intraspecies variability). Therefore, the benchmark MOE for DEHP is 30, and is based on effects on the developing male reproductive system, consistent with a disruption of androgen action and phthalate syndrome, specifically the increased incidence of reproductive tract malformations, and was used to characterize risk from exposure to DEHP for acute, intermediate, and chronic exposure scenarios. A lower benchmark MOE (*e.g.,* 30) indicates greater certainty in the data (because the total uncertainty factor (UF) for the relevant POD is low). A higher benchmark MOE (*e.g.*, 100) would indicate more extrapolation uncertainty for specific hazard endpoints and scenarios. Additional information regarding the non-cancer hazard identification and the benchmark MOE is in Section 4.2 of this risk evaluation. An MOE that is less than the benchmark MOE indicates risk and is a starting point for informing a determination of unreasonable risk of injury to health, based on non-cancer effects. EPA also considers the conservative assumptions to assess exposures in this unreasonable risk determination. It is important to emphasize that these calculated risk estimates and benchmarks alone 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.

6.1.1 Populations and Exposures EPA Assessed for Human Health

EPA has evaluated risk to workers (16+ years old) including occupational non-users (ONUs) and female workers of reproductive age directly working with DEHP; consumers and bystanders (adults and children); and the general population (including fenceline communities), using reasonably available monitoring and modeling data for inhalation, dermal, and ingestion exposures, as applicable. EPA has evaluated risk from inhalation and dermal exposure of DEHP to workers. The Agency assessed the exposure of two occupational exposure groups, which are workers and ONUs. Workers work in close proximity to DEHP and may handle DEHP while ONUs do not directly handle DEHP but may be indirectly exposed to it as part of their employment. The Agency also evaluated risk from inhalation, dermal, and ingestion exposures to consumers. For the general population, EPA has evaluated risk from the following: (1) ingestion exposure via drinking water, incidental surface water ingestion, fish ingestion (including subsistence and tribal fishers); (2) dermal exposure to surface water during swimming; (3) inhalation of DEHP in ambient air resulting from industrial releases; and (4) exposures measured through urinary biomonitoring (*i.e.*, NHANES data).

Although no studies have evaluated only lactational exposure from quantified levels of DEHP in milk, the human health hazard values are based on studies that cover the lactational period. Because these values designed to be protective of infants are expressed in terms of maternal exposure levels and hazard values to assess direct exposures to infants are unavailable, EPA concluded that further characterization of infant exposure through human milk ingestion would be uninformative.

Descriptions of the data used for human health exposure are in Section 4.1. Uncertainties for overall exposures are presented in the respective occupational, consumer, and general population exposure sections of this risk evaluation and are considered in the unreasonable risk determination.

6.1.2 Summary of Human Health Effects

EPA has determined that DEHP presents unreasonable risk to human health because of non-cancer effects in the following populations:

- workers, including ONUs and female workers of reproductive age, from acute, intermediate, and chronic inhalation DEHP exposures

With respect to the health endpoint that EPA has based this unreasonable risk determination, the non-cancer effects on the developing male reproductive system are consistent with a disruption of androgen action and phthalate syndrome and increased overall incidence of reproductive tract malformations observed in both generations in a multi-generation reproduction study, following continuous dietary exposure *(e.g.*, gestational and lactational exposure). The selected POD to estimate non-cancer risks from oral exposure to DEHP is a NOAEL of 4.8 mg/kg-day associated with effects on the developing male reproductive system at the LOAEL of 14 mg/kg-day from a three-generation reproduction study (Blystone et al., 2010; TherImmune Research Corporation, 2004) and a supporting study presented in publications by Andrade and Grande (2006b; 2006a; 2006) which established a NOAEL of 5 mg/kg-day, along with 13 additional studies reporting effects on the developing male reproductive system consistent with disrupted androgen action and phthalate syndrome at lowest-observed-adverse-effect levels (LOAELs) in a narrow range of 10 to 15 mg/kg-day. Notably, the NOAEL-to-LOAEL ratio is approximately 2×, which indicates a relatively narrow dose-spread between the NOAEL and LOAEL and is a strength of the selected POD.

Further benchmark dose (BMD) modeling of the F1, F2 and combined F1 and F2 male reproductive malformation data by Blystone et al. supports $BMD_5/BMDL_5$ estimates of 11.6/7.0 mg/kg-day for the F1 generation, 10.4/2.2 mg/kg-day for the F2 generation, and 8.5/5.6 mg/kg-day for combined F1 and F2 generations. $BMDL_5$ estimates range from 2.2 to 7.0 mg/kg-day and are similar to the selected POD based on a NOAEL of 4.8 mg/kg-day, further supporting its selection for use in risk characterization. EPA used allometric body weight scaling to the ¾-power to derive an HED of 1.1 mg/kg-day from the NOAEL of 4.8 mg/kg-day (U.S. EPA, 2011c). Body weight scaling to the three-quarters power is EPA's default approach for deriving an HED in the absence of more chemical-specific information (*e.g.*, PBPK model or data derived extrapolation factor) for such an extrapolation (U.S. EPA, 2011c). The HED of 1.1 mg/kg-day was selected as the acute/intermediate/chronic duration POD for use in characterizing risk from exposure to DEHP. Risk estimates based on the developmental toxicity POD are relevant for females of reproductive age and males at any life stage. Additionally, there is epidemiological evidence that DEHP exposure can adversely affect the developing male reproductive system consistent with phthalate syndrome in males of any age, with effects including decreases in AGD and testosterone and effects on sperm parameters in humans, and that DEHP exposure at higher concentrations can cause other health effects in females as well (see the *Non-cancer Human Health Hazard Assessment for DEHP* (U.S. EPA, 2025aa)). Therefore, EPA considers the selected POD to be relevant across sex, life stage, and durations. The Agency has robust overall confidence in the selected developmental toxicity POD. The confidence in the POD and descriptions of the data used to determine the human health effects from DEHP are explained in Section 4.2.2.

No data are reasonably 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 of 1.1 mg/kg-day to evaluate risks from dermal and inhalation exposure to DEHP. For the dermal route, EPA accounted for differences in absorption in dermal exposure estimates in the risk evaluation for DEHP. As described in Section 4.1.1.4 and Section 4.1.2.1.2, the dermal flux value for liquid products was from Hopf et al. (2014) and solid products was from Chemical Manufacturers Association (1991).

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, 1994b) 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).

EPA has concluded that DEHP is *Not Likely to be Carcinogenic to Humans* and did not conduct a quantitative cancer dose-response assessment or evaluate DEHP for cancer risk (Section 4.2.1).

EPA has robust overall confidence in the selected POD for acute, intermediate, and chronic durations (see Section 4.2.2 for further discussion of the weight of scientific evidence).

The health risk estimates for consumers and bystanders are presented in Table 4-18 and in the *DEHP Consumer Risk Calculator* (U.S. EPA, 2025f) and are characterized in Section 4.3. Health risk estimates for the general population are presented in the *Environmental Media and General Population and Environmental Exposure for DEHP* (U.S. EPA, 2025s) and characterized in Section 4.3.4. Health risk estimates for workers including ONUs are presented in Table 4-17 and characterized in Section 4.3.2. Additionally, the human health risk characterization in Section 4.2 describes EPA's selection of a benchmark MOE of 30 for use in different risk estimates and the respective confidence and identified uncertainties for each scenario. Section 4.2 describes EPA's selection of a benchmark MOE of 30 for use in different risk estimates and the respective confidence and identified uncertainties for each scenario. Given the available strengths and uncertainties in the human hazard database considered in deriving the non-cancer POD (*e.g.,* strengths include hazard identification in most sensitive sex and life stage; uncertainties include human kinetic and dynamic process differences),

EPA selected a total UF of 30 for use as the benchmark MOE based upon an interspecies UF (UF_A) of 3 and an intraspecies UF (UF_H) of 10. The UF_H of 10× accounts for variability in toxicokinetics and toxicodynamics within the human population to account for differences in sensitivity. However, data are not available to characterize the magnitude of differences in variability/sensitivity across the human population. Therefore, consistent with agency guidance (U.S. EPA, 2002b), EPA selected a default UF_H of 10×. Consistent with Agency guidance (U.S. EPA, 2011c), the UF_A was reduced from a factor of 10 to 3 because allometric body-weight scaling was used to derive an HED, which accounts for toxicokinetic differences between species. The remaining UF_A of 3× accounts for species differences in toxicodynamics. EPA considered reducing the UF_A further to a value of 1 based on apparent differences in toxicodynamics between rats and humans. However, as discussed in Section 4.2.2, EPA did not reduce the UF_A further to a value of 1 because the available human explant and xenograft studies have limitations and uncertainties, which preclude definitive conclusions related to species differences in sensitivity.

6.1.3 Basis for Unreasonable Risk to Human Health

In developing the exposure and hazard assessments for DEHP, EPA has 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 DEHP. For the DEHP risk evaluation, EPA has accounted for the following PESS: females of reproductive age, pregnant women, infants, children and adolescents, people who frequently use consumer products and/or articles containing high-concentrations of DEHP, people exposed to DEHP in the workplace, people in close proximity to releasing facilities (including fenceline communities), and Tribes and subsistence fishers whose diets include large amounts of fish.. 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.

Because EPA was able to calculate risk estimates for PESS groups in this assessment (*e.g.*, female workers of reproductive age, and infants and children), EPA did not always use risk estimates based on high-end exposure levels as the basis of the unreasonable risk determination for DEHP. Additionally, EPA considered whether high-end risk estimates represented sentinel exposure levels accurately. As explained in the human health risk characterization, due to a variety of factors discussed further in Section 6.1.4, for most occupational COUs, both central tendency and high-end risk estimates were expected to be representative of worker exposures and were therefore both considered when determining risk. For consumer COUs, high-intensity risk estimates were used to determine unreasonable risk except for dermal estimates for the consumer use of fabric, textile and leather products; furniture and furnishings; and novelty articles, for which the high-intensity scenario for dermal risk estimates were determined to be unlikely either due to a lack of adequate input parameters, the input parameters may not reflect actual use scenarios, or the calculated estimates may not effectively represent actual exposures and risks (see Section 4.3.3 for further information). The non-cancer POD for DEHP selected by EPA for use in risk characterization is based on the most sensitive developmental effects observed following exposure during the most sensitive life stage (*i.e.*, gestation) and is therefore expected to be based on the most sensitive population. More information on how EPA characterized PESS risks is provided in Section 4.3.5.

Additionally, 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 occupational and consumer COU to calculate aggregate risk estimates (Section 4.4). The Agency aggregated exposures across routes for workers, including ONUs, and consumers for COUs with quantitative risk estimates. The inhalation exposure to workers is the primary route contributing to the aggregate and cumulative exposure for workers (cumulative = aggregate + NHANES background). EPA did not consider aggregate exposure for the general population. As described in Section 4.1.3, EPA employed a risk screening approach for the general population exposure assessment. More information on how EPA characterized sentinel and aggregate risks is provided in Section 4.1.5.

In addition to the analysis done for DEHP alone (referred to as "single chemical analysis"), EPA applied both the methods and principles of CRA in the *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, 2023d), as well as the *Technical Support Document for the Cumulative Risk Analysis of DEHP, DBP, BBP, DIBP, DCHP, and DINP Under TSCA* (U.S. EPA, 2025al), to derive non-cancer risk estimates for occupational and consumer exposures. EPA's CRA TSD includes cumulative exposure to other toxicologically similar phthalates being evaluated under TSCA (*i.e.*, DBP, BBP, DIBP, DCHP, and DINP) and uses two approaches to characterize the cumulative exposure. For the second approach, individual phthalate exposures for consumer and occupational COUs are not scaled by RPFs, but use the individual phthalate hazard values, and are combined with non-attributable cumulative exposures estimated using NHANES. As explained in Section 4.4.3.1, based on the weight of scientific evidence considerations outlined in the developed framework, EPA has weighed the strengths and uncertainties associated with the DEHP POD (Approach 2 and individual DEHP risk assessment). As discussed in Section 4 of the CRA TSD (U.S. EPA, 2025al), application of Approach 2 leads to risk estimates that are approximately 1.1× to 1.2× more sensitive than in the individual DEHP risk evaluation.

6.1.4 Workers

Based on the occupational risk estimates and related risk factors, EPA is determining that ten COUs significantly contribute to unreasonable risk to human health due to non-cancer risks from acute, intermediate and chronic inhalation exposure to workers, including ONUs (for 8 COU) (see Table 6-1 for specific COUs and associated unreasonable risk by route of exposure). EPA has determined that occupational COUs do not significantly contribute to unreasonable risk from the dermal exposure route, since dermal MOEs were well above the benchmark MOE and the aggregate MOEs are equal or slightly less than the inhalation MOEs, indicating that the risk is driven by the inhalation exposure.

In determining whether a COU significantly contributes to the unreasonable risk of DEHP, EPA considers the appropriateness of high-end and central tendency exposure estimates to ensure that the risk determination is representative of actual, expected worker exposures for each COU. EPA's consideration of both the risk estimates and risk related factors is discussed through this section (Section 6.1.4). For situations where COUs were evaluated using multiple OESs, EPA considered MOEs from all associated OESs for the purposes of making an unreasonable risk determination, such as Processing – incorporation into article – plasticizer in basic organic chemical manufacturing; plastics product manufacturing; rubber product manufacturing; miscellaneous manufacturing; and PVC extruding, mapped to the rubber manufacturing and plastic converting OESs (see Table 3-1 and Table 3-2).

Processing COUs with Reasonably Available Monitoring Data
EPA has determined that two processing COUs associated with rubber manufacturing significantly contribute to unreasonable risk to workers from acute, intermediate, and chronic inhalation exposures:

- Processing – incorporation into formulation, mixture, or reaction product – plasticizer in plastic material and resin manufacturing; synthetic rubber manufacturing; basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint and coating manufacturing; adhesive manufacturing; basic inorganic chemical manufacturing; wholesale and retail trade; services; and ink, toner, and colorant manufacturing; and
- Processing – incorporation into article – plasticizer in basic organic chemical manufacturing; plastics product manufacturing; rubber product manufacturing; miscellaneous manufacturing; and PVC extruding.

Although EPA did not identify any references with discrete, full-shift samples for these COUs through systematic review, EPA was able to assess risk from worker inhalation exposures based on high quality monitoring data (PBZ and/or area sampling) from the European Commission document (ECJRC, 2003), which provided maximum concentrations based on time-weighted average personal and area samples from a plant performing rubber calendaring (ECJRC, 2003). These data included the highest air concentration values for each sampling event along with the sampling duration. Because EPA's occupational risk assessment incorporates DEHP inhalation monitoring data, the Agency's risk estimates, including estimates at the high-end (95th percentile), reflect working conditions at facilities handling DEHP. Therefore, high-end estimates are reasonably expected to occur and were considered in EPA's risk determination for these COUs with monitoring data supporting the estimates. However, uncertainty in the estimates based on a statistical distribution of multiple single day measurements increases as the single day results are extrapolated to longer durations. Therefore, EPA's risk determination generally relies on high-end estimates to support its determination for workers for shorter-term inhalation exposures. This is because consistent high-end exposures are more likely to occur over shorter periods of time, while central tendency estimates are used for longer-term exposures (*i.e.*, several decades for chronic non-cancer). Therefore, based on the previously discussed confidences and uncertainties, and the high-end estimates for acute and intermediate exposures (*i.e.*, MOEs of 1.0-1.3 for females of reproductive age), and central tendency for chronic exposures (*i.e.*, MOE of 7.0 for females of reproductive age), EPA is determining that these two COUs associated with rubber manufacturing significantly contribute to the unreasonable risk of DEHP.

COUs Associated with Non-Spray Applications

EPA has determined that three industrial and commercial COUs associated with the Non-spray application of paints, coatings, adhesives, and sealants OES:

- Industrial use – construction, paint, electrical, and metal products – paints and coatings;
- Commercial use – construction, paint, electrical, and metal products – paints and coatings;
- Commercial use – construction, paint, electrical, and metal products – adhesives and sealants;

and the one COU associated with the Use of dyes, pigments, and fixing agents OES:

- Commercial use – packaging, paper, plastic, toys, hobby products – inks, toner, and colorants.

significantly contribute to unreasonable risk to workers from acute, intermediate, and chronic inhalation exposures.

EPA received public comment regarding the use of rubber manufacturing data to derive risk from exposure under the non-spray application of paints, coatings, adhesives, and sealants, as well as the use of dyes, pigments, and fixing agents scenario. EPA used inhalation monitoring data from rubber manufacturing as a surrogate for these COUs given that volatilization is the primary contributor to the air concentration, and no inhalation monitoring data were identified specifically for the scenarios associated with non-spray application of paints, coatings, adhesives, and sealants, or dyes, pigments, and fixing agents. EPA acknowledges that rubber manufacturing (calendering) employs high temperatures (200 °C) which likely result in higher air concentrations compared to other non-spray scenarios such as dyes, pigments, and fixing agents. Therefore, EPA compared the dose from non-spray application of application of paints, coatings, adhesives, and sealants and the use of dyes, pigments, and fixing agents for DEHP (both based on rubber calendering) to another phthalate (DBP) which had inhalation monitoring data for non-spray application of paints, coatings, adhesives from operations that did not entail elevated temperatures.

The DEHP inhalation dose to females of reproductive age using rubber calendering data for non-spray applications and dyes, pigments, and fixing agents (0.23 mg/kg-day at central tendency and 1.12 mg/kg-day for high-end) is very similar to DBP for non-spray applications (0.21 mg/kg-day at central tendency and 1.02 mg/kg-day for high-end), and thereby increases EPA's confidence in the use of rubber manufacturing inhalation monitoring data as a surrogate for both the three COUs mapped to non-spray application of paints, coatings, adhesives, and sealants (Industrial use – construction, paint, electrical, and metal products – paints and coatings; commercial use – construction, paint, electrical, and metal products – paints and coatings; and commercial use – construction, paint, electrical, and metal products – adhesives and sealants), and the one COU mapped to dyes, pigments, and fixing agents scenarios (Commercial use – packaging, paper, plastic, toys, hobby products – inks, toner, and colorants). Additionally, risk estimates were considerably below the benchmark, supporting the basis for determining that these COUs significantly contribute to unreasonable risk. Therefore, based on the previously discussed confidences and uncertainties, and considering the high-end estimates for acute and intermediate exposures (*i.e.*, MOEs of 1.0–1.3 for females of reproductive age), and central tendency for chronic exposures (*i.e.*, MOE of 7.0 for females of reproductive age), EPA is determining that these three COUs associated with non-spray application of paints and coatings, and the one COU associated with the use of dyes, pigments, and fixing agents, significantly contribute to the unreasonable risk of DEHP.

Import and Repackaging COUs with Reasonably Available Monitoring Data
EPA has determined that two COUs associated with the import and repackaging occupational exposure scenario significantly contribute to unreasonable risk to workers from acute and intermediate inhalation exposures:

- Manufacturing – importing; and
- Processing – repackaging – repackaging in wholesale and retail trade and in paint and coating manufacturing.

For these two COUs, EPA calculated the central tendency estimates from an arithmetic mean comprising an unknown number of PBZ samples from a single facility from workers performing drumming operations with DINP, used as a surrogate for DEHP exposure. The high-end risk estimates were calculated using the maximum value from an unknown number of area samples taken within a single facility from workers performing drumming operations on DEHP. Given the limited reporting of sample data from the data source, EPA used the maximum concentration of the area sample data to determine high-end worker inhalation exposure for these COUs. Although this high-end value is based on the maximum area sample concentration rather than a 95th percentile of the distribution, this value was based on a high-quality study specific to DEHP and is considered to be a reasonable estimate of high-end worker exposure for these COUs. As discussed previously for the processing COUs with reasonable available information, the Agency's risk estimates for these COUs, including estimates at the high-end (95th percentile), reflect working conditions at facilities handling DEHP based on DEHP inhalation monitoring data. EPA's risk determination generally relies on high-end estimates to support its determination for workers for shorter-term inhalation exposures and central tendency estimates for longer-term exposures (*i.e.*, several decades for chronic non-cancer). Therefore, both the central tendency (based on surrogate data) and high-end (based on DEHP data) are considered appropriate to be used to inform EPA's risk determination. For these two COUs, risk was only indicated based on high-end risk estimates (*e.g.*, MOEs of 57 for central tendency and 15 for high-end based on acute inhalation exposures to females of reproductive age).

However, there is uncertainty about how well these monitoring data represent the true distribution of inhalation concentrations for these COUs because the representativeness of this scenario is influenced by the variability in worker activities, schedules, and facility operations across the full distribution of facilities. For these reasons, EPA's determination of unreasonable risk for workers (not ONUs) based on significant contributions from the processing – repackaging COU is driven by acute and intermediate high-end exposures associated with drumming operations at a repackaging facility. Due to the uncertainties in the extrapolated single day samples applied to longer durations, chronic exposures do not significantly contribute to the unreasonable risk of processing – repackaging based on central tendency estimates, better representing exposures over chronic durations as discussed, well above the benchmark MOE. EPA's determination of unreasonable risk based on significant contributions from the manufacturing – importing COU is driven by acute inhalation exposures alone. Although high-end MOEs were also well below the benchmark for intermediate and chronic exposures for the manufacturing – importing COU, an acute (8-hr) shift is expected to be a more reasonable representation of activity occurring at an import facility, rather than assuming the estimated high-end repackaging activity's occurrence at an import facility each day for 30 days, or longer.

COUs Associated with Spray Applications
EPA has determined that four COUs associated with the spray application of paints, coatings, adhesives, and sealants significantly contribute to unreasonable risk to workers from acute inhalation exposures:

- Industrial use – construction, paint, electrical, and metal products – paints and coatings;

- Commercial use – construction, paint, electrical, and metal products – paints and coatings;
- Commercial use – construction, paint, electrical, and metal products – adhesives and sealants; and
- Commercial use – furnishing, cleaning, and treatment care products – all-purpose waxes and polishes.

EPA assessed exposures from spray application of paints, coatings, adhesives, and sealants using the Automotive Refinishing Spray Coating Mist Inhalation Model, which estimates worker inhalation exposure based on the concentration of the chemical of interest in the nonvolatile portion of the sprayed product, and the concentration of over-sprayed mist/particles (OECD, 2011). The difference in the central tendency and high-end value is representative of the difference in the spray equipment, engineering controls, and resulting exposure reduction. While central tendency generally represents the typical exposure of most workers to DEHP through spray application, a confluence of a subset of variables (*e.g.*, low ventilation, high-pressure spray, etc.) resulting in risk further below the benchmark is possible, and EPA evaluated such a situation based on an existing DEHP product. 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 reasonable for such exposures to occur in an acute one-day scenario. EPA identified a paint and coating product line that reinforces the exposure scenario for this OES, as it is spray applied in industrial settings using high-pressure spray application and with high temperatures, providing further support that the exposure scenario is accurate and potentially represents real worker exposures to paints and coatings. Therefore, based on consideration of both central tendency (*e.g.*, MOE of 26 for females of reproductive age) and high-end exposure risk estimates (*e.g.*, MOE of 0.4 for females of reproductive age), EPA has determined that the four COUs associated with this spray application of paints, coatings, adhesives, and sealants significantly contribute to the unreasonable risk to DEHP.

Similarly, EPA has determined that the following COU associated with formulation for diffusion bonding significantly contributes to unreasonable risk to workers from acute inhalation exposures:

- Industrial use – construction, paint, electrical, and metal products – adhesives and sealants

EPA assessed exposures from formulation for diffusion bonding using the previously discussed Automotive Refinishing Spray Coating Mist Inhalation Model. EPA used the 50th and 95th percentile mist concentrations along with the maximum and central tendency concentrations of DEHP identified in diffusion bonding formulations to estimate the central tendency and high-end inhalation exposures, respectively. The primary uncertainty comes from the lack of DEHP-specific monitoring data, with the ESD serving 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. The inhalation monitoring data used were specific to the spray application of coating materials, so the estimates may not be representative of exposure during other application methods. Considering the fact that the concentrations of DEHP used are specific to diffusion bonding products, along with the more generic mist concentrations derived from a relevant surrogate OES, EPA expects the resulting central tendency and high-end risk estimates to be plausible representations of worker exposures for this activity. Therefore, based on consideration of both central tendency (*e.g.*, MOE of 23 for females of reproductive age) and high-end exposure risk estimates (*e.g.*, MOE of 1.0 for females of reproductive age), EPA has determined that the COU associated with formulations for diffusion bonding significantly contribute to the unreasonable risk to DEHP. EPA only assessed mist exposures to DEHP over a full 8-hour work shift to estimate the level of exposure, though other activities may result in exposures other than mist and application duration may be variable depending on the job site. This scenario represents a worker with 8 exposure hours per day and 250 exposure days per year with continuous DEHP exposure based on workers using diffusion bonding formulations on every working day. However, since application sites may use DEHP-containing diffusion bonding formulations at lower or variable frequencies, EPA has determined the chronic exposures do not significantly contribute to the unreasonable risk based on central tendency estimates, better representing exposures over chronic durations as discussed, well above the benchmark MOE.

Overall, EPA has moderate to robust confidence in the quantitative risk estimates calculated for workers for inhalation and dermal exposure scenarios.

Risk to ONUs

EPA determined that eight COUs significantly contribute to unreasonable risk for ONUs from acute, intermediate, and chronic inhalation exposure:

- Processing – incorporation into formulation, mixture, or reaction product – plasticizer in plastic material and resin manufacturing; synthetic rubber manufacturing; basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint and coating manufacturing; adhesive manufacturing; basic inorganic chemical manufacturing; wholesale and retail trade; services; and ink, toner, and colorant manufacturing;
- Processing – incorporation into article – plasticizer in basic organic chemical manufacturing; plastics product manufacturing; rubber product manufacturing; miscellaneous manufacturing; and PVC extruding;
- Industrial use – construction, paint, electrical, and metal products – paints and coatings;
- Industrial use – construction, paint, electrical, and metal products – adhesives and sealants;
- Commercial use – construction, paint, electrical, and metal products – adhesives and sealants;
- Commercial use – construction, paint, electrical, and metal products – paints and coatings;
- Commercial use – furnishing, cleaning, treatment care products – all-purpose waxes and polishes; and
- Commercial use – packaging, paper, plastic, toys, hobby products – inks, toner, and colorants

For all OESs associated with risk estimates indicating risk, no reasonably available ONU exposure data were found, so the worker central tendency value was presented to represent ONU exposure. The MOEs for these ONUs use the adult male worker central tendency MOEs as surrogates. Because of this, there is lower confidence in the exposure values for ONUs.

For the two processing COUs listed above associated with rubber manufacturing, the ONU MOEs range from 5.3 to 7.7. Although the data used to inform these estimates are not from ONU-specific exposures, it is still high-quality monitoring data (PBZ and/or area sampling) from the European Commission document from a plant performing rubber calendaring (ECJRC, 2003). Additionally, even if the typical ONU exposures were slightly less than what is expected for the average worker, and EPA considered the ONU estimates for these COUs as an overestimate, there is still notable unreasonable risk to ONUs working in the same exposure area as those directly involved in rubber manufacturing with MOEs considerably below the benchmark. Therefore, EPA has determined that those two COUs significantly contribute to the unreasonable risk for ONUs from acute, intermediate, and chronic inhalation exposure.

Similarly, for the three COUs associated with the non-spray application of paints, coatings, adhesives, and sealants, and the one COU associated with the use of dyes, pigments, and fixing agents, the ONU MOEs range from 5.3 to 7.7. Although the data used to inform these estimates are not from ONU-specific exposures, it is still high-quality monitoring data (PBZ and/or area sampling) from the European Commission document from a plant performing rubber calendaring (ECJRC, 2003), which EPA considers a reasonable surrogate for these two scenarios, as discussed previously. Additionally, even if the typical ONU exposures were slightly less than what is expected for the average worker, and EPA considered the ONU estimates for these COUs as an overestimate, there is still notable unreasonable risk to ONUs working in the same exposure area as those directly involved in the non-spray application of paints, coatings, adhesives, and sealants, or those directly involved in the user of dyes, pigments, and fixing agents, with MOEs considerably below the benchmark. Therefore, EPA has determined that those four COUs significantly contribute to the unreasonable risk for ONUs from acute, intermediate, and chronic inhalation exposure, based on their associations with non-spray application of paints, coatings, adhesives, and sealants, and with use of dyes, pigments, and fixing agents.

As discussed previously, for the five industrial and commercial uses associated with spray application and formulation for diffusion bonding, EPA considered that it is reasonable for high-end exposures to occur in an acute one-day scenario. However, given the lack of ONU specific data supporting a high-end 8-hour exposure scenario, there is uncertainty in whether high-end estimates are appropriate or truly representative of an ONU exposure. Therefore, for ONUs working within the same exposure area as those directly involved in the spray painting or application of spray adhesive at auto refinishing shops, central tendency exposure of an adult male worker (*i.e.*, the less sensitive population to females of reproductive age) is used as a surrogate resulting in an MOE of 29 (MOE of 26 for formulation for diffusion bonding scenario) for ONUs under these five COUs. Although this MOE borders the benchmark MOE of 30, given the confluence of factors resulting in potential higher exposures reasonably expected to occur for an acute duration, it is possible that for these activities, the use of central tendency estimates for adult worker as a surrogate could be a potential underestimation of the exposures to ONUs, during 8-hour days where engineering controls are not addressing high-end exposures. Therefore, EPA has determined that these five commercial and industrial uses significantly contribute to unreasonable risk due to acute inhalation exposures to ONUs in spray application and formulation for diffusion bonding scenarios. EPA also notes, additionally, that three of the COUs associated with the spray application of paints, coatings, adhesives, and sealants were also assessed with the non-spray application of paints, coatings, adhesives, and sealants scenario, which also showed significant contributions to unreasonable risk to ONUs indicated for acute, intermediate, and chronic durations, as discussed above.

EPA notes that there is lower confidence in the exposure values for ONUs, given that EPA relied on central tendency exposure estimates for workers as surrogate data to estimate exposure.

COUs Which Do Not Significantly Contribute to Unreasonable Risk

For the Disposal COU which was evaluated with the Waste handling, treatment, and disposal OES, central tendency inhalation exposure estimates are more representative because the air concentrations were modeled assuming that: the dust present during waste handling, treatment, and disposal is at the level in the subset of the PNOR data from facilities associated with the NAICS code for Administrative and Support and Waste Management and Remediation Services (U.S. EPA, 2021d); the dust is comprised entirely of abraded plastic products containing DEHP; and the concentration of DEHP in the abraded plastic is the highest concentration reported in SDS (*i.e.*, 44% DEHP in Vinoprene 647 (HB Chemical, 2015)). The high-end estimates are more likely to occur under the more conservative combination of these parameters per Section 4.3.2.17.3. Although the waste handling, treatment, and disposal OES resulted in high-end, inhalation risk estimates for workers indicating potential risk, due to the factors discussed above describing the central tendency estimates to be most representative of this OES, EPA is determining that the associated Disposal COU does not significantly contribute to the unreasonable risk of DEHP to workers.

For three COUs (industrial use – other uses – solid rocket motor insulation and other aerospace applications; industrial use – other uses – automotive articles; and recycling) that were preliminarily determined to significantly contribute to unreasonable risk of DEHP to workers in the *Draft Risk Evaluation for DEHP* (U.S. EPA, 2025q), EPA is now determining that these COUs do not significantly contribute to the unreasonable risk of DEHP to workers, due to receipt of occupational inhalation exposure data through public comment relevant to the plastic compounding, plastic converting, as well as the recycling OES, that were used for these three COUs. In the draft risk evaluation, data from literature and from the OSHA CEHD were used for these occupational exposure estimates and resulted in MOEs indicating risk. However, the data received through public comment is more recent, from multiple sites, and with metadata that indicated variability in the worker activities, operations, and resulting exposures. These data had a data quality rating of high and included workers across a variety of departments and facility operations. This exposure data was incorporated into the occupational exposure assessment. As a result, risk estimates and conclusions were impacted for two plastic OESs, along with the recycling OES, as EPA used plastic converting inhalation monitoring data as surrogate data for recycling. Subsequently, MOEs for two COUs associated with the plastic converting OESs (*i.e.*, industrial use – other uses – solid rocket motor insulation and other aerospace applications and industrial use – other uses – automotive articles) and one COU associated with the recycling OES (*i.e.*, Processing – Recycling) are no longer indicating risk (see Table 4-17); EPA is therefore determining that these three COUs do not significantly contribute to unreasonable risk of DEHP to workers.

EPA has assessed one (the following) occupational COU qualitatively:

- Distribution in commerce.

For purposes of assessment, EPA determined distribution in commerce consists of the activities associated with the transportation of DEHP or DEHP-containing products and/or articles between sites that manufacture, process, and use DEHP. Additionally, this COU includes the transportation of DEHP containing wastes to recycling sites or for final disposal. EPA expects all the DEHP or DEHP-containing products and/or articles to be transported in a closed system or otherwise to be transported in a form (*e.g.*, articles containing DEHP) such that there is negligible potential for releases except during an accident. Therefore, no occupational exposures are reasonably expected to occur, no separate assessment was performed for estimating releases and exposures from distribution in commerce, and distribution in commerce would not result in unreasonable risk.

EPA's overall risk characterization confidence for workers is summarized in Section 4.3. More information on occupational risk estimates can be found in Section 4.3.2.

6.1.5 Consumers

Based on the consumer risk estimates and related risk factors, EPA is determining that DEHP does not present unreasonable risk of injury to human health for consumers.

Under the COUs, EPA assessed consumer risk from inhalation, ingestion, and dermal exposures, as well as aggregated exposure from these three routes. Consumer and bystander populations assessed were infants (<1 year), toddlers (1–2 years), preschoolers (3–5 years), middle childhood (6–10 years), young teens (11–15 years), teenagers (16–20), and adults (21+ years). A screening-level assessment for consumers was conducted, with refinements where applicable, considering high-intensity exposure scenario risk estimates, which rely on conservative assumptions to assess exposures that would be expected to be on the high-end of the exposure distribution.

From the single chemical consumer DEHP risk assessment, two consumer COUs, consumer use – furnishing, cleaning, treatment care products – fabric, textile, and leather products; furniture and furnishings; and consumer use – packaging, paper, plastic, toys, hobby products – toys, playground, and sporting equipment, resulted in acute, aggregate, high-intensity MOEs of 30 and 32 respectively, for infants. The COU, consumer use – furnishing, cleaning, treatment care products – fabric, textile, and leather products; furniture and furnishings, had a medium-intensity MOE of 160. Comparatively, based on Approach 2 of the cumulative risk assessment, the acute cumulative MOEs for infants were 26 and 28 for the high intensity, and 88 and 122 for medium intensity, respectively (Section 4.3.3 and Section 4.4.5). These COUs were assessed for DEHP exposure via multiple exposure pathways, including inhalation, ingestion, and mouthing. Several factors varied across the different intensity use scenarios (*e.g.*, low, medium, high), including: the surface area of the articles (considering the number and size), the weight fraction of DEHP in the article; and the mouthing intensity. See Sections 4.3.3 and 4.4.5 for further characterization and specific parameters for these COUs.

As discussed in Section 4.4.5, while EPA has high confidence in the data underlying each of the values representing these different exposure parameters, as they are based on extensive empirical evidence (*e.g.*, experiments and marketplace monitoring), EPA considers the confluence of factors that contribute to these high-intensity use scenarios (*e.g.*, high number, size, and weight fraction of DEHP in the article and harsh mouthing intensity) to be unlikely. Furthermore, regarding the mouthing intensity, the Danish Environmental Protection Agency's report on Determination of Migration Rates for Certain Phthalate stated that the "mild conditions result generally in lower migration rates compared with the *in vivo* adult migration rates for the simulation of children's sucking and chewing of soft PVC products." Therefore, it is possible that the use of harsh mouthing intensity overestimates exposure for infants. Given that, and the fact that the resulting MOEs from exposure to DEHP alone were at or slightly above the benchmark from high-intensity use for these two COUs, EPA expects that the cumulative MOEs for the high-intensity scenario, which are marginally below the benchmark, likewise overestimate exposure. In considering these combined uncertainties, EPA has determined that these COUs do not significantly contribute to unreasonable risk.

One COU, Consumer use – packaging, paper, plastic, toys and hobby products – packaging (excluding food packaging) and other articles with routine direct contact during normal use, including rubber articles; plastic articles (hard); plastic articles (soft) had risk estimates within the single chemical risk assessment indicating potential risk for the high-, medium-, and low-intensity use exposure scenarios in a screening dermal exposure risk assessment for air beds. Because risk was indicated, EPA refined the screening approach used for dermal exposures to air beds and, instead of using a flux-limited dermal absorption model, used a more refined approach which models dermal absorption using DEHP concentration in the article, material and DEHP specific partition coefficients, and a barrier bedsheet between the air bed and skin (Section 4.1.2.1). The refinement with inclusion of a bedsheet and consideration of an 8-hour duration did not result in a risk estimate indicating risk, even without clothing (*e.g.*, 50% body surface). Based on the analysis conducted, EPA has determined that this COU does not significantly contribute to unreasonable risk (see Section 2.3.2 of *Consumer and Indoor Dust Exposure Assessment for DEHP*).

Three COUs were assessed qualitatively for consumers: Consumer use – packaging, paper, plastic, toys hobby products – ink, toner and colorants; Consumer use – construction, paint, electrical, and metal products – batteries; and Disposal. The qualitative assessments for these COUs are summarized in Section 4.3.3 and do not indicate risk. As such, EPA has determined that these COUs do not significantly contribute to unreasonable risk.

EPA's overall confidence in the acute, intermediate, and chronic consumer inhalation, ingestion, and dermal exposure risk estimates ranges from moderate to robust. EPA has moderate to robust confidence in the risk estimates calculated for consumers inhalation, ingestion, and dermal exposure scenarios (Section 4.3.3). EPA's confidence in the cumulative consumer MOEs is moderate to robust (Section 4.4.5.2).

6.1.6 General Population

Based on the risk estimates, EPA did not identify risk to the general population from the following exposure routes and pathways for DEHP:

- acute and chronic soil ingestion exposure from air deposition to soil;
- acute and chronic dermal and oral exposure to surface water (incidental ingestion and dermal contact from swimming, and ingestion of drinking water);
- acute and chronic ingestion exposure from fish consumption; and
- acute and chronic inhalation exposure to ambient air.

EPA employed a screening method assessing high-end exposure scenarios with data that reflects exposure expected to occur in proximity to releasing facilities, including to fenceline communities. The Agency evaluated surface water, drinking water, fish ingestion, ambient air, and soil via deposition from ambient air pathways using 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 for a COU and given pathway of exposure, then EPA determined that the pathway was not a pathway of concern, and the pathway was not evaluated 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 if available, additional subpopulations and COUs.

No MOEs indicated risk for the highest exposure scenarios for surface water, drinking water, ambient air and soil via deposition from ambient air. The ambient air assessment evaluated exposures to the general population in proximity to releasing facilities, including fenceline communities, through a screening analysis using the highest exposure scenario. This resulted in MOEs well above benchmark. For fish ingestion, MOEs indicated risk only for the Use of automotive care products OES, which discharges to multiple media types. EPA has only slight confidence in risk estimates for the OESs with multimedia releases in the absence of information relative to what fraction is released to water, as described further in Section 4.1.3.1. Without further information, EPA is unable to refine its analysis specifically for multimedia releases because of the resultant slight confidence and high uncertainty in assuming what fraction may be released to water. However, EPA did use monitoring studies to determine that no fish tissue concentration as high as those associated with Use of automotive care products OES have been measured. EPA relied on the Plastic compounding OES, which had the highest reported release to water, for its fish ingestion assessment and found that there were no MOEs below the benchmark. Therefore, using a screening level approach, with additional refinements where needed, described for all pathways in Section 4.1.3, exposure to DEHP through biosolids, landfills, surface water, drinking water, fish ingestion, and ambient air were not determined to be pathways of concern for any COU listed in Table 3-1. Considering this, EPA has determined that DEHP does not significantly contribute to unreasonable risk to the general population through the above listed pathways.

EPA has not derived risk estimates for the land pathway (*i.e.*, landfills and application of biosolids), including down-the-drain releases of consumer products and landfill disposal of consumer articles.

Exposure potential was based on physical and chemical properties, and/or available relevant data. DEHP can leach from landfill material but is expected to have limited mobility beyond the landfill. DEHP in leachate is unlikely to infiltrate groundwater due to the high affinity to organic matter and sediment. Interpretation of the physical and chemical property data also suggest that DEHP is unlikely to infiltrate groundwater or surface runoff from landfills and is also unlikely to migrate to groundwater via runoff after land application of biosolids due to its low water solubility and high affinity for sorption to soil. Considering this, EPA is determining that the COUs do not significantly contribute to unreasonable risk of DEHP due to the general population exposure to soil and water contaminated with DEHP migrating from biosolids and landfills, including down-the-drain releases and disposal of consumer products.

EPA has robust confidence that modeled releases used are appropriately conservative for a screening level analysis. Therefore, EPA has robust confidence that no general population exposure scenarios via the air, land, or surface water pathways will lead to greater exposures than presented in this evaluation. Despite moderate confidence in the estimated values themselves, confidence in exposure estimates capturing high-end exposure scenarios was robust given the conservative assumptions used for the estimates. Along with EPA's robust confidence in the non-cancer POD selected to characterize risk from acute, intermediate, and chronic duration exposures to DEHP (see Section 4.2 and (U.S. EPA, 2025aa)), EPA has robust confidence that the risk estimates calculated for the general population, including fenceline communities, were conservative and appropriate for a screening level analysis. Sections 4.1.3 and 4.3.4 provide more detail about the general population assessment.

6.2 Environment

Based on the risk evaluation for DEHP—including the risk estimates, the environmental effects of DEHP, the exposures, the physical and chemical properties of DEHP, and the consideration of uncertainties as well as feedback received during the public comment period and SACC review —EPA is determining that DEHP presents unreasonable risk of injury to the environment driven by significant contributions to unreasonable risk due to chronic exposures to aquatic organisms in surface water from 20 COUs, and sediment-dwelling organisms in sediment pore water from 18 COUs, as follows:

- Manufacturing – domestic manufacturing (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);
- Manufacturing – importing (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);
- Processing – incorporation into formulation, mixture, or reaction product – plasticizer in plastic material and resin manufacturing; synthetic rubber manufacturing; basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint and coating manufacturing; adhesive manufacturing; basic inorganic chemical manufacturing; wholesale and retail trade; services; and ink, toner, and colorant manufacturing (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);
- Processing – incorporation into article – plasticizer in basic organic chemical manufacturing; plastics product manufacturing; rubber product manufacturing; miscellaneous manufacturing; and PVC extruding (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);
- Processing – other uses – miscellaneous processing (cyclic crude and intermediate manufacturing; processing aid specific to hydraulic fracturing) (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);
- Processing – repackaging – repackaging in wholesale and retail trade and in paint and coating manufacturing (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);

- Industrial use – construction, paint, electrical, and metal products – paints and coatings (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);
- Industrial use – construction, paint, electrical, and metal products – adhesives and sealants (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);
- Industrial use – other uses – solid rocket motor insulation and other aerospace applications (aquatic vertebrates only through surface water);
- Industrial use – other uses – automotive articles (aquatic vertebrates only through surface water);
- Industrial use – other uses – hydraulic fracturing (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);
- Commercial use – construction, paint, electrical, and metal products – adhesives and sealants (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);
- Commercial use – construction, paint, electrical, and metal products – paints and coatings (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);
- Commercial use – furnishing, cleaning, treatment care products – all-purpose waxes and polishes (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);
- Commercial use – packaging, paper, plastic, toys, hobby products – ink, toner, and colorants (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);
- Commercial use – furnishing, cleaning, treatment care products – fabric enhancer (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);
- Commercial use – furnishing, cleaning, treatment care products – fabric, textile, and leather products; furniture and furnishings (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);
- Commercial use – other uses – laboratory chemicals (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water);
- Commercial use – other uses – automotive articles and products (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water); and
- Disposal (aquatic vertebrates and sediment-dwelling invertebrates through surface water and pore water).

Calculated risk quotients (RQs) can provide a risk profile by presenting a range of estimates for different environmental hazard effects for different COUs. An RQ equal to 1 indicates that the exposures are the same as the concentration that has been shown to cause effects. An RQ is less than 1 when the exposure is less than the effect concentration. This generally indicates that there is not risk of injury to the environment that would support a determination of unreasonable risk for DEHP. An RQ is greater than 1 when the exposure is greater than the effect concentration. This generally indicates that there is risk of injury to the environment that would support a determination of unreasonable risk for DEHP. Additionally, if a chronic RQ is 1 or greater, the Agency evaluates whether the chronic RQ is 1 or greater for 21 days or more for aquatic species, or 31 days or more for sediment-dwelling species, before making a determination of unreasonable risk. Risk was also characterized qualitatively for specific receptor groups to support conclusions (Table 5-9). Consistent with EPA's determination of unreasonable risk to human health, the RQ is not treated as a "bright-line" and other risk-based factors may be considered (*e.g.,* confidence in the hazard and exposure characterization, duration, magnitude, uncertainty) for purposes of making an unreasonable risk determination.

6.2.1 Populations and Exposures EPA Assessed for the Environment

EPA estimated environmental exposures to both aquatic and terrestrial species based on releases of DEHP and concentrations of DEHP in the environment as part of its environmental risk assessment. For aquatic organisms inhabiting the water column and benthic zone, EPA estimated exposures from surface water and sediment (including pore water). EPA estimated exposure to aquatic plants and algae from surface water. For soil invertebrates and terrestrial plants, EPA estimated exposures from air deposition to soil. EPA estimated exposures to terrestrial mammals, from biosolids and landfills. Additionally, for terrestrial organisms, EPA estimated exposures from trophic transfer of DEHP from soil and surface water.

EPA assessed risk for aquatic vertebrates and sediment-dwelling organisms using a bounding assessment, where the OES resulting in the highest surface water release concentrations represented the upper bound, and the OES resulting in the lowest surface water release concentrations represented the lower bound, according to TRI data. Surface water RQ values for site specific TRI-derived DEHP concentrations represent the highest and lowest releasing COUs (Table 5-4) and modeled generic scenario-based COUs (Table 5-6). Therefore, this method of assessment captures releases from all COUs with reported water releases included within the bounding assessment. For aquatic organisms, EPA has quantitatively evaluated exposures via surface water and subsequent deposition to sediment. For aquatic plants and algae, the Agency has evaluated exposures qualitatively since a hazard threshold could not be established. Therefore, EPA is determining that DEHP is unlikely to present unreasonable risk to aquatic plants or algae. Similarly, for aquatic vertebrates and aquatic invertebrates, the data suggests that DEHP has low acute toxicity, and no definitive effects were observed below the limit of water solubility. Therefore, EPA is determining that DEHP is unlikely to present unreasonable risk from acute exposure to aquatic species. For aquatic vertebrates and sediment-dwelling invertebrates, the Agency has quantitatively evaluated chronic exposures via surface water and sediment concentrations resulting from COU releases. As previously explained, EPA is determining that those COUs significantly contribute to unreasonable risk of DEHP from chronic exposures to aquatic vertebrates and sediment-dwelling invertebrates.

For terrestrial plants, the Agency has evaluated exposures via air deposition to soil and biosolids application using a screening level risk assessment that applies the OES with the highest air release or considers if air releases were not reported. The assessment results do not indicate risk via the air deposition to soil pathway. Soil surface concentrations for biosolids were calculated using the minimum and maximum recommended application rates for each agricultural crop cover. The maximum concentration of DEHP within topsoil resulted in an RQ of 0.62 for terrestrial plants (Table 5-8), indicating no unreasonable risk from biosolids application.

For terrestrial vertebrates (*i.e.*, mammals), terrestrial invertebrates, and birds, the Agency evaluated exposures qualitatively, due to limited DEHP bioavailability in the terrestrial environment, with assessment results not indicating unreasonable risk.

EPA qualitatively evaluated exposures for all environmental receptors from trophic transfer, as the physical properties, fate, and exposure of the chemical determined that it does not biomagnify and is characterized as demonstrating trophic dilution. Additionally, EPA qualitatively evaluated exposures from biosolids (excluding terrestrial plants, for which a quantitative biosolids assessment was conducted), landfills, and down the drain disposal associated with consumer use.

EPA's confidence in the aquatic exposure assessment is robust for COUs with TRI and DMR release data that were evaluated using a bounding assessment. As reflected in Table 5-4, DEHP concentrations modeled via TRI data are within an order of magnitude of the maximum environmental monitoring sample values for DEHP from surface water reported within the EPA's Six-Year Review of Drinking Water Standards (U.S. EPA, 2025ah). Releases modeled using generic scenarios were paired with the generic receiving water body flow rate to model DEHP concentrations (Table 5-6). These concentrations are higher than any monitored water concentrations of DEHP from different monitoring programs shown in Table 5-1 and higher than water concentrations based on actual reported releases. EPA has slight confidence in the environmental concentration and resulting RQs modeled using generic scenarios, but moderate confidence that it is an upper bound estimate as the concentrations are higher than any monitored value and concentrations resulting from actual reported releases. More information about the Agency's confidence in the estimates for these COUs and the evidence available about the aquatic, terrestrial, and trophic transfer exposure assessments are provided in Sections 5.3.5 and 5.3.6, and in Table 5-9 of this risk evaluation.

6.2.2 Summary of Environmental Effects

EPA is determining that 17 COUs assessed quantitatively and 3 COUs assessed with modeled generic scenarios significantly contribute to unreasonable risk to the environment presented by DEHP because of the following chronic effects:

- reduced growth and development for aquatic vertebrates; and
- reduced growth and development for sediment-dwelling invertebrates.

There was no hazard threshold identified from chronic DEHP exposure for pelagic invertebrates, or aquatic invertebrates in the water column, because no studies below the limit of water solubility were available to establish the threshold; however, the results of the quantified risk estimates using COCs representing chronic DEHP exposures to fish (*i.e.*, aquatic vertebrates) and sediment-dwelling invertebrates add to the weight of scientific evidence supporting the identification of risk to the aquatic environment for this chemical as discussed in Section 5.3.6.

As discussed in Sections 0 and 5.3.5, several hazard studies indicate that DEHP does not harm aquatic species from acute exposure durations (*i.e.*, 48- or 95-hour exposures); however, exposure to DEHP for longer periods of time at lower concentrations has been shown to impact sensitive endpoints of growth, development, and reproduction in some studies. EPA has robust confidence that DEHP poses chronic hazard to aquatic vertebrates, with studies indicating lowest observable effect concentrations on growth, development, and reproduction at concentrations well below 1 µg/L (Corradetti et al., 2013; Zanotelli et al., 2010; Chikae et al., 2004a; Chikae et al., 2004b). The NOAEC and LOAEC values in the Chikae study were 0.01 and 0.1 µg/L DEHP, respectively. Aquatic invertebrates are also sensitive to chronic exposures of DEHP, with moderate confidence from DEHP exposure in sediment organisms altering growth within midge exposed for 32 days to 0.3 µg/L DEHP (Kwak and Lee, 2005) with impacts to male body weight and female emergence. It is noted that Appendix A of the *Environmental Hazard Assessment for DEHP* describes studies that do not show effects at concentrations below 1 µg/L (U.S. EPA, 2025r).

Other authoritative sources have designated limits for DEHP in efforts to recognize concentrations that could be used to maintain environmental quality standards. Most recently, Health Canada (Health Canada, 2020) derived a predicted no effect concentration (PNEC) of 0.07 µg/L from 21-day exposure of DEHP to zebrafish embryos (Corradetti et al., 2013). The Health Canada (Health Canada, 2020) assessment concluded that "DEHP has the potential to cause adverse effects in populations of aquatic organisms in Canada at current exposure levels". Further examination indicates that the Health Canada PNEC was represented by a single unbounded LOEC and an assessment factor of 3 while the current chronic aquatic vertebrate COC within EPA's assessment was derived using the geometric mean of the NOAEC and LOAEC data and including an assessment factor of 10. The 2009 *Toxicological Profile for DEHP* by the California Environmental Protection Agency (OEHHA, 2009) was not able to derive an environmental risk limit (ERL) for water, due to uncertainties in water solubility and a lack of chronic studies to aquatic organisms, however, did cite the derivation of an ERL of 0.19 µg/L from older work by van Wezel (van Wezel et al., 2000) using sediment hazard data. The Texas Commission on Environmental Quality followed guidance RG-194 (RG-194; accessed December 19, 2025) to establish freshwater chronic benchmarks for DEHP utilizing acute exposure data from Mayer and Ellersieck (Mayer and Ellersieck, 1986) by applying a 0.1 multiplier to the acute LC50 of 200 µg/L for a value of 20 µg/L. Although this is not an exhaustive review of ERLs from authoritative sources, it demonstrates the range of values and the uncertainty associated with deriving chronic limits for DEHP.

Modeled concentrations of DEHP within surface water are generally no higher than the maximum measured water concentration measured in the studies summarized in Table 5-1, although it should be noted that the monitoring data typically shows a low frequency of detection and summary statistics were not provided. Modeled surface water concentrations are within the same order of magnitude as the maximum monitoring data presented in Table 5-1, which provides confidence in the ability to determine that DEHP is entering the environment, although the exact source of monitored data on DEHP summarized within Table 5-1 is unknown. The concentrations of DEHP used to derive RQs for COUs are largely represented with site-specific TRI release data. When using reported TRI releases, EPA was able to determine facility-specific receiving waterbody information to pair with reported releases to model surface water concentrations, which increases the confidence for the TRI release upper bound (Plastic compounding) and lower bound (Plastic converting) estimates. EPA notes that there are roughly four orders of magnitude difference in the upper and lower bound modeled concentrations, depending on the flow rate assumed.

More information about EPA's confidence in the aquatic, terrestrial, and trophic transfer hazard assessments is provided in Sections 0 and 5.3 of this risk evaluation.

6.2.3 Basis for Unreasonable Risk to the Environment

Based on the assessment, EPA is determining that 20 COUs significantly contribute to the unreasonable risk to the environment. Of these 20 COUs, 17 COUs were assessed using a bounding assessment based on two OESs representing the upper bound (plastic compounding) and the lower bound (plastic converting) of exposures from water releases (see Table 5-4 and Table 5-5 for RQ values for surface water and sediment, respectively). Direct releases to surface water reported via TRI and DMR were applied as the actual loading to surface water, including any onsite treatment prior to discharge. As a result, WWTP efficiency is represented with a 64 percent removal based on a comprehensive USPOTW survey (U.S. EPA, 1982) and examples of this application are demonstrated within Table 5-6. EPA acknowledges that treatment removal of DEHP is represented across a range of wastewater removal efficiencies within the literature; the value of 64 percent removal was selected as a conservative removal value for U.S. WWTPs based on the discussion and confidence presented in the *Physical Chemistry and Fate and Transport Assessment for DEHP* (U.S. EPA, 2025af). As noted in Section 5.3.5, the EPA method for measuring phthalates in water is 8061A SW846, with a MDL for DEHP of 0.270 µg/L (U.S. EPA, 1998b).

For the surface water risk estimates (Table 5-4), similar to all OESs with surface water releases (including the upper bound OES, with RQ = >937.5 at all flow rates), even the lowest-releasing OES, or the lower bound, has RQs indicating risk at all flow rates, and using TRI and DMR monitoring data which accounts for wastewater treatment (RQ = 7.2 at the harmonic mean flow rate; RQ = 10.6 at 30Q5; and RQ = 14.1 at 7Q10); therefore all 17 COUs in this bounding assessment indicate risk to the environment through surface water (see Section 5.3.2 for additional characterization). These risk estimates were calculated using a COC derived from the chronic value (ChV) of 0.032 µg/L, which is the geometric mean of the NOAEC of 0.01 µg/L and the LOAEC of 0.1 µg/L divided by an assessment factor (AF) of 10 (Chikae et al., 2004a; Chikae et al., 2004b). EPA notes that in total, eight chronic aquatic studies have reported endpoints less than 3.0 µg/L with organism level effects on growth, reproduction, and development. Where concentrations exceeded the limit of solubility for DEHP (3.0 µg/L), EPA used 3.0 µg/L as the value for surface water concentration in the calculation of RQs, and risk was still indicated. EPA has determined that these 17 COUs within the bounding assessment significantly contribute to unreasonable risk to the environment from chronic exposures for aquatic vertebrates through surface water.

For the sediment pore water risk estimates (Table 5-5), risk estimates for the lowest-releasing OES, or lower bound, are not indicating risk. However, as explained in Section 5.3.2, all other facilities reporting releases resulted in pore water concentrations with resulting RQs greater than 1, as reflected by the second lowest-releasing OES (manufacturing at the 7Q10 flow rate) resulting in a RQ of 13 when using the COC for sediment-dwelling invertebrates of 0.03 µg/L. Therefore, with the exception of two COUs (Industrial use – other uses – solid rocket motor insulation and other aerospace applications; and Industrial use – other uses – automotive articles) mapped exclusively to the lower bound OES, all other COUs within this bounding assessment indicate risk to sediment-dwelling organisms, based on results from TRI and DMR monitoring data accounting for wastewater treatment, and RQs across all flow rates. EPA has determined that these 15 COUs (of the 17 COUs within the bounding assessment) significantly contribute to unreasonable risk to the environment from chronic exposures for sediment-dwelling invertebrates through sediment pore water.

The robust confidence for the modeled surface water and benthic pore water bounding concentrations of DEHP based on release data, combined with robust and moderate hazard confidences for aquatic and sediment-dwelling assessments, respectively, resulted in overall confidences of robust and moderate, respectively, in the risk characterization that the chronic aquatic assessment and chronic sediment-dwelling assessment are protective (Table 5-4 and Table 5-5, respectively). This confidence is reinforced by the fact that RQs would still be greater than 1 for all scenarios even if the chronic value hazard threshold (ChV; geometric mean of NOAEC and LOAEC values from) of 0.03 µg/L identified for aquatic vertebrates (Chikae et al., 2004a; Chikae et al., 2004b) was applied to COUs representing within Table 5-4 and Table 5-5. However, EPA notes that there is variation in the demonstrated toxicity levels in various studies, and there is uncertainty in regard to the magnitude of potential overestimation. Discussion regarding the choices on the risk inputs and availability of information can be found in Sections 5.3.5 and 5.3.6.

Three COUs (Industrial use – other uses – hydraulic fracturing; Commercial use – other uses – laboratory chemicals; and Commercial use – other uses – automotive articles and products) were assessed using modeled, generic release scenarios. The Industrial use – other uses – hydraulic fracturing COU was assessed using a generic scenario with a surface water release, while the scenarios for the remaining two COUs encompass environmental releases that discharge to a combination of surface water, incineration, or landfill. EPA is unable to quantify the release to water for COUs with releases to a combination of surface water, incineration, or landfill due to the lack of specificity regarding the media of release. Surface and pore water concentrations of DEHP modeled for the Commercial use – other uses – automotive articles and products COU result in concentrations above the highest bound of DEHP concentrations from TRI releases, resulting in a RQ value greater than 1. The remaining two COUs result in concentrations within the bounds of the lowest and highest DEHP concentrations from TRI releases; therefore, they also result in RQs greater than 1 under several flow conditions and release distributions (Table 5-6). EPA acknowledges that although COUs associated with OESs modeled from generic scenarios result in lower confidence compared to TRI releases, the chronic COCs for aquatic species indicate potential hazard. The robust and moderate confidences, respectively, in aquatic and benthic hazard thresholds increase confidence in the assessment for these three COUs. Therefore, based on this evaluation, the COUs based on generic scenarios result in effects to aquatic organisms, despite the lower confidence in the exposure level and given the sensitive hazard values for aquatic organisms. EPA has determined that these three COUs significantly contribute to unreasonable risk to the environment. See Section 5.3.2 for more information regarding the aquatic assessment. Table 5-10 summarizes how each COU was assessed.

Further discussion of the bounding approach and the modeled generic scenarios can be found in Sections 5.1 and Section 5.3.2, respectively.

EPA has determined that nine occupational COUs do not significantly contribute to unreasonable risk to the environment. Since all TRI sites associated with these COUs report no water releases, EPA is concluding that these nine COUs result in no releases to the surface water pathway. Additionally, these COUs result in no risk through the air deposition to soil or biosolid application pathways. More information regarding environmental release estimates and the associated weight of scientific evidence conclusions is in Section 3.2.2 of this risk evaluation. The nine occupational COUs associated with an OES reporting no water releases and therefore not contributing to unreasonable risk to the environment are as follows:

- Processing - recycling;
- Commercial use – automotive, fuel, agriculture, outdoor use products – lawn and garden care products;
- Commercial use – construction, paint, electrical, and metal products – batteries and capacitors;
- Commercial use – construction, paint, electrical, and metal products – construction and building materials covering large surface areas, including paper articles; metal articles; stone, plaster, cement, glass and ceramic articles;
- Commercial use – construction, paint, electrical, and metal products – machinery, mechanical appliances, electrical/electronic articles;
- Commercial use – furnishing, cleaning, treatment care products – floor coverings; construction and building materials covering large surface areas including stone, plaster, cement, glass and ceramic articles; fabrics, textiles, and apparel;
- Commercial use – packaging, paper, plastic, toys, hobby products – packaging (excluding food packaging) and other articles with routine direct contact during normal Use, including rubber articles; plastic articles (hard); plastic articles (soft);
- Commercial use – packaging, paper, plastic, toys, hobby products – packaging (excluding food packaging), including paper articles; and
- Commercial use – packaging, paper, plastic, toys, hobby products – toys, playground, and sporting equipment.

In addition, releases to the environment from the 14 consumer COUs are anticipated to be more dispersed and less direct than DEHP releases from occupational COUs with quantified risk estimates for aquatic and terrestrial receptors. See Section 5.1 and Table 5-10 for additional information. As noted in Section 5.1, EPA did not quantify these end-of-life and down-the-drain exposures due to limited information on source attribution of the consumer COUs. Section 3.1.4 provides further details on the qualitative assessment of consumer disposal of DEHP containing products and articles. Although EPA acknowledges that there may be DEHP releases to the environment from consumer disposal, the Agency did not quantitatively assess these scenarios due to limited information, monitoring data, or modeling tools. DEHP from down-the-drain disposal of consumer products or landfill disposal of consumer articles is not likely to lead to environmental concentrations that exceed hazard values for aquatic and terrestrial organisms. It is important to note that the Disposal COU encompasses DEHP contained in a waste stream collected from facilities, or DEHP contained in wastewater discharged by occupational users, in addition to consumer products and articles that are disposed of, as explained in Appendix E.

EPA has determined that DEHP does not significantly contribute to unreasonable risk from acute exposures to aquatic vertebrates and aquatic invertebrates. The data suggest that DEHP has low acute toxicity as no definitive effects were observed below the limit of water solubility. Thus, EPA has determined that DEHP is unlikely to result in risk for acute exposure to aquatic species, including sediment-dwelling organisms (Section 5.3.2).

Although there are limited measured data on DEHP in landfill leachates, the data suggest that DEHP is unlikely to be present in landfill leachates. Further, the small amounts of DEHP that could potentially be in landfill leachates will have limited mobility and are unlikely to infiltrate groundwater due to high affinity of DEHP for organic compounds that would be present in receiving soil and sediment (U.S. EPA, 2025s).

EPA has determined that DEHP does not significantly contribute to unreasonable risk to terrestrial plants through air deposition to soil or biosolid application to soil pathways, as the screening level RQ was less than 1 for terrestrial plants exposed via air deposition (fugitive or stack release), and the RQ was less than 1 for terrestrial plants exposed via biosolid application using a generic application scenarios and biosolid concentrations collected from the national survey.

EPA has determined that DEHP does not significantly contribute to unreasonable risk to terrestrial mammals, terrestrial invertebrates, and birds, based on conservative assumptions of environmental topsoil concentrations and food consumption; the absence of studies with measurable effects for terrestrial invertebrates; and biota monitoring studies recording values orders of magnitude less than concentrations used in bird studies.

EPA assessed the potential for trophic transfer of DEHP through food webs to wildlife using the available environmental monitoring information and physical and chemical properties. DEHP is not expected to be persistent in the environment as it is expected to degrade rapidly under most environmental conditions (though there is delayed biodegradation in low-oxygen media). Furthermore, DEHP's bioavailability is expected to be limited (see Section 5.3.4). With respect to trophic transfer, concentrations of DEHP in soil (biosolids, landfills, air deposition) and air is limited or is not expected to be bioavailable. Therefore, EPA is determining that DEHP does not significantly contribute to unreasonable risk to the environment via trophic transfer. The Agency has robust confidence that that DEHP is not readily found in organism tissues, and if it is found, DEHP is observed in relatively low concentrations. Additionally, since DEHP has low bioaccumulation and biomagnification potential in aquatic and terrestrial organisms, it has a low potential for trophic transfer through food webs. Therefore, EPA has determined that DEHP does not significantly contribute to unreasonable risk to the environment via trophic transfer.

EPA evaluated activities resulting in exposures associated with distribution in commerce throughout the various life cycle stages and COUs (*e.g.*, manufacturing, processing, industrial use, commercial use, transportation) rather than a single distribution scenario. The Agency expects that environmental releases from distribution in commerce will be similar or less than the exposure estimates from the COUs evaluated that did not exceed hazard to ecological receptors. Furthermore, EPA expects all the DEHP or DEHP-containing products and/or articles to be transported in a closed system or otherwise to be transported in a form (*e.g.*, articles containing DEHP) such that there is negligible potential for releases except during an incident. Therefore, no separate assessment was performed for estimating releases and exposures from distribution in commerce.

Environmental risk characterization confidence levels ranged from moderate to robust for all quantitative assessments; however, there is uncertainty in the evaluation that may lead to overestimates in the contributions to unreasonable risk. EPA has identified areas of uncertainty, as described in Section 5.3.6 (*e.g.*, variations in surface water concentrations per TRI data, flow rate representation, wastewater treatment efficiencies, derivation of the COC, and limit of solubility) that impact the RQ calculation and ultimately the unreasonable risk determination. Because EPA purposefully chose assumptions and inputs that err on the side of protection, the compounded conservatisms may overestimate the RQs. More information about EPA's confidence and uncertainties associated with the evidence available regarding the environmental risk assessment are provided in Sections 5.3.5 and 5.3.6 and in Table 5-9 of this risk evaluation.

6.3 Additional Information Regarding the Basis for the Risk Determination

Table 6-1 summarizes the basis for this unreasonable risk determination of injury to human health presented in this DEHP risk evaluation. In this table, bold text and shading indicate that the COU significantly contributes to unreasonable risk. This table identifies the duration of exposure (*e.g.*, acute, intermediate, or chronic duration) and the exposure route to the population. As explained in Section 6.2, for this unreasonable risk determination, EPA has considered the effects of DEHP to human health, including PESS, as well as a range of risk estimates as appropriate, risk related factors and the confidence in the analysis. See Sections 4.3 and 5.3 for a summary of risk estimates, and refer to Sections 5.3.2 and 6.2, for information on the risk estimates from the environmental assessment.

Table 6-1. Overall Worker Risk Summary Table

COU		OES	Worker Population	Exposure Level	Inhalation Risk Estimates (Benchmark MOE = 30)				Dermal Risk Estimates (Benchmark MOE = 30)			Aggregate Risk Estimates (Benchmark MOE = 30)			
Life Cycle Stage – Category	Subcategory				Acute	Inter.	Chronic	APF[a]	Acute	Inter.	Chronic	Acute	Inter.	Chronic	APF[a]
Manufacturing – Domestic Manufacturing	Domestic manufacturing	Manufacturing	Average Adult Worker	CT	733	1,000	1,071	N/A	15,816	21,567	23,091	701	956	1,023	N/A
				HE	400	545	584	N/A	7,908	10,784	11,546	381	519	556	N/A
			Females of Reproductive Age	CT	664	905	969	N/A	17,214	23,474	25,133	639	872	933	N/A
				HE	362	494	529	N/A	8,607	11,737	12,566	348	474	507	N/A
			ONU [b]	CT	733	1,000	1,071	N/A	–	–	–	–	–	–	–
Manufacturing – Importing	Importing	Import and repackaging	Average Adult Worker	CT	63	86	92	N/A	15,816	21,567	23,091	63	85	91	N/A
				HE	**17**	23	25	APF 5	7,908	10,784	11,546	17	23	25	APF 5
Processing – Repacking	Repackaging in wholesale and retail trade and in paint and coating manufacturing		Females of Reproductive Age	CT	57	78	83	N/A	17,214	23,474	25,133	57	77	83	N/A
				HE	**15**	**21**	22	APF 5	8,607	11,737	12,566	15	21	22	APF 5
			ONU [b]	CT	63	86	92	N/A	–	–	–	–	–	–	–
Processing – Incorporation into article	Plasticizer in basic organic chemical manufacturing; plastics product manufacturing; rubber product manufacturing; miscellaneous manufacturing; PVC extruding	Rubber manufacturing	Average Adult Worker	CT	**5.3**	**7.2**	**7.7**	APF 10	428	584	625	5.2	7.1	7.6	APF 10
				HE	**1.1**	**1.5**	**1.6**	APF 50	214	292	313	1.1	1.5	1.6	APF 50
Processing – Incorporation into formulation, mixture, or reaction product	Plasticizer in basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint and coating manufacturing; adhesive manufacturing; plastic material and resin manufacturing; synthetic rubber manufacturing; all other basic inorganic chemical manufacturing; wholesale and retail trade; services; ink, toner and colorant manufacturing		Females of Reproductive Age	CT	**4.8**	**6.5**	**7.0**	APF 10	466	636	681	4.7	6.4	6.9	APF 10
				HE	**1.0**	**1.3**	**1.4**	APF 50	233	318	340	1.0	1.3	1.4	APF 50
			ONU [b]	CT	**5.3**	**7.2**	**7.7**	APF 10	428	584	625	5.2	7.1	7.6	APF 10
Processing – Incorporation into formulation, mixture, or reaction product	Plasticizer in basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint and coating manufacturing; adhesive manufacturing; plastic material and resin manufacturing; synthetic rubber manufacturing; all other basic inorganic chemical manufacturing; wholesale and retail trade; services; ink, toner and colorant manufacturing	Plastic compounding	Average Adult Worker	CT	104	141	151	N/A	428	584	625	83	114	122	N/A
				HE	104	141	151	N/A	214	292	313	70	95	102	N/A
			Females of Reproductive Age	CT	94	128	137	N/A	466	636	681	78	106	114	N/A
				HE	94	128	137	N/A	233	318	340	67	91	98	N/A
			ONU [b]	CT	104	141	151	N/A	428	584	625	83	114	122	N/A

COU		OES	Worker Population	Exposure Level	Inhalation Risk Estimates (Benchmark MOE = 30)				Dermal Risk Estimates (Benchmark MOE = 30)			Aggregate Risk Estimates (Benchmark MOE = 30)			
Life Cycle Stage – Category	Subcategory				Acute	Inter.	Chronic	APF[a]	Acute	Inter.	Chronic	Acute	Inter.	Chronic	APF[a]
Processing – Incorporation into formulation, mixture, or reaction product	Plasticizer in basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint and coating manufacturing; adhesive manufacturing; plastic material and resin manufacturing; synthetic rubber manufacturing; all other basic inorganic chemical manufacturing; wholesale and retail trade; services; ink, toner and colorant manufacturing	Incorporation into formulation, mixture, or reaction product	Average Adult Worker	CT	733	1,000	1,071	N/A	15,816	21,567	23,091	701	956	1,023	N/A
				HE	400	545	584	N/A	7,908	10,784	11,546	381	519	556	N/A
			Females of Reproductive Age	CT	664	905	969	N/A	17,214	23,474	25,133	639	872	933	N/A
Processing – Other uses	Miscellaneous processing (cyclic crude and intermediate manufacturing; processing aid specific to hydraulic fracturing)			HE	362	494	529	N/A	8,607	11,737	12,566	348	474	507	N/A
			ONU[b]	CT	733	1,000	1,071	N/A	–	–	–	–	–	–	–
Processing – Incorporation into article	Plasticizer in basic organic chemical manufacturing; plastics product manufacturing; rubber product manufacturing; miscellaneous manufacturing; PVC extruding	Plastic converting	Average Adult Worker	CT	173	235	252	N/A	428	584	625	123	168	180	N/A
				HE	173	235	252	N/A	214	292	313	96	130	140	N/A
Industrial Use – Other uses	Solid rocket motor insulation and other aerospace applications		Females of Reproductive Age	CT	156	213	228	N/A	466	636	681	117	160	171	N/A
				HE	156	213	228	N/A	233	318	340	94	128	137	N/A
	Automotive Articles		ONU[b]	CT	173	235	252	N/A	428	584	625	123	168	180	N/A
Industrial Use – Construction, paint, electrical, and metal products	Paints and coatings	Spray application of paints, coatings, adhesives, and sealants	Average Adult Worker	CT	29	40	42	APF 5	822	1,121	1,201	28	38	41	APF 5
Commercial Use – Construction, paint, electrical, and metal products	Adhesives and sealants			HE	**0.4**	0.5	0.6	APF 1000	411	561	600	0.4	0.5	0.6	APF 1000
	Paints and coatings		Females of Reproductive Age	CT	**26**	36	38	APF 5	895	1,221	1,307	25	35	37	N/A
				HE	**0.4**	0.5	0.5	APF 1000	448	610	653	0.4	0.5	0.5	APF 1000
Commercial Use – Furnishing, cleaning, and treatment care products	All-purpose waxes and polishes		ONU[b]	CT	**29**	40	42	APF 5	822	1,121	1,201	28	38	41	APF 5

COU		OES	Worker Population	Exposure Level	Inhalation Risk Estimates (Benchmark MOE = 30)				Dermal Risk Estimates (Benchmark MOE = 30)			Aggregate Risk Estimates (Benchmark MOE = 30)			
Life Cycle Stage – Category	Subcategory				Acute	Inter.	Chronic	APF[a]	Acute	Inter.	Chronic	Acute	Inter.	Chronic	APF[a]
Industrial Use – Construction, paint, electrical, and metal products	Paints and coatings	Non-spray application of paints, coatings, adhesives, and sealants	Average Adult Worker	CT	**5.3**	**7.2**	**7.7**	APF 10	822	1,121	1,201	5.2	7.1	7.6	APF 10
Commercial Use – Construction, paint, electrical, and metal products	Paints and coatings			HE	**1.1**	**1.5**	**1.6**	APF 50	411	561	600	1.1	1.5	1.6	APF 50
Commercial Use – Construction, paint, electrical, and metal products	Adhesives and sealants		Females of Reproductive Age	CT	**4.8**	**6.5**	**7.0**	APF 10	895	1,221	1,307	4.7	6.5	6.9	APF 10
				HE	**1.0**	**1.3**	**1.4**	APF 50	448	610	653	1.0	1.3	1.4	APF 50
			ONU[b]	CT	**5.3**	**7.2**	**7.7**	APF 10	–	–	–	–	–	–	–
Commercial Use – Furnishing, cleaning, and treatment care products	Fabric, textile, and leather products; furniture and furnishings	Textile finishing	Average Adult Worker	CT	2,838,710	3,870,968	4,819,205	N/A	428	584	727	428	584	727	N/A
	Fabric enhancer			HE	204,651	279,070	347,431	N/A	214	292	364	214	292	363	N/A
			Females of Reproductive Age	CT	2,569,919	3,504,435	4,362,886	N/A	466	636	791	466	636	791	N/A
				HE	185,273	252,645	314,534	N/A	233	318	396	233	317	395	N/A
			ONU[b]	CT	2,838,710	3,870,968	4,819,205	N/A	428	584	727	428	584	727	N/A
Commercial Use – Construction, paint, electrical, and metal products	Batteries and capacitors	Fabrication or use of final products and articles	Average Adult Worker	CT	220	300	337	N/A	428	584	657	145	198	223	N/A
	Construction and building materials covering large surface areas, including paper articles; metal articles; stone, plaster, cement, glass and ceramic articles			HE	80	109	123	N/A	214	292	328	58	79	89	N/A
	Machinery, mechanical appliances, electrical/electronic articles		Females of Reproductive Age	CT	199	272	305	N/A	466	636	715	140	190	214	N/A
Commercial Use – Automotive, fuel, agriculture, and outdoor use products	Lawn and garden care products			HE	72	99	111	N/A	233	318	357	55	75	85	N/A
Commercial Use – Packaging, paper, plastic, toys, hobby products	Packaging (excluding food packaging) and other articles with routine direct contact during normal use, including paper articles; rubber articles; plastic articles (hard); plastic articles (soft)		ONU[b]	CT	220	300	337	N/A	428	584	657	145	198	223	N/A
	Packaging (excluding food packaging), including paper articles														
	Toys, playground, and sporting equipment														

COU		OES	Worker Population	Exposure Level	Inhalation Risk Estimates (Benchmark MOE = 30)				Dermal Risk Estimates (Benchmark MOE = 30)			Aggregate Risk Estimates (Benchmark MOE = 30)			
Life Cycle Stage – Category	Subcategory				Acute	Inter.	Chronic	APF[a]	Acute	Inter.	Chronic	Acute	Inter.	Chronic	APF[a]
Commercial Use – Furnishing, Cleaning, and Treatment care products	Floor coverings; Construction and building materials covering large surface areas including stone, plaster, cement, glass and ceramic articles fabrics, textiles, and apparel														
Commercial Use – Packaging, paper, plastic, toys, hobby products	Ink, toner and colorants	Use of Dyes, Pigments, and Fixing Agents	Average Adult Worker	CT	**5.3**	**7.2**	**7.7**	APF 10	822	1,121	1,201	5.2	7.1	7.6	APF 10
				HE	**1.1**	**1.5**	**1.6**	APF 50	411	561	600	1.1	1.5	1.6	APF 50
			Females of Reproductive Age	CT	**4.8**	**6.5**	**7.0**	APF 25	895	1,221	1,307	4.7	6.5	6.9	APF 25
				HE	**1.0**	**1.3**	**1.4**	APF 50	448	610	653	1.0	1.3	1.4	APF 50
			ONU [b]	CT	**5.3**	**7.2**	**7.7**	APF 10	–	–	–	–	–	–	–
Industrial Use – Construction, paint, electrical, and metal products	Adhesives and Sealants	Formulation for Diffusion Bonding	Average Adult Worker	CT	26	35	38	APF 5	822	1,121	1,201	25	34	37	N/A
				HE	**1.1**	1.5	1.6	APF 50	411	561	600	1.1	1.5	1.6	APF 50
			Females of Reproductive Age	CT	**23**	32	34	APF 5	895	1,221	1,307	23	31	33	N/A
				HE	**1.0**	1.4	1.5	APF 50	448	610	653	1.0	1.4	1.5	APF 50
			ONU [b]	CT	**26**	35	38	APF 5	–	–	–	–	–	–	–
Commercial Use – Other uses	Laboratory chemicals	Use of Laboratory Chemicals	Average Adult Worker	CT	880	1,200	1,367	N/A	428	584	665	288	393	447	N/A
				HE	88	120	128	N/A	214	292	313	62	85	91	N/A
			Females of Reproductive Age	CT	797	1,086	1,237	N/A	466	636	724	294	401	457	N/A
				HE	80	109	116	N/A	233	318	340	59	81	87	N/A
			ONU [b]	CT	880	1,200	1,367	N/A	428	584	665	288	393	447	N/A
				HE	880	1,200	1,285	N/A	428	584	625	288	393	421	N/A
Commercial Use – Other uses	Automotive articles	Use of Automotive Care Products	Average Adult Worker	CT	160	218	249	N/A	822	1,121	1,277	134	183	208	N/A
				HE	80	109	117	N/A	411	561	600	67	91	98	N/A
			Females of Reproductive Age	CT	145	198	225	N/A	895	1,221	1,390	125	170	194	N/A
				HE	72	99	106	N/A	448	610	653	62	85	91	N/A
			ONU [b]	CT	176	240	273	N/A	–	–	–	–	–	–	–
				HE	147	200	214	N/A	–	–	–	–	–	–	–

COU		OES	Worker Population	Exposure Level	Inhalation Risk Estimates (Benchmark MOE = 30)				Dermal Risk Estimates (Benchmark MOE = 30)			Aggregate Risk Estimates (Benchmark MOE = 30)			
Life Cycle Stage – Category	Subcategory				Acute	Inter.	Chronic	APF[a]	Acute	Inter.	Chronic	Acute	Inter.	Chronic	APF[a]
Industrial Use – Other uses	Hydraulic fracturing	Use in Hydraulic Fracturing	Average Adult Worker	CT	733	22,000	267,667	N/A	822	24,673	300,187	388	11,630	141,498	N/A
				HE	400	4,000	48,667	N/A	411	4,112	50,031	203	2,028	24,670	N/A
			Females of Reproductive Age	CT	664	19,917	242,322	N/A	895	26,854	326,726	381	11,436	139,132	N/A
				HE	362	3,621	44,059	N/A	448	4,476	54,454	200	2,002	24,354	N/A
			ONU[b]	CT	733	22,000	267,667	N/A	–	–	–	–	–	–	–
				HE	733	7,333	89,222	N/A	–	–	–	–	–	–	–
Processing – Recycling	Recycling	Recycling	Average Adult Worker	CT	173	235	252	N/A	428	584	625	123	168	180	N/A
				HE	173	235	252	N/A	214	292	313	96	130	140	N/A
			Females of Reproductive Age	CT	156	213	228	N/A	466	636	681	117	160	171	N/A
				HE	156	213	228	N/A	233	318	340	94	128	137	N/A
			ONU[b]	CT	173	235	252	N/A	428	584	625	123	168	180	N/A
Disposal: Disposal	Disposal	Waste handling, treatment and disposal	Average Adult Worker	CT	83	113	121	N/A	428	584	625	70	95	102	N/A
				HE	5.7	7.8	8.3	APF 10	214	292	313	5.6	7.6	8.1	APF 10
			Females of Reproductive Age	CT	75	102	110	N/A	466	636	681	65	88	94	N/A
				HE	5.2	7.1	7.6	APF 10	233	318	340	5.1	6.9	74	APF 10
			ONU[b]	CT	83	113	121	N/A	428	584	625	70	95	102	N/A

[a] This value is the protection factor of personal protective equipment required to raise the acute MOE above the benchmark of 30. The Assigned Protection Factors (APF) associated with different types of respirators based on function (air-purifying, powered air purifying, supplied air) and fit (quarter mask, half-mask, full-face piece, helmet/hood, loose-fitting facepiece) are presented above. It should be noted that certain respirators are only applicable to specific types of inhalation exposure. See the OSHA Small Entity Compliance Guide for the Respiratory Protection Standard for detailed descriptions on the respirators corresponding to the APFs in the table.

[b] CT = central tendency; HE = high-end; MOE = margin of exposure, APF = assigned protection factor, Pop = Population, Expos = Exposure, Repro = Reproductive, Inter = Intermediate
[c] Benchmark MOE = 30. **Bold text** in a gray shaded cell indicates an MOE is below the benchmark value of 30.

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APPENDICES

Appendix A KEY ABBREVIATIONS AND ACRONYMS

AD	Acute Dose
ADC	Average daily concentration
ADD	Average daily dose
ADR	Acute dose rate
AERMOD	American Meteorological Society/EPA Regulatory Model
AERR	Air Emissions Reporting Requirements
AGD	Anogenital distance
APDR	Acute Potential Dose Rate
BLS	Bureau of Labor Statistics (U.S.)
CASRN	Chemical Abstracts Service Registry Number
CAP	Criteria Air Pollutants and PreCursors
CBI	Confidential business information
CDR	Chemical Data Reporting
CEHD	Chemical Exposure Health Data
CEM	Consumer Exposure Model
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COU	Condition(s) of Use
CPSC	Consumer Product Safety Commission (U.S.)
CWA	Clean Water Act
DEHP	Diethylhexyl phthalate
DIDP	Diisodecyl phthalate
DINP	Diisononyl phthalate
DIY	Do-it-yourself
DMR	Discharge Monitoring Report
ECHO	Enforcement and Compliance History Online
EPA	Environmental Protection Agency (U.S.)
EPCRA	Emergency Planning and Community Right-to-Know Act
ESD	Emission scenario document
EU	European Union
FDA	Food and Drug Administration
FFDCA	Federal Food, Drug, and Cosmetic Act
GWPC	Ground Water Protection Council
GS	Generic scenario
HAP	Hazardous air pollutant
HEC	Human equivalent concentration
HED	Human equivalent dose
IADD	Intermediate average daily dose
IIOAC	Integrated Indoor-/Outdoor Air Calculator (Model)
IOGCC	Interstate Oil and Gas Compact Commission
IR	Ingestion rate
K_{OC}	Soil organic carbon: water partitioning coefficient
K_{OW}	Octanol: water partition coefficient
LCD	Life cycle diagram
LOD	Limit of detection

LOEC	Lowest-observed-effect concentration
Log K_{OC}	Logarithmic organic carbon: water partition coefficient
Log K_{OW}	Logarithmic octanol: water partition coefficient
MOE	Margin of exposure
MRD	Methodology Review Draft
NAICS	North American Industry Classification System
NEI	National Emissions Inventory
NHANES	National Health and Nutrition Examination Survey
NICNAS	National Industrial Chemicals Notification and Assessment Scheme
NOAEL	No-observed-adverse-effect level
NOEC	No-observed-effect concentration
NPDES	National Pollutant Discharge Elimination System
NTP	National Toxicology Program
OCSPP	Office of Chemical Safety and Pollution Prevention (EPA)
OECD	Organisation for Economic Co-operation and Development
OEL	Occupational exposure limit
OES	Occupational exposure scenario
ONU	Occupational non-user
OPPT	Office of Pollution Prevention and Toxics (EPA)
OSHA	Occupational Safety and Health Administration (U.S.)
PBZ	Personal breathing zone
PECO	Population, exposure, comparator, and outcome
PEL	Permissible exposure limit (OSHA)
PESS	Potentially exposed or susceptible subpopulations
PND	Postnatal day
PNOR	Particulates not otherwise regulated
POD	Point of departure
POTW	Publicly owned treatment works
PPARα	Peroxisome proliferator activated receptor alpha
PSC	Point Source Calculator (tool)
PVC	Polyvinyl chloride
REL	Recommended Exposure Limit
SACC	Science Advisory Committee on Chemicals
SCC	Source Classification Code
SDS	Safety data sheet
SLT	State/Local/Tribal
SOC	Standard Occupational Classification
SpERC	Specific Emission Release Category
SUSB	Statistics of U.S. Businesses (U.S. Census)
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
VVWM	Variable Volume Water Model
WebFIRE	Web Factor Information Retrieval (FIRE) Data System
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 4	Provides EPA with authority to issue rules, orders, or consent agreements requiring manufacturers (including importers) and processors to test chemical substances and mixtures.	25 chemical data submissions from test rules received for diethylhexyl phthalate: Ecotoxicity Acute aquatic plant toxicity (1) Acute aquatic toxicity (8) Chronic aquatic toxicity (1) Environmental fate Persistence (3) Biodegradation (3) Transport Between Environmental Compartments (Fugacity) (1) Sorption to Soil and Sediments (1) Human health Metabolism and Pharmacokinetics (3) Mutagenicity/Genetic toxicity (6) Physical and chemical properties Vapor pressure (1) Water solubility (1) (1982–1985) (U.S. EPA, ChemView. Accessed April 9, 2019).
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 three and one-half years after the date of enactment of the Frank R. Lautenberg Chemical Safety for the 21st Century Act.	Diethylhexyl phthalate 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 di-ethylhexyl phthalate 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.	Diethylhexyl phthalate manufacturing (including importing), processing and use information is reported under the CDR rule (76 FR 50816, August 16, 2011).
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.	Diethylhexyl phthalate 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).
Toxic Substances Control Act (TSCA) – section 8(d)	Provides EPA with authority to issue rules requiring producers, importers, and (if specified) processors of a chemical substance or mixture to submit	No health and safety studies were received for diethylhexyl phthalate (1982–1992). (U.S. EPA, ChemView. Accessed April 24, 2019). Diethylhexyl phthalate is listed under

Statutes/Regulations	Description of Authority/Regulation	Description of Regulation
	lists and/or copies of ongoing and completed, unpublished health and safety studies.	the category "Alkyl phthalates — all alkyl esters of 1, 2-benzenedicarboxylic acid (ortho -phthalic acid)" (40 CFR 716.120).
Toxic Substances Control Act (TSCA) section 8(e)	Manufacturers (including importers), processors, and distributors must immediately notify EPA if they obtain information that supports the conclusion that a chemical substance or mixture presents a substantial risk of injury to health or the environment.	14 risk reports received for diethylhexyl phthalate (1992–2009) (U.S. EPA, ChemView. Accessed (April 9, 2019)).
Emergency Planning and Community Right-To-Know Act (EPCRA) – section 313	Requires annual reporting from facilities in specific industry sectors that employ 10 or more full-time equivalent employees and that manufacture, process or otherwise use a TRI-listed chemical in quantities above threshold levels. A facility that meets reporting requirements must submit a reporting form for each chemical for which it triggered reporting, providing data across a variety of categories, including activities and uses of the chemical, releases and other waste management (*e.g.*, quantities recycled, treated, combusted) and pollution prevention activities (under Section 6607 of the Pollution Prevention Act). These data include on- and off-site data as well as multimedia data (*i.e.*, air, land and water).	Diethylhexyl phthalate is a listed substance subject to reporting requirements under 40 CFR 372.65 effective as of January 1, 1987.
Clean Air Act (CAA) – section 112(b)	Defines the original list of 189 hazardous air pollutants (HAPs). Under 112(c) of the CAA, EPA must identify and list source categories that emit HAP and then set emission standards for those listed source categories under CAA Section 112(d). CAA Section 112(b)(3)(A) specifies that any person may petition the Administrator to modify the list of HAP by adding or deleting a substance. Since 1990, EPA has removed two pollutants from the original list leaving 187 at present.	Diethylhexyl phthalate is listed as a HAP (42 U.S.C. 7412).
Clean Air Act (CAA) – section 112(d)	Directs EPA to establish, by rule, NESHAPs for each category or subcategory of listed major sources and area sources of HAPs (listed pursuant to section 112(c)). For major sources, the standards must require the maximum degree of emission reduction that EPA determines is achievable by each	EPA has established NESHAPs for a number of source categories that emit diethylhexyl phthalate to air (See https://www.epa.gov/stationary-sources-air-pollution/national-emission-standards-hazardous-air-pollutants-neshap-9; Accessed December 31, 2025).

Statutes/Regulations	Description of Authority/Regulation	Description of Regulation
	particular source category. This is generally referred to as maximum achievable control technology (MACT). For area sources, the standards must require generally achievable control technology (GACT) though may require MACT.	
Clean Water Act (CWA) – section 304(a)(1)	Requires EPA to develop and publish ambient water quality criteria (AWQC) reflecting the latest scientific knowledge on the effects on human health that may be expected from the presence of pollutants in any body of water.	In 2015, EPA published updated AWQC for diethylhexyl phthalate, including recommendations for "water + organism" and "organism only" human health criteria for states and authorized Tribes to consider when adopting criteria into their water quality standards. Human Health for the consumption of Water + Organism (µg/L): 0.32 Human Health for the consumption of Organism Only (µg/L): 0.37 Human Health WQC is based on carcinogenicity of 10^{-6} risk.
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 401.15. The "priority pollutants" specified by those families are listed in 40 CFR Part 423. 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.	DEHP 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). Under CWA Section 304, DEHP is included in the list of total toxic organics (TTO) (40 CFR 413.02(i)). Appendix A to 40 CFR, part 423-126 Priority Pollutants Aluminum Forming Point Source Category 40 CFR part 467 The Centralized Waste Treatment Point Source Category 40 CFR part 437 Coil Coating Point Source Category 40 CFR part 465 Electrical and Electronic Components Point Source Category 40 CFR part 469 Electroplating Point Source Category 40 CFR part 413 Metal Finishing Point Source Category 40 CFR part 433 Metal Molding and Casting Point Source Category 40 CFR part 464 Organic Chemicals, Plastics, And Synthetic Fibers 40 CFR part 414 Plastics Molding And Forming Point Source Category 40 CFR part 463

Statutes/Regulations	Description of Authority/Regulation	Description of Regulation
		Steam Electric Power Generating Point Source Category 40 CFR part 423
Safe Drinking Water Act (SDWA) – section 1412	Requires EPA to publish a non-enforceable maximum contaminant level goal (MCLG) for a contaminant for which EPA makes the determination that the contaminant: 1. may have an adverse effect on the health of persons; 2. is known to occur or there is a substantial likelihood that the contaminant will occur in public water systems with a frequency and at levels of public health concern; and 3. in the sole judgement of the Administrator, regulation of the contaminant presents a meaningful opportunity for health risk reductions for persons served by public water systems. When EPA publishes an MCLG, EPA must also promulgate a National Primary Drinking Water Regulation (NPDWR) which includes either an enforceable maximum contaminant level (MCL), or a required treatment technique. Public water systems are required to comply with NPDWRs.	DEHP is subject to NPDWR under the SDWA with an MCLG of zero and an enforceable MCL of .006 mg/L (40 CFR 141.24).
Resource Conservation and Recovery Act (RCRA) – section 3001	Directs EPA to develop and promulgate criteria for identifying the characteristics of hazardous waste, and for listing hazardous waste, taking into account toxicity, persistence, and degradability in nature, potential for accumulation in tissue and other related factors such as flammability, corrosiveness, and other hazardous characteristics.	Diethylhexyl phthalate is included on the list of hazardous wastes pursuant to RCRA 3001. RCRA Hazardous Waste Code: U028 (40 CFR 261.33). (Appendix VIII to Part 261—Hazardous Constituents)
Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) – sections 102(a) and 103	Authorizes EPA to promulgate regulations designating as hazardous substances those substances which, when released into the environment, may present substantial danger to the public health or welfare or the environment. EPA must also promulgate regulations establishing the quantity of any hazardous substance the release of which must be reported under section 103. Section 103 requires persons in charge of vessels or facilities to report to the National Response Center if they have knowledge of a release of a hazardous	Diethylhexyl phthalate is a hazardous substance under CERCLA. Releases of di-ethylhexyl phthalate in excess of 100 lb must be reported (40 CFR 302.4).

Statutes/Regulations	Description of Authority/Regulation	Description of Regulation
	substance above the reportable quantity threshold.	
Superfund Amendments and Reauthorization Act (SARA)	Requires the Agency to revise the hazardous ranking system and update the National Priorities List of hazardous waste sites, increases state and citizen involvement in the superfund program and provides new enforcement authorities and settlement tools.	Diethylhexyl phthalate is listed on SARA, an amendment to CERCLA and the CERCLA Priority List of Hazardous Substances. This list includes substances most commonly found at facilities on the CERCLA National Priorities List (NPL) that have been deemed to pose the greatest threat to public health. ATSDR ranked #77.
Other federal statutes/regulations		
Consumer Product Safety Improvement Act 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 8 phthalates in toys and child care articles at concentrations greater than 0.1 percent: DEHP, DBP, BBP, DINP, DIBP, DPENP, DHEXP and DCHP.	The use of diethylhexyl phthalate at concentrations greater than 0.1 percent is banned in toys and child care articles (16 CFR part 1307).
Federal Hazardous Substance Act (FHSA)	Requires precautionary labeling on the immediate container of hazardous household products and allows the Consumer Product Safety Commission (CPSC) to ban certain products that are so dangerous or that the nature of the hazard is such that labeling is not adequate to protect consumers.	Use of diethylhexyl phthalate was banned by the CPSC in 2008 in any children's toy or child care article that contains concentrations of more than 0.1 percent of di-ethylhexyl phthalate (16 CFR part 1307)
Federal Food, Drug, and Cosmetic Act (FFDCA)	Provides the FDA with authority to oversee the safety of food, drugs and cosmetics.	Diethylhexyl phthalate is an optional substance that can be used in: the base sheet and coating of cellophane, alone or in combination with other phthalates where total phthalates do not exceed 5 percent (21 CFR § 177.1200) Non-regulatory Warning FDA Public Health Notification: PVC Devices Containing the Plasticizer DEHP (medical).
Occupational Safety and Health Act (OSHA)	Requires employers to provide their workers with a place of employment free from recognized hazards to safety and health, such as exposure to toxic chemicals, excessive noise levels, mechanical dangers, heat or cold stress or unsanitary conditions (29 U.S.C Section 651 et seq.). Under the Act, OSHA can issue occupational safety and health standards including such provisions as Permissible Exposure Limits (PELs),	OSHA established a PEL for diethylhexyl phthalate of 5 mg/m^3 as an 8-hour, TWA (29 CFR 1910.1000). OSHA established a Sampling and Analytical Method for DEHP.

Statutes/Regulations	Description of Authority/Regulation	Description of Regulation
	exposure monitoring, engineering and administrative control measures, and respiratory protection.	
Federal Hazardous Materials Transportation Act (HMTA)	Section 5103 of the Act directs the Secretary of Transportation to: • Designate material (including an explosive, radioactive material, infectious substance, flammable or combustible liquid, solid or gas, toxic, oxidizing or corrosive material, and compressed gas) as hazardous when the Secretary determines that transporting the material in commerce may pose an unreasonable risk to health and safety or property. Issue regulations for the safe transportation, including security, of hazardous material in intrastate, interstate and foreign commerce.	Diethylhexyl phthalate is listed as a hazardous material with regard to transportation and is subject to regulations prescribing requirements applicable to the shipment and transportation of listed hazardous materials Reportable Quantity 100 lb. (45.4 kg) (49 CFR 172.1, Appendix A, Table 1).

B.2 State Laws and Regulations

Table_Apx B-2. State Laws and Regulations

State Actions	Description of Action
State Air Regulations	New Hampshire (Env-A 1400: Regulated Toxic Air Pollutants; accessed December 31, 2025) Toxicity Class I, 24-hour AAL 18 (µg/m^3), Annual AALB 12 (µg/m^3), 24-hour De Minimis 0.21 (lb/day), Annual De Minimis 78 (lb/year) Rhode Island (Air Pollution Regulation No. 22; accessed December 31, 2025) Acceptable Ambient Levels (AALs) (mg/m3) 24 Hour 70, Annual 0.4
State Drinking Water Standards and Guidelines	Arizona (14 Ariz. Admin. Register 2978, August 1, 2008; accessed December 31, 2025) MCL .0006 mg/L MCLG 0 mg/L Discharge from rubber and chemical factories California (Cal Code Regs. Title 26, § 22-64444; accessed December 31, 2025) Table 64444-A Maximum Contaminant Levels Organic Chemicals 0.004 mg/L Connecticut (Conn. Agencies Regs. § 19-13-B102; accessed December 31, 2025) Maximum Contaminant Level (mg/l) 0.006 Delaware (Del. Admin. Code Title 16, § 4462; accessed December 31, 2025) Synthetic organic contaminants including pesticides and herbicides: Traditional MCL 0.006 mg/L To convert for CCR, multiply by 1,000 MCL in CCR units 6, MCLG 0 Florida (Fla. Admin. Code R. Chap. 62-550; accessed December 31, 2025), 6 µg/L MCL Maine (10 144 Me. Code R. Chap. 231; accessed December 31, 2025), 0.006 mg/L Massachusetts (310 Code Mass. Regs. § 22.00; accessed December 31, 2025), 0.006 mg/L Michigan (Mich. Admin. Code r.299.44 and r.299.49, 2017; accessed December 31, 2025) Minnesota (Minn R. Chap. 4720; accessed December 31, 2025)

State Actions	Description of Action
	Maximum Contaminant Level (MCL) for di-ethylhexyl phthalate of 6 ppb New Jersey (7:10 N.J Admin. Code § 5.2; accessed December 31, 2025), Standard 6 µg/L Pennsylvania (25 Pa. Code § 109.202; accessed December 31, 2025) Synthetic Organic Chemicals (SOCs): 0.006 mg/L Rhode Island (Rules and Regulations Pertaining to Public Drinking Water R46-13-DWQ; accessed December 31, 2025) MCLG 0 mg/L MCL 0.006 mg/L
State PELs	California (PEL of 5 mg/m^3 (Cal Code Regs. Title 8, § 5155; accessed December 31, 2025) Hawaii PEL TWA 5 mg/m^3 and PEL STEL 10 mg/m3 (Hawaii Administrative Rules Section 12-60-50; accessed December 31, 2025)
State Right-to-Know Acts	Massachusetts (105 Code Mass. Regs. § 670.000 Appendix A) (accessed December 31, 2025) New Jersey (8:59 N.J. Admin. Code § 9.1; accessed December 31, 2025) Carcinogen, Teratogen Pennsylvania (P.L. 734, No. 159 and 34 Pa. Code § 323; accessed December 31, 2025)
Chemicals of High Concern to Children	Several states have adopted reporting laws for chemicals in children's products containing di-ethylhexyl phthalate including: Maine (38 MRSA Chapter 16-D; accessed December 31, 2025) Minnesota (Toxic Free Kids Act Minn. Stat. 116.9401 to 116.9407) (accessed December 31, 2025) Oregon (Toxic-Free Kids Act, Senate Bill 478, 2015; accessed December 31, 2025) Vermont (18 V.S.A § 1776; accessed December 31, 2025) Washington State (Wash. Admin. Code 173-334-130; accessed December 31, 2025)
Other	California listed DEHP on Proposition 65 in 1988 due cancer and in 2003 due to developmental male cancer. (Cal Code Regs. Title 27, § 27001; accessed December 31, 2025). California issued a Health Hazard Alert for DEHP (Hazard Evaluation System and Information Service, 2016; accessed December 31, 2025). California lists di-ethylhexyl phthalate as a designated priority chemical for biomonitoring (California SB 1379; accessed December 31, 2025). Di-ethylhexyl phthlate is on the MA Toxic Use Reduction Act (TURA) list MGL, Chapter 21I, Section 1 to Section 23 (accessed December 31, 2025) Maine 2019 ME H 1043 (accessed December 31, 2025) Prohibition of sale of food package containing phthalates.

B.3 International Laws and Regulations

Table_Apx B-3. International Laws and Regulations

Country/ Organization	Requirements and Restrictions
Canada	Di-ethylhexyl phthlate is on the Canadian List of Toxic Substances (Government of Canada. Managing substances in the environment. Substances search; accessed December 31, 2025). Other Canadian regulations include: • Canada's National Pollutant Release Inventory (NPRI; accessed December 31, 2025).

Country/ Organization	Requirements and Restrictions
	• For soft vinyl children's toys and child-care articles, compliance and enforcement of the existing regulation of DEHP (and 5 other phthalates) will continue as part of the regular enforcement of the Phthalates Regulations under the Canada Consumer Product Safety Act. (accessed December 31, 2025) • Compliance and enforcement of the existing requirements for medical devices containing di-ethylhexyl phthalate will continue as part of the regular enforcement of the Medical Devices Regulations under the Food and Drugs Act (accessed December 31, 2025) • Diethylhexyl phthlate, which was previously concluded to be harmful to human health, was added to the Cosmetic Ingredient Hotlist (accessed December 31, 2025) in 2009. The listing indicates that the use of di-ethylhexyl phthalate is prohibited and must not be present in cosmetic products. • Risk Management Scope for 1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester [DEHP] Chemical Abstracts Service Registry Number (CAS RN): 117-81-7.
European Union	Di-ethylhexyl phthlate is registered for use in the EU (European Chemicals Agency (ECHA) database. Accessed December 31, 2025). **Restriction** Annex XVII TO REACH (accessed December 31, 2025) – Conditions of restriction Restrictions on the manufacture, placing on the market and use of certain dangerous substances, mixtures and articles. **Candidate Substance** In 2008, di-ethylhexyl phthalate was listed on the Candidate list as a Substance of Very High Concern (SVHC) under Article 59 regulation (EC) No 1907/2006 - REACH (Registration, Evaluation, Authorization and Restriction of Chemicals due to its reproductive toxicity (category 1B) (accessed December 31, 2025). Reason for inclusion: Toxic for reproduction (Article 57c), Endocrine disrupting properties (Article 57(f) - environment), Endocrine disrupting properties (Article 57(f) - human health. **Authorisation** In August 2013, di-ethylhexyl phthalate was added to Annex XIV of REACH (Authorisation List) with a sunset date of February 21, 2015. After the sunset date, only persons with approved authorization applications may continue to use the chemical (European Chemicals Agency (ECHA) database. Accessed December 31, 2025). Commission Delegated Directive ../…/EU of 31.3.2015 amending Annex II to Directive 2011/65/EU of the European Parliament and of the Council as regards the list of restricted substances. **Restriction of Hazardous Substances Directive (RoHS), EU/2015/863** Di-ethylhexyl phthlate is subject to the Restriction of Hazardous Substances Directive (RoHS), EU/2015/863 (accessed December 31, 2025), which restricts the use of hazardous substances at more than 0.1% by weight at the 'homogeneous material' level in electrical and electronic equipment, beginning July 22, 2019. (European Commission RoHS).
Australia	Diethylhexyl phthlate was assessed under Human Health Tier II of the Inventory Multi-Tiered Assessment and Prioritisation (IMAP). The chemical is listed on the 2006 High Volume Industrial Chemicals List (HVICL) with a total reported volume between 10,000 and 99,000 tonnes per annum.

Country/ Organization	Requirements and Restrictions
	Diethylhexyl phthalate is used in the production of plastic products. Plastic products that contain more than 1 percent of di-ethylhexyl phthalate are permanently banned from sale. (*1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester: Human health tier II assessment (2013)*; Accessed December 31, 2025).
Japan	Diethylhexyl phthalate 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; accessed December 31, 2025) • Act on Confirmation, etc. of Release Amounts of Specific Chemical Substances in the Environment and Promotion of Improvements to the Management Thereof (accessed December 31, 2025) • Industrial Safety and Health Act (ISHA; accessed December 31, 2025) • Air Pollution Control Act (accessed December 31, 2025) • Water Pollution Control Law (accessed December 31, 2025)
World Health Organization (WHO)	Evaluations of the Joint FAO/WHO Expert Committee on Food Additives (JECFA) 1989 The Committee previously concluded that di-ethylhexyl phthalate is a peroxisome-proliferator and carcinogen in the livers of both rats and mice and induces age-dependent testicular atrophy in rats. The use of food-contact materials from which bis(2-ethylhexyl) phthalate may migrate is provisionally accepted on condition that the amount of the substance migrating into food is reduced to the lowest level technologically attainable. **Tolerable Intake: NONE ESTABLISHED** 1999 Monograph
Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Hungary, Ireland, Japan, New Zealand, Poland, South Korea, Spain, Sweden Switzerland, United Kingdom	Occupational exposure limits for DEHP (GESTIS International limit values for chemical agents (Occupational exposure limits, OELs) database. Accessed December 31, 2025).

B.4 Assessment History

Table_Apx B-4. Assessment History of DEHP

Authoring Organization	Publication
U.S. EPA publications	
EPA Integrated Risk Information System	*Integrated Risk Information System (IRIS), chemical assessment summary, di(2-ethylhexyl)phthalate (DEHP); CASRN 117-81-7* (U.S. EPA, 1988)
Other U.S.-based organizations	

Authoring Organization	Publication
Agency for Toxic Substances and Disease Registry (ATSDR)	*Toxicological profile for di(2-ethylhexyl)phthalate (DEHP)* (ATSDR, 2022) *Toxicological profile for di(2-ethylhexyl)phthalate (DEHP): draft for public comment* (ATSDR, 2019) *Toxicological profile for di(2-ethylhexyl) phthalate* (ATSDR, 2002) *Toxicological profile for di(2-ethylhexyl)phthalate* (ATSDR, 1993) *Toxicological profile for di(2-ethylhexyl)phthalate* (ATSDR, 1989)
California Office of Environmental Health Hazard Assessment (OEHHA)	*Proposition 65 Maximum Allowable Dose Level (MADL) for reproductive toxicity for di(2-ethylhexyl)phthalate (DEHP) by intravenous injection* (OEHHA, 2006) *Proposition 65 Maximum Allowable Dose Level (MADL) for reproductive toxicity for di(2-ethylhexyl)phthalate (DEHP) by oral exposure* (OEHHA, 2005) *No Significant Risk Level (NSRL) for the Proposition 65 carcinogen di(2-ethylhexyl)phthalate* (OEHHA, 2002)
Consumer Product Safety Commission (CPSC)	*Chronic Hazard Advisory Panel on Phthalates and Phthalate Alternatives (with Appendices)* (U.S. CPSC, 2014) *Toxicity review of Di(2-ethylhexyl) Phthalate (DEHP)* (U.S. CPSC, 2010)
National Academies of Sciences, Engineering, and Medicine (NASEM)	*Application of systematic review methods in an overall strategy for evaluating low-dose toxicity from endocrine active chemicals* (NASEM, 2017) *Phthalates and cumulative risk assessment: The task ahead* (NRC, 2008)
National Institute for Occupational Safety and Health (NIOSH)	*NIOH and NIOSH basis for an occupational health standard. Di(2-ethylhexyl)phthalate (DEHP)* (Garberg et al., 1989)
National Toxicology Program (NTP)	*Report on Carcinogens, Fifteenth Edition – Di(2-ethylhexyl) Phthalate* (NTP, 2021a) *Toxicology and Carcinogenesis Studies of Di(2-ethylhexyl) Phthalate (CASRN 117-81-7) Administered in Feed to Sprague Dawley (Hsd:Sprague Dawley SD) Rats* (NTP, 2021b) *Carcinogenesis bioassay of di(2-ethylhexyl)phthalate (CAS No. 117-81-7) in F344 rats and B6C3F1 mice (feed studies)* (NTP, 1982)
National Toxicology Program Center for Evaluation of Risks to Human Reproduction (NTP-CERHR)	*NTP-CERHR Monograph on the Potential Human Reproductive and Developmental Effects of di(2-ethylhexyl) phthalate (DEHP)* (NTP-CERHR, 2006)
International	

Authoring Organization	Publication
Australia National Industrial Chemicals Notification and Assessment Scheme (NICNAS)	*Phthalate esters: Environment tier II assessment* (NICNAS, 2019) *1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester: Human health tier II assessment* (NICNAS, 2013) *Priority existing chemical draft assessment report: Diethylhexyl phthalate* (NICNAS, 2010)
European Chemicals Agency (ECHA)	*Annex to the Background document to the Opinion on the Annex XV Dossier Proposing 588 Restrictions on Four Phthalates (DEHP, BBP, DBP, DIBP)* (ECHA, 2017a) *Opinion on an Annex XV Dossier Proposing Restrictions on Four Phthalates (DEHP, BBP,* 590 *DBP, DIBP)* (ECHA, 2017b) *Member state committee support document for identification of bis(2-ethylhexyl) phthalate (DEHP) as a substance of very high concern because of its endocrine disrupting properties which cause probable serious effects to the environment which give rise to an equivalent level of concern to those of CMR and PBT/vPvB substances* (ECHA, 2014) Annex XV restriction report: Proposal for a restriction, version 2. Substance name: bis(2-ehtylhexyl)phthlate (DEHP), benzyl butyl phthalate (BBP), dibutyl phthalate (DBP), diisobutyl phthalate (DIBP) (ECHA, 2011) *Member state committee support document for identification of bis(2-ethylhexyl)phthalate (DEHP) as a substance of very high concern* (ECHA, 2008) *European Union risk Assessment Report: Bis(2-ethylhexyl)phthalate (DEHP)* (ECJRC, 2008)
Environment Canada and Health Canada	*Screening assessment - Phthalate substance grouping* (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* (Health Canada, 2015a) *Supporting documentation: Carcinogenicity of phthalates - mode of action and human relevance* (Health Canada, 2015b) *Canadian Environmental Protection Act: Priority substances list assessment report: Bis(2-ethylhexyl) phthalate* (EC/HC, 1994)
European Food Safety Authority (EFSA)	*Update of the risk assessment of di-butylphthalate (DBP), butyl-benzyl-phthalate (BBP), bis(2-ethylhexyl)phthalate (DEHP), di-isononylphthalate (DINP) and di-isodecylphthalate (DIDP) for use in food contact materials* (EFSA, 2019)

Authoring Organization	Publication
	Opinion of the Scientific Panel on food additives, flavourings, processing aids and materials in contact with food (AFC) related to Bis(2-ethylhexyl)phthalate (DEHP) for use in food contact materials (EFSA, 2005)
International Agency for Research on Cancer (IARC)	*Some chemicals present in industrial and consumer products, food and drinking-water – Di(2-ethylhexyl) phthalate* (IARC, 2013)

Appendix C LIST OF TECHNICAL SUPPORT DOCUMENTS AND SUPPLEMENTAL FILES

Appendix C includes a list and citations for all technical support documents (TSDs) and supplemental files associated with this risk evaluation. These include discipline-specific assessments, systematic review results, risk calculations, modeling outputs, and public communication documents (see also Docket ID EPA-HQ-OPPT-2018-0433).

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.

2. *Systematic Review Protocol for Diethylhexyl Phthalate (DEHP)* (U.S. EPA, 2025ak) – 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 Risk Evaluation for DEHP 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 "DEHP Systematic Review Protocol."

3. *Data Quality Evaluation and Data Extraction Information for Physical and Chemical Properties for Diethylhexyl Phthalate (DEHP)* (U.S. EPA, 2025k)– Provides a compilation of tables for the data extraction and data quality evaluation information for DEHP. 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 "DEHP Data Quality Evaluation and Data Extraction Information for Physical and Chemical Properties."

4. *Data Quality Evaluation and Data Extraction Information for Environmental Fate and Transport for Diethylhexyl Phthalate (DEHP)* (U.S. EPA, 2025i)– Provides a compilation of tables for the data extraction and data quality evaluation information for DEHP. 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 "DEHP Data Quality Evaluation and Data Extraction Information for Environmental Fate and Transport."

5. *Data Quality Evaluation and Data Extraction Information for Environmental Release and Occupational Exposure for Diethylhexyl Phthalate (DEHP)* (U.S. EPA, 2025j)– 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 "DEHP Data Quality Evaluation and Data Extraction Information for Environmental Release and Occupational Exposure."

6. *Data Quality Evaluation Information for General Population, Consumer, and Environmental Exposure for Diethylhexyl Phthalate (DEHP)* (U.S. EPA, 2025m)– Provides a compilation of tables for the data quality evaluation information for DEHP. 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 "DEHP Data Quality Evaluation Information for General Population, Consumer, and Environmental Exposure."

7. *Data Extraction Information for General Population, Consumer, and Environmental Exposure for Diethylhexyl Phthalate (DEHP)* (U.S. EPA, 2025h)– Provides a compilation of tables for the data extraction for DEHP. 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 "DEHP Data Extraction Information for General Population, Consumer, and Environmental Exposure."

8. *Data Quality Evaluation Information for Human Health Hazard Epidemiology for Diethylhexyl Phthalate (DEHP)* (U.S. EPA, 2025o) – Provides a compilation of tables for the data quality evaluation information for DEHP. 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 "DEHP Data Quality Evaluation Information for Human Health Hazard Epidemiology."

9. *Data Quality Evaluation Information for Human Health Hazard Animal Toxicology for Diethylhexyl Phthalate (DEHP)* (U.S. EPA, 2025n)– Provides a compilation of tables for the data quality evaluation information for DEHP. 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 "DEHP Data Quality Evaluation Information for Human Health Hazard Animal Toxicology."

10. *Data Quality Evaluation Information for Environmental Hazard for Diethylhexyl Phthalate (DEHP)* (U.S. EPA, 2025l) – Provides a compilation of tables for the data quality evaluation information for DEHP. 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 "DEHP Data Quality Evaluation Information for Environmental Hazard."

11. *Data Extraction Information for Environmental Hazard and Human Health Hazard Animal Toxicology and Epidemiology for Diethylhexyl Phthalate (DEHP)* (U.S. EPA, 2025g) – Provides a compilation of tables for the data extraction for DEHP. 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 "DEHP Data Extraction Information for Environmental Hazard and Human Health Hazard Animal Toxicology and Epidemiology."

12. *Data Quality Evaluation and Data Extraction Information for Dermal Absorption for Diethylhexyl Phthalate (DEHP)* (U.S. EPA, 2025am) – Provides a compilation of tables for the data extraction and data quality evaluation information for DEHP. 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 dermal absorption.

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

13. *Physical Chemistry and Fate and Transport Assessment for Diethylhexyl Phthalate (DEHP)* (U.S. EPA, 2025af).

14. *Environmental Release and Occupational Exposure Assessment for Diethylhexyl Phthalate (DEHP)* (U.S. EPA, 2025u).

15. *Consumer and Indoor Dust Exposure Assessment for Diethylhexyl Phthalate (DEHP)* (U.S. EPA, 2025c).

16. *Environmental Media and General Population and Environmental Exposure Assessment for Diethylhexyl Phthalate (DEHP)* (U.S. EPA, 2025s).

17. *Environmental Hazard Assessment for Diethylhexyl Phthalate (DEHP)* (U.S. EPA, 2025r).

18. *Non-Cancer Human Health Hazard Assessment for Diethylhexyl Phthalate (DEHP)* (U.S. EPA, 2025aa).

19. *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, 2025b).

20. *Occupational Risk Calculator for Diethylhexyl Phthalate (DEHP)* (U.S. EPA, 2025ae).

21. *Fish Ingestion Risk Calculator for Diethylhexyl Phthalate (DEHP)* (U.S. EPA, 2025v).

22. *Ambient Air Exposure Assessment for Diethylhexyl Phthalate (DEHP)* (U.S. EPA, 2025a).

23. *Consumer Risk Calculator for Diethylhexyl Phthalate (DEHP)* (U.S. EPA, 2025f).

24. *Consumer Exposure Analysis for Diethylhexyl Phthalate (DEHP)* (U.S. EPA, 2025d).

25. *Surface Water Human Exposure Risk Calculator for Diethylhexyl Phthalate (DEHP)* (U.S. EPA, 2025aj).

26. *Occupational and Consumer Cumulative Risk Calculator for Diethylhexyl Phthalate (DEHP)* (U.S. EPA, 2025ad).

27. *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, 2025w).

28. *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, 2025al).

29. *Summary of Facility Release Data for Di(2-ethylhexyl) Phthalate (DEHP), Dibutyl Phthalate (DBP), and Butyl Benzyl Phthalate (BBP)* (U.S. EPA, 2025ai).

Appendix D UPDATES TO THE DEHP CONDITIONS OF USE TABLE

After the draft risk evaluation was released, EPA made adjustments to one COU based on reasonably available information. The Commercial use – other uses – automotive articles COU was updated to be inclusive of both articles and products; it is now mapped to both the Use of automotive care products OES it was originally mapped to, as well as the Fabrication of final product from articles OES. Subsequently, the COU title was updated to "Commercial use – other uses – automotive articles and products" for the conditions of use included in the final risk evaluation.

After the final scope document (U.S. EPA, 2020c) was released, EPA received updated submissions from the 2020 CDR cycle (U.S. EPA, 2020a) prior to releasing the draft risk evaluation. In addition to new submissions received under the 2020 CDR cycle, the use and processing codes changed for the 2020 CDR cycle. Therefore, EPA amended the description of certain DEHP COUs in the draft risk evaluation based on those new submissions and new use and processing codes. Also, EPA received information from stakeholders about uses of DEHP. For cases where COUs were consolidated under a category, if the category was not present in the scope, the nomenclature was taken directly from the 2020 CDR cycle codes and categories. Table_Apx D-1 summarizes the changes to the COUs for the draft risk evaluation based on the new codes in the 2020 CDR and any other additional information reasonably available to EPA since the publication of the final scope document (U.S. EPA, 2020c).

Table_Apx D-1. Changes to Categories and Subcategories of COUs Between Final Scope and Draft Risk Evaluation

Life Cycle Stage and Category in the Final Scope Document	Subcategory in the Final Scope Document	Occurred Change	Revised COU in the 2025 Draft Risk Evaluation
Processing – as a reactant	Plasticizer in plastic material and resin manufacturing, rubber product manufacturing, and synthetic manufacturing And Adhesive and sealant chemical in adhesive manufacturing	Consolidated under "Processing - incorporation into article," and "Processing - incorporation into formulation, mixture, or reaction product" categories based on stakeholder feedback (U.S. EPA, 2025p).	Processing – incorporation into article - plasticizer in basic organic chemical manufacturing; plastics product manufacturing; rubber product manufacturing; miscellaneous manufacturing; and PVC extruding And Processing – incorporation into formulation, mixture, or reaction product - plasticizer in plastic material and resin manufacturing; synthetic rubber manufacturing; basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint and coating manufacturing; adhesive manufacturing; basic inorganic chemical manufacturing; wholesale and retail trade; services; and ink, toner, and colorant manufacturing
Processing - incorporation into article	Plasticizer in all other basic organic chemical manufacturing, plastics product manufacturing	Added sectors "miscellaneous manufacturing" and "PVC extruding" based on 2020 CDR reports.	Processing – incorporation into article - plasticizer in basic organic chemical manufacturing; plastics product manufacturing; rubber product manufacturing; miscellaneous manufacturing; and PVC extruding

Life Cycle Stage and Category in the Final Scope Document	Subcategory in the Final Scope Document	Occurred Change	Revised COU in the 2025 Draft Risk Evaluation
		Recategorized "plastics product manufacturing" and "rubber product manufacturing" which were previously categorized under the "Incorporation into formulation, mixture, or reaction product" category to more accurately reflect use of DEHP.	
Processing - incorporation into formulation, mixture, or reaction product	Plasticizer in all other basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint and coating manufacturing; plastics material and resin manufacturing; plastics product manufacturing; And Plasticizer in adhesive manufacturing; all other basic inorganic chemical manufacturing; rubber product manufacturing; and services And Plasticizer in all other chemical product and preparation manufacturing	Consolidated subcategories and added sector "synthetic rubber manufacturing, wholesale and retail trade, and ink, toner, and colorant manufacturing (including pigment)" based on 2020 CDR cycle data and identified products based on reasonably available information.	Processing – incorporation into formulation, mixture, or reaction product - plasticizer in plastic material and resin manufacturing; synthetic rubber manufacturing; basic organic chemical manufacturing; custom compounding of purchased resins; miscellaneous manufacturing; paint and coating manufacturing; adhesive manufacturing; basic inorganic chemical manufacturing; wholesale and retail trade; services; and ink, toner, and colorant manufacturing (including pigment)
Processing – intermediate	Intermediate in plastic products manufacturing	Consolidated COU; see below table for further explanation.	N/A
Processing - repackaging	Repackaging – other functional use in wholesale and retail trade	Added "paint and coating manufacturing" sector based on 2020 CDR cycle data.	Processing – repackaging - repackaging in wholesale and retail trade and in paint and coating manufacturing
N/A	N/A	Added category and subcategory to reflect updates from 2020 CDR cycle.	Processing - other uses - miscellaneous processing (cyclic crude and intermediate manufacturing; processing aid specific to hydraulic fracturing)
Processing - incorporation into formulation, mixture, or reaction product	Solid rocket motor insulation	Redesignated category to Industrial use and added additional aerospace applications based on public comment (AIA, 2019).	Industrial use - other uses - solid rocket motor insulation and other aerospace applications

Life Cycle Stage and Category in the Final Scope Document	Subcategory in the Final Scope Document	Occurred Change	Revised COU in the 2025 Draft Risk Evaluation
Distribution	Distribution	Revised to align with "Distribution in commerce" in TSCA statute	Distribution in commerce
Industrial use - processing aid, specific to petroleum production	Hydraulic fracturing	Consolidated this subcategory under new "Other uses" category for Industrial use to better reflect DEHP use.	Industrial use - other uses - hydraulic fracturing
Industrial use - reference material and/or laboratory reagent	Laboratory chemicals	Redesignated this subcategory as a Commercial use within the "other uses" category.	Commercial use - other uses - laboratory chemicals
Industrial use – transportation equipment manufacturing	(*e.g.,* formulations for diffusion bonding and manufacture of aero engine fan blades)	Consolidated under "Industrial use – construction, paint, electrical, and metal products - adhesives and sealants" and "Commercial use – construction, paint, electrical, and metal products - adhesives and sealants" to avoid redundancy and better reference products (Morgan Advanced Materials Wesgo Metals, 2016a, b).	Industrial use – construction, paint, electrical, and metal products - adhesives and sealants And Commercial use – construction, paint, electrical, and metal products - adhesives and sealants
Industrial use - paints and coatings	Paints and coatings (*e.g.,* industrial polish)	Consolidated under "Construction, paint, electrical, and metal products" category within Industrial use life cycle and removed "(*e.g.,* Industrial Polish)" sector from subcategory name reflect updates from 2020 CDR cycle.	Industrial use - construction, paint, electrical, and metal products - paints and coatings
N/A	N/A	Added Industrial use – construction, paint, electrical, and metal products - adhesives and sealants to account for products used in an industrial setting identified through further investigation for ongoing use, as well as products categorized under previous "Industrial use - transportation equipment manufacturing - (*e.g.,* formulations for diffusion bonding and manufacture of aero engine fan blades)" COU.	Industrial use – construction, paint, electrical, and metal products - adhesives and sealants
N/A	N/A	Added "Automotive articles" subcategory to "Other uses" category within Industrial use life cycle due to public comment (AIA, 2019).	Industrial use – other uses - automotive articles

Life Cycle Stage and Category in the Final Scope Document	Subcategory in the Final Scope Document	Occurred Change	Revised COU in the 2025 Draft Risk Evaluation
Commercial use - adhesives and sealants	Adhesives and sealants	Consolidated under “Construction, paint, electrical, and metal products” category to be consistent with 2020 CDR codes.	Commercial use - construction, paint, electrical, and metal products - adhesives and sealants
Commercial use – arts, crafts, and hobby materials	Arts, crafts, and hobby materials	Removed category and subcategory because it was not reported in CDR data in 2016, or 2020, and no products with ongoing use were identified.	N/A
Commercial use - batteries	Batteries (*e.g.,* digital camera)	Consolidated under “Construction, paint, electrical, and metal products” category and removed “*e.g.,* digital camera” to be consistent with 2020 CDR codes. Added “and capacitors” to account for additional products identified (Just In Time Chemical, 2015).	Commercial use - construction, paint, electrical, and metal products - batteries and capacitors
Commercial use - building/construction materials not covered elsewhere	Building/construction materials not covered elsewhere	Consolidated under “Construction, paint, electrical, and metal products” category and updated subcategory name to be consistent with 2020 CDR codes.	Commercial use - construction, paint, electrical, and metal products - construction and building materials covering large surface areas, including paper articles; metal articles; stone, plaster, cement, glass and ceramic articles
Commercial use - dyes, pigments, and fixing agents	Dyes, pigments, and fixing agents	Consolidated under “Packaging, paper, plastic, toys, hobby products” category and updated subcategory name to be consistent with 2020 CDR codes.	Commercial use - packaging, paper, plastic, toys, hobby products - ink, toner, and colorants
Commercial use - Electrical and electronic products	Electrical and electronic products	Consolidated under “Construction, paint, electrical, and metal products” category and updated subcategory name to be consistent with 2020 CDR codes and identified products (ESAB, 2024; QuickCable Corporation, 2024; Just In Time Chemical, 2015).	Commercial use - construction, paint, electrical, and metal products - machinery, mechanical appliances, electrical/electronic articles
Commercial use - fabric, textile, and leather products not covered elsewhere	Fabric, textile, and leather products not covered elsewhere	Consolidated under “Furnishing, cleaning, treatment care products” category and updated subcategory name to be consistent with 2020 CDR codes. Added “furniture and furnishings” (previously “Furniture and furnishings not covered elsewhere” subcategory) because products identified for the previously two separate	Commercial use - furnishing, cleaning, treatment care products - fabric, textile, and leather products; furniture and furnishings

Life Cycle Stage and Category in the Final Scope Document	Subcategory in the Final Scope Document	Occurred Change	Revised COU in the 2025 Draft Risk Evaluation
		subcategories appeared to be the same or similar.	
Commercial use - lawn and garden care products	Lawn and garden care products	Consolidated under "Automotive, fuel, agriculture, outdoor use products" category to be consistent with 2020 CDR codes.	Commercial use - automotive, fuel, agriculture, outdoor use products - lawn and garden care products
Commercial use - paints and coatings	Paints and coatings (*e.g.*, sealer for decorative concrete as waterproof polyurethane)	Consolidated under "Construction, paint, electrical, and metal products" category and removed "(*e.g.*, sealer for decorative concrete as waterproof polyurethane)" to be consistent with 2020 CDR codes.	Commercial use - construction, paint, electrical, and metal products - paints and coatings
Commercial use - plastic and rubber products not covered elsewhere	Plastic and rubber products not covered elsewhere	Consolidated under "Packaging, paper, plastic, toys, hobby products" category and updated subcategory name to be consistent with 2020 CDR codes.	Commercial use - packaging, paper, plastic, toys, hobby products - packaging (excluding food packaging) and other articles with routine direct contact during normal use, including rubber articles; plastic articles (hard); plastic articles (soft)
Commercial use - toys, playground, and sporting equipment	Toys, playground, and sporting equipment	Consolidated under "Packaging, paper, plastic, toys, hobby products" category to be consistent with 2020 CDR codes.	Commercial use - packaging, paper, plastic, toys, hobby products - toys, playground, and sporting equipment
N/A	N/A	Added subcategory "All-purpose waxes and polishes" to be consistent with 2020 CDR codes.	Commercial use - furnishing, cleaning, treatment care products - all-purpose waxes and polishes
N/A	N/A	Added subcategory "Fabric enhancer" to be consistent with 2020 CDR codes.	Commercial use - furnishing, cleaning, treatment care products - fabric enhancer
N/A	N/A	Added subcategory "Floor coverings; construction and building materials covering large surface areas including stone, plaster, cement, glass and ceramic articles; fabrics, textiles, and apparel (including ducting connector fabric)" to be consistent with 2020 CDR codes.	Commercial use - furnishing, cleaning, treatment care products - floor coverings; construction and building materials covering large surface areas including stone, plaster, cement, glass and ceramic articles; fabrics, textiles, and apparel
N/A	N/A	Added subcategory "Packaging (excluding food packaging), including paper articles" to be consistent with 2020 CDR codes.	Commercial use - packaging, paper, plastic, toys, hobby products - packaging (excluding food packaging), including paper articles
N/A	N/A	Added subcategory "Automotive articles" due to public comment (EPA-HQ-OPPT-2019-0131-0022).	Commercial use - other uses - automotive articles
Consumer use - adhesives and sealants	Adhesives and sealants	Consolidated under "Construction, paint, electrical, and metal products" category to	Consumer use - construction, paint, electrical, and metal products - adhesives and sealants

Life Cycle Stage and Category in the Final Scope Document	Subcategory in the Final Scope Document	Occurred Change	Revised COU in the 2025 Draft Risk Evaluation
		be consistent with 2020 CDR codes.	
Consumer use – Arts, crafts, and hobby materials	Arts, crafts, and hobby materials	Removed category and subcategory because it was not reported in CDR data in 2016, or 2020, and no products with ongoing use were identified.	N/A
Consumer use - batteries	Batteries (*e.g.,* digital camera)	Consolidated under "Construction, paint, electrical, and metal products" category and removed "*e.g.,* digital camera" to be consistent with 2020 CDR codes.	Consumer use - construction, paint, electrical, and metal products - batteries
Consumer use - building/construction materials not covered elsewhere	Building/construction materials not covered elsewhere	Consolidated under "Construction, paint, electrical, and metal products" category to be consistent with 2020 CDR codes.	Consumer use - construction, paint, electrical, and metal products - construction and building materials covering large surface areas, including paper articles; metal articles; stone, plaster, cement, glass and ceramic articles
Consumer use - dyes, pigments, and fixing agents	Dyes, pigments, and fixing agents	Consolidated under "Packaging, paper, plastic, toys, hobby products" category to be consistent with 2020 CDR codes.	Consumer use - packaging, paper, plastic, toys, hobby products - ink, toner, and colorants
Consumer use - electrical and electronic products	Electrical and electronic products	Consolidated under "Construction, paint, electrical, and metal products" category to be consistent with 2020 CDR codes.	Consumer use - construction, paint, electrical, and metal products - machinery, mechanical appliances, electrical/electronic articles
Consumer use - fabric, textile, and leather products not covered elsewhere	Fabric, textile, and leather products not covered elsewhere	Consolidated under "Furnishing, cleaning, treatment care products" category to be consistent with 2020 CDR codes. Added "furniture and furnishings" (previously "Furniture and furnishings not covered elsewhere" subcategory) as the reported products referred to the same or similar products.	Consumer use - furnishing, cleaning, treatment care products - fabric, textile, and leather products; furniture and furnishings
Consumer use - lawn and garden care products	Lawn and garden care products	Consolidated under "Automotive, fuel, agriculture, outdoor use products" category to be consistent with 2020 CDR codes.	Consumer use - automotive, fuel, agriculture, outdoor use products - lawn and garden care products
Consumer use - paints and coatings	Paints and coatings (*e.g.,* sealer for decorative concrete as waterproof polyurethane)	Consolidated under "Construction, paint, electrical, and metal products" category and removed "(*e.g.,* sealer for decorative concrete as waterproof polyurethane)" to be consistent with 2020 CDR codes.	Consumer use - construction, paint, electrical, and metal products - paints and coatings

Life Cycle Stage and Category in the Final Scope Document	Subcategory in the Final Scope Document	Occurred Change	Revised COU in the 2025 Draft Risk Evaluation
Consumer use - plastic and rubber products not covered elsewhere	Plastic and rubber products not covered elsewhere	Consolidated under "Packaging, paper, plastic, toys, hobby products" category and updated subcategory name to be consistent with 2020 CDR codes.	Consumer use - packaging, paper, plastic, toys, hobby products - packaging (excluding food packaging) and other articles with routine direct contact during normal use, including rubber articles; plastic articles (hard); plastic articles (soft)
Consumer use - toys, playground, and sporting equipment	Toys, playground, and sporting equipment	Consolidated under "Packaging, paper, plastic, toys, hobby products" category to be consistent with 2020 CDR codes.	Consumer use - packaging, paper, plastic, toys, hobby products - toys, playground, and sporting equipment
N/A	N/A	Added subcategory "Floor coverings; construction and building materials covering large surface areas including stone, plaster, cement, glass and ceramic articles; fabrics, textiles, and apparel" to reflect 2020 CDR cycle data.	Consumer use - furnishing, cleaning, treatment care products - floor coverings; construction and building materials covering large surface areas including stone, plaster, cement, glass and ceramic articles; fabrics, textiles, and apparel
N/A	N/A	Added subcategory "Packaging (excluding food packaging), including paper articles" to reflect 2020 CDR cycle data.	Consumer use - packaging, paper, plastic, toys, hobby products - packaging (excluding food packaging), including paper articles
N/A	N/A	Added subcategory "Automotive articles" due to public comment (EPA-HQ-OPPT-2019-0131-0022).	Consumer use - other uses - automotive articles
N/A	N/A	Added subcategory "novelty articles" based on additional information (Stabile, 2013).	Consumer use - other uses - novelty articles

In addition, EPA is including further detail about edits to the following COUs, which are already presented in Table_Apx D-1:

- *Processing, incorporation into a formulation, mixture, or reaction product, "Plastic product manufacturing"* was consolidated under *Processing – incorporation into articles* to better represent incorporation of DEHP into plastic articles, as opposed to incorporation into plastic material or resin.
- *Processing, incorporation into a formulation, mixture, or reaction product, "Rubber product manufacturing"* was consolidated under the *Processing, incorporation into articles* category to better represent incorporation of DEHP into rubber articles, as opposed to rubber material.
- *Processing - as a reactant,* and its associated subcategories, *"Plasticizer in plastic material and resin manufacturing, rubber product manufacturing, and synthetic rubber manufacturing"* and "*Adhesive and sealant chemical in adhesive manufacturing*" were consolidated under either *Processing - incorporation into article* or *Processing, incorporation into formulation, mixture, or reaction products,* based on EPA's understanding of DEHP's use in processing following further consultations with industry (U.S. EPA, 2025p).
- *Processing – intermediate,* and its associated subcategory, "*Intermediate in plastics product manufacturing*" were consolidated under *Processing, incorporation into formulation, mixture, or reaction products - plasticizer* because upon further investigation, the Agency determined that

the two COUs were redundant. The term "intermediate" is used here to describe the intermediate step in plastic product/article production where a PVC plastic or non-PVC resin is formed prior to conversion to the final article.

- The subcategory "*automotive care products"* in the COUs, *Commercial use - automotive care products – automotive care products* and *Consumer use – automotive care products - automotive care products* was revised to *"automotive articles"* based on further investigation revealing a lack of ongoing use for referenced automotive care products and to clarify DEHP's use in automotive applications. This subcategory was additionally added to the "Industrial use" life cycle stage within the "other uses" category, to reflect DEHP's use in industrial settings for automotive applications.

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 the last two CDR cycles for DEHP (CASRN 117-81-7) and the COU descriptions reflect what EPA identified as the best fit for that submission. 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 the Agency in reference to a code from the CDR reports which are referenced; for example, "plastic products manufacturing," or "fabric, textile, and leather products." EPA will clarify as needed when these references are included throughout the COU descriptions below.

E.1 Manufacturing – Domestic Manufacturing

Domestic manufacturing means to manufacture or produce DEHP within the Unites States. For purposes of the DEHP risk evaluation, this includes the extraction of DEHP 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 DEHP.

DEHP is typically manufactured through catalytic esterification of phthalic anhydride with 2-ethylhexyl alcohol in the presence of an acid catalyst. A typical manufacturing operation takes place in closed systems either via batch or more automated continuous operations and will involve the purification of diethylhexyl phthalate product streams via either vacuum distillation or by passing over activated charcoal as a means of recovering unreacted alcohols (U.S. EPA, 2021c). This condition of use includes the typical manufacturing process and any other similar manufacturing of DEHP.

Examples of CDR Submissions

In the 2016 CDR cycle, one company reported domestic manufacture of DEHP, and in 2020, another company reported domestic manufacture of DEHP (U.S. EPA, 2020a, 2019b).

E.2 Manufacturing – Importing

Import refers to the import of DEHP into the customs territory of the United States. This condition of use includes loading/unloading and repackaging (but not transport) associated with the import of DEHP. In general, chemicals may be imported into the United States in bulk via water, air, land, and intermodal shipments. These shipments take the form of oceangoing chemical tankers, railcars, tank trucks, and intermodal tank containers. Imported DEHP is shipped in liquid or solid pellet form (U.S. EPA, 2019b).

Examples of CDR Submissions

In the 2016 and 2020 CDR cycles, several companies reported import of DEHP (U.S. EPA, 2020a, 2019b).

E.3 Processing – Incorporation into a Formulation, Mixture, or Reaction Product – Plasticizer in Plastic Material and Resin Manufacturing; Synthetic Rubber Manufacturing; Basic Organic Chemical Manufacturing; Custom Compounding of Purchased Resins; Miscellaneous Manufacturing; Paint and Coating Manufacturing; Adhesive Manufacturing; Basic Inorganic Chemical Manufacturing; Wholesale and Retail Trade; Services; and Ink, Toner, and Colorant Manufacturing

This COU refers to the preparation of a product; that is, the incorporation of DEHP into formulation, mixture, or a reaction product which 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 DEHP as a plasticizer into several different products for use in multiple sectors, such as basic organic chemical manufacturing, wholesale and retail trade, and services. DEHP is also blended with other volatile and nonvolatile chemical components to produce hydraulic fluid and capacitor fluid, plastic material and resin, synthetic rubber, compounded resin, paints and coatings, ink, toner, and colorants, and adhesives and sealants (ACC HPP, 2019; Just In Time Chemical, 2015; OECD, 2009).

A plasticizer provides flexibility to non-PVC and PVC plastic materials. In manufacturing of plastic material and resin through non-PVC and PVC compounding, DEHP is blended into polymers. compounding involves the mixing of the polymer with the plasticizer and other chemicals 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 transferring 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. DEHP is also added to produce a mixture of chemical substances used as a reference standard in analytical methods monitoring chemical substances in aqueous and solid samples (Chem Service Inc, 2018; Phenova, 2018).

Examples of CDR Submissions

In the 2016 CDR cycle, two companies reported use of DEHP as a plasticizer in all other basic organic chemical manufacturing; one company reported use of DEHP as a plasticizer in custom compounding of purchased resin; another company reported use of DEHP as a plasticizer in miscellaneous manufacturing; two other companies reported use of DEHP as a plasticizer in paint and coating manufacturing; five other companies reported using DEHP as a plasticizer in plastics material and resin manufacturing; two companies reported use of DEHP as a plasticizer in synthetic rubber manufacturing; one company reported using DEHP in adhesive manufacturing for all other basic inorganic chemical manufacturing, this same company reported using DEHP as a plasticizer and as a plasticizer in services (U.S. EPA, 2019b).

In the 2020 CDR cycle, one company reported use of DEHP as a plasticizer in all other basic organic chemical manufacturing; two companies reported using DEHP as a plasticizer in custom compounding of purchased resin; another company reported using DEHP as a plasticizer in miscellaneous manufacturing; three other companies reported the use of DEHP as a plasticizer in plastics material and resin manufacturing; one company reported use of DEHP as a plasticizer in synthetic rubber manufacturing; and another company reported use of DEHP as a plasticizer for processing in wholesale and retail trade (U.S. EPA, 2020a).

E.4 Processing – Incorporation into Article – Plasticizer in Basic Organic Chemical Manufacturing; Plastics Product Manufacturing; Rubber Product Manufacturing; Miscellaneous Manufacturing; PVC Extruding

This COU refers to the preparation of an article; that is, the incorporation of DEHP into articles, meaning DEHP becomes a component of the article, after its manufacture, for distribution in commerce. In this case, DEHP 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. The raw material is converted by processes such as calendaring, extrusion, injection molding, and plastisol spread coating. This COU encompasses the step that occurs immediately after PVC compounding, where the compounded resin is sent to an extruder that shapes and sizes the plastic into an article or pellet to be used in downstream processing at PVC or non-PVC conversion sites (U.S. EPA, 2021e). This COU also includes the forming, shaping, or cutting articles containing DEHP and the incorporation of the rubber or plastic and other articles into finished articles, such as electrical and electronic articles, machinery, mechanical appliances, fabric, textiles and leather articles, or furniture and furnishings.

DEHP is additionally incorporated as a plasticizer into articles used for food contact materials like food additives, and into medical devices; Food additives and medical devices are exempt from TSCA's definition of chemical substance.

DEHP may be incorporated into machinery or machinery parts as part of a hydraulic fluid mixture, as well as a dielectric fluid in capacitors (Just In Time Chemical, 2015).

In toy manufacturing, toys could contain up to 0.1 percent of DEHP. (The CPSC has a regulatory limit of no more than 0.1% for DEHP concentration in toys.) Additionally, it is possible that DEHP could be incorporated into playground equipment manufacturing due to its use as a plasticizer in PVC and non-PVC articles that may be components of playground equipment (U.S. EPA, 2019a).

Examples of CDR Submissions

In the 2016 CDR cycle, five companies reported use of DEHP as a plasticizer in plastic product manufacturing. One company reported using DEHP as a plasticizer in medical devices, as well as food, beverage, and tobacco product manufacturing. As noted above, the use in food additives and medical devices are exempt from the TSCA definition of chemical substance and the processing into food additives and medical devices are not subject to evaluation under TSCA. Another company used DEHP as a plasticizer in basic organic chemical manufacturing. Three companies reported using DEHP as a plasticizer in rubber product manufacturing (U.S. EPA, 2019b).

In the 2020 CDR cycle, four companies reported using DEHP as a plasticizer in plastic product manufacturing. One company also reported use of DEHP as a plasticizer in food, beverage, and tobacco product manufacturing, as well as miscellaneous manufacturing. Three companies reported use of DEHP as a plasticizer in rubber product manufacturing. Another company reported use of DEHP as a plasticizer in PVC extruding (U.S. EPA, 2020a).

E.5 Processing – Repackaging – Repackaging in Wholesale and Retail Trade and in Paint and Coating Manufacturing

Repackaging refers to the preparation of DEHP for distribution in commerce in a different form, state, or quantity than originally received or stored by various industrial sectors, including the repackaging of

DEHP for adhesion/cohesion promoter applications in wholesale and retail trade, as well as the paint and coating manufacturing sector. This COU includes the transferring of DEHP from a bulk storage container into smaller containers. 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.

Examples of CDR Submissions
In the 2016 CDR cycle, three companies all reported use of DEHP in repackaging for wholesale and retail trade (U.S. EPA, 2019b).

In the 2020 CDR cycle, one company reporting use in repackaging for wholesale and retail trade and repacking for adhesion/cohesion promoter in wholesale and retail trade, another company reporting use in repackaging for paint and coating manufacturing (U.S. EPA, 2020a).

E.6 Processing – Other uses – Miscellaneous Processing (Cyclic Crude and Intermediate Manufacturing; Processing Aid Specific to Hydraulic Fracturing)

This COU refers to the preparation of a product, that is, the incorporation of DEHP into formulation, mixture, or a reaction product which occurs when DEHP is added to a product (or product mixture) after its manufacture, for distribution in commerce. In this case, DEHP is incorporated into products that then are used as a processing aid for hydraulic fracturing and the exploration and/or extraction of natural gas through horizontal drilling, particularly in shale formations, as well as cyclic crude and intermediate manufacturing, or distilling coal tars and/or manufacturing cyclic crudes or cyclic intermediates (*i.e.*, hydrocarbons, except aromatic petrochemicals) from refined petroleum or natural gas. DEHP has been identified in EPA's Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States (EPA-600-R-16-236Fb), December 2016 document to be a known constituent of hydraulic fracturing fluid.

Examples of CDR Submissions
In the 2016 CDR cycle, one company reported use of DEHP in cyclic crude and intermediate manufacturing (U.S. EPA, 2019b).

E.7 Processing – Recycling

This COU refers to the process of treating generated waste streams (*i.e.*, which would otherwise be disposed of as waste), containing DEHP, that are collected, either on-site or at a third-party site, for commercial purpose.

Examples of CDR Submissions
The 2016 and 2020 CDR cycles indicate DEHP is recycled (U.S. EPA, 2020a, 2019b).

E.8 Distribution in Commerce

For purposes of assessment in this risk evaluation, distribution in commerce consists of the transportation associated with the moving of DEHP or DEHP-containing products and/or articles between sites manufacturing, processing or recycling DEHP or DEHP-containing products and/or articles, or to final use sites, or for final disposal of DEHP or DEHP-containing products and/or articles. More broadly under TSCA, "distribution in commerce" and "distribute in commerce" are defined under TSCA section 3(5).

E.9 Industrial Use – Construction, Paint, Electrical, and Metal Products – Paint and Coatings

This COU refers to the use of DEHP in various industrial sectors as a component of paints and coatings. This is a use of DEHP after it has already been incorporated into a paint or coating or mixture, as opposed to when it is used upstream (*e.g.*, when DEHP is processed into the paint or coating formulation).

EPA has identified off the shelf paints and sealants in the industrial use of paint and coating materials (EPA-HQ-OPPT-2019-0501-0043). An example of a type of coating product that contains DEHP indicates that the product is used for "part of a comprehensive bridge waterproofing system typically used on heavy highway projects" but the supplier also noted it has many industrial applications. As noted in the product SDS: "In order to obtain the optimum results, a system must be capable of applying at pressures greater than 2,500 psi and at temperatures of 140 - 160°F" (Wasser Technologies, 2021). Another example of a type of coating product that contains DEHP is used to protect metals and concrete from UV, weathering, and abrasion. It can be applied by brush, roller, mitt or spray methods (Wasser Corporation, 2021). EPA also identified products that used to contain DEHP but have been reformulated. The typical industrial application of these paints and coatings would take place on metal alloys (*e.g.*, steel), metals, or concrete during fabrication of structural components that would later be installed by commercial contractors. The coatings can be used to protect components from water, UV light, and abrasion. This COU includes these typical paint and coating uses, and any similar paint and coating use of DEHP.

Additionally, this COU encompasses DEHP-containing coatings and lacquers are used in the aerospace industry, including for very specific applications such as aluminum pigmented coatings on fasteners, strippable coatings, and maskants (EPA-HQ-OPPT-2018-0433-0004).

In the *Final Scope of the Risk Evaluation for DEHP* (U.S. EPA, 2020c) EPA identified a product used in wood, automotive original equipment manufacturing, marine, and aerospace applications as a paint and coating. This product seems to have been reformulated without DEHP as of 2023; however, the product formulated with DEHP is likely still in use (3M Company, 2019).

Examples of CDR Submissions

The industrial use of DEHP in paints and coatings was not reported in the 2016 or 2020 CDR cycles. However, one company reported Processing – incorporation into formulation, mixture, or reaction product – paints and coatings – plasticizer in the 2016 CDR cycle. One company reported the use of DEHP in paints and coatings, but the life stage and category were reported as NKRA (U.S. EPA, 2019b). In the 2020 CDR cycle, one company reported the processing-repackaging of DEHP for use in the paints and coatings industry (U.S. EPA, 2020a).

E.10 Industrial Use – Construction, Paint, Electrical, and Metal Products - Adhesives and Sealants

This COU refers to DEHP as it is used in various industrial sectors as a component of adhesive or sealant mixtures, meaning the use of DINP 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 DEHP is processed into the adhesive and sealant formulation). EPA identified a product used as a barrier to the flow of molten metal alloys during soldering processes to protect holes and non-braze areas from coverage and clogging (Morgan Advanced Materials Wesgo Metals, 2016a, b). In the *Final Scope of the Risk Evaluation for DEHP* (U.S. EPA, 2020c) EPA included this product under the "Transportation Equipment

Manufacturing" COU; however, the "Transportation Equipment Manufacturing" COU was consolidated under this adhesives and sealants COU to avoid redundancy, as this product was better categorized as a sealant. Additionally, this COU encompasses DEHP-containing adhesives and tapes are used in the aerospace industry (EPA-HQ-OPPT-2018-0433-0004), and DEHP used as a component of adhesives and sealants used for sealing vacuum system connection points. NASA considered this use as mission critical (EPA-HQ-OPPT-2018-0501-0043).

The industrial use of DEHP in adhesives and sealants was not reported during the 2016 and 2020 CDR cycles.

E.11 Industrial Use – Other Uses – Hydraulic Fracturing

This COU refers to the use of DEHP as a processing aid for hydraulic fracturing and the exploration and/or extraction of natural gas through horizontal drilling, particularly in shale formations (EPA-HQ-OPPT-2019-0131-0054). DEHP has been identified in *EPA's Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States* (EPA-600-R-16-236Fb), December 2016 document to be a known constituent of hydraulic fracturing fluid. This COU is associated with the actual use of DEHP as a component of the hydraulic fracturing fluid or other products, as opposed to when DEHP is used upstream (*e.g.*, when DEHP is processed into the hydraulic fluid or other products).

The industrial use of DEHP as a processing aid specific to petroleum (hydraulic fracturing) was not reported during the 2016 and 2020 CDR cycles.

E.12 Industrial Use – Other Uses – Solid Rocket Motor Insulation and Other Aerospace Applications

This COU refers to the use of DEHP as a component of solid rocket motor insulation for human-related space vehicles (EPA-HQ-OPPT-2018-0501-0043). The use was described by NASA as a mission critical use. Additionally, this COU encompasses DEHP-containing materials that are used in aerospace applications such as tubing and pressure pads in composite processing (EPA-HQ-OPPT-2018-0433-0004).

The industrial use of DEHP in solid rocket motor insulation and other aerospace applications does not have data reported for the 2016 and 2020 CDR cycles.

E.13 Industrial Use – Other Uses – Automotive Articles

This COU refers to the use of DEHP in the automobile manufacturing sector as a component in various automotive articles. This is a use of DEHP after it has already been incorporated into a plastic article, as opposed to when it is used upstream (*e.g.*, when DEHP is processed into an article).
This COU includes DEHP used in a number of automotive parts, both in current production and replacement parts, including electrical system wiring, seat assemblies, radiator assemblies, hoses in chassis assembly, and hardware modules in the automobile doors (EPA-HQ-OPPT-2019-0131-0022).

Based on DEHP found downstream in tire crumb applications for playgrounds and turf (Armada et al., 2022; U.S. EPA, 2019e), users may be handling DEHP in tires for automobiles in industrial settings.

The industrial use of DEHP in automotive articles does not have CDR data reported for the 2016 and 2020 cycles.

E.14 Commercial Use – Automotive, Fuel, Agriculture, Outdoor Use Products – Lawn and Garden Care Products

This COU refers to the use of DEHP in lawn and garden care products. This is a use of DEHP after it has already been incorporated into a lawn and garden care product, as opposed to when it is used upstream (*e.g.*, when DEHP is processed into a product).

Use of lawn and garden care products containing DEHP in commercial settings would typically be handled by landscapers or maintenance technicians for properties or facilities. This COU includes plastic sheeting or film, also known as "plastic mulch" for agricultural applications (Scopetani et al., 2023). EPA was unable to identify any products in the marketplace containing DEHP.

Example of CDR Submissions

In the 2020 CDR cycle, one company reported both the commercial and consumer use of DEHP for use in lawn and garden care products (U.S. EPA, 2020a).

E.15 Commercial Use – Construction, Paint, Electrical, and Metal Products – Adhesives and Sealants

This COU refers to the commercial use of DEHP in adhesives and sealants. This COU includes one-component caulks, fillers and putties, as well as sealant barrier items. This is a use of DEHP-containing adhesives and sealants in a commercial setting, such as a business or at a job site, as opposed to upstream use of DEHP (*e.g.*, when DEHP-containing products are used in the manufacturing of the construction products) or use in an industrial setting.

EPA identified several examples of products under this COU. DEHP is present in a glazing product used to repair scratches and other imperfections on the exterior of the automotive body (U.S. Chemical & Plastics, 2020). This COU would include the commercial use in automotive shops that focus on automobile repair and maintenance post-original manufacture. This product may be used for consumer use and included in a different COU. Another example is a DEHP-containing product that acts as a barrier to the flow of molten metal alloys during brazing processes (Morgan Advanced Materials Wesgo Metals, 2016a, b). A sealant product used on floor and sidewalk joints contains DEHP (Tremco, 2015). Also, DEHP is used in adhesives tapes to protect electrical equipment and pipes from corrosion and temperature change, such as conduits, pipes, and metal-clad cables (3M, 2019). The description of the tape indicates that it is used in commercial construction, industrial construction, irrigation, maintenance and repair operations, mining, residential construction, solar, utility, and wind power. The tape is not intended for consumer use.

Additionally, this COU includes DEHP-containing construction materials used in the aerospace industry, such as epoxy adhesives, self-leveling compounds, and stop-off materials (EPA-HQ-OPPT-2018-0433-0004).

Example of CDR Submissions

In the 2020 CDR cycle, one company reported both commercial and consumer use of DEHP in one-component caulks (U.S. EPA, 2020a).

E.16 Commercial Use – Construction, Paint, Electrical, and Metal Products – Batteries and Capacitors

This COU refers to the commercial use of DEHP in batteries for articles such as digital cameras, as well as capacitors containing DEHP.

In the *Final Scope of the Risk Evaluation for DEHP* (U.S. EPA, 2020c), EPA identified DEHP in a replacement digital camera battery, which was available for purchase on Amazon at some point in 2023 but appears to be no longer available for purchase. EPA has identified battery products listing California Proposition 65 warnings for DEHP content, including battery replacements for trail cameras, and digital camera batteries (Kastar, 2024; Spypoint, 2024; Thumper Massager Inc, 2024).

Capacitors may include DEHP as a dielectric fluid (Just In Time Chemical, 2015). These capacitors may also be used in industrial settings.

The commercial use of DEHP in batteries and capacitors was not reported during the 2016 and 2020 CDR cycles.

E.17 Commercial Use – Construction, Paint, Electrical, and Metal Products – Construction and Building Materials Covering Large Surface Areas, Including Paper Articles; Metal Articles; Stone, Plaster, Cement, Glass and Ceramic Articles

This COU refers to the commercial installation of building and construction materials that already have DEHP incorporated (*e.g.*, asphalt, pipe wraps),maintenance and repair of construction and building materials that have already been installed with DEHP-containing materials.

DEHP is found in modified asphalt used for many waterproofing and sealing applications such as in roads and highways (Valero, 2014). DEHP is found in wraps that are used for fire protection of plastic pipes in walls and floors (Rockwool, 2017). EPA identified references indicating DEHP may be used in wallpaper (Hsu et al., 2017).

Examples of CDR Submissions

In the 2016 CDR cycle, two companies reported commercial use of DEHP in building/construction materials not covered elsewhere (U.S. EPA, 2019b).

In the 2020 CDR cycle, one company reported commercial use and consumer use of DEHP in construction and building materials covering large surface areas, including paper articles; metal articles; stone, plaster, cement, glass and ceramic articles (U.S. EPA, 2020a).

E.18 Commercial Use – Construction, Paint, Electrical, and Metal Products – Machinery, Mechanical Appliances, Electrical/Electronic Articles

This COU refers to the commercial use of DEHP already incorporated as a plasticizer in machinery, mechanical appliances, and electrical and electronic articles. This is a use of DEHP in such articles, as opposed to upstream use of DEHP (*e.g.*, when DEHP is processed into the articles). EPA identified the use of DEHP in PVC formulations for wire and cable insulation (QuickCable Corporation, 2024). The Danish EPA identifies use of DEHP in electrical and electronic articles in Denmark. EPA was not able to verify if DEHP is still used in these articles in the U.S. DEHP is part of a plastic electrode used in underwater cutting processes (ESAB, 2024). DEHP may be used as a hydraulic fluid in machinery or machinery parts (Just In Time Chemical, 2015).

Examples of CDR Submissions

In the 2016 CDR cycle, one company reported commercial use and consumer use of DEHP in electrical and electronic products (U.S. EPA, 2019b).

In the 2020 CDR cycle, one company reported the commercial use of DEHP as a plasticizer in machinery, mechanical appliances, and electrical/electronic articles (U.S. EPA, 2020a).

E.19 Commercial Use – Construction, Paint, Electrical, and Metal Products – Paints and Coatings

This COU refers to the commercial use of paints and coatings with DEHP already incorporated. EPA also expects that some of these products could be used for industrial applications; however, they would be available and used in smaller scale commercial settings for similar purposes (*e.g.*, corrosion protection on structural components, residential construction, etc.). This COU encompasses solvent- and water-based paints.

DEHP is found in pigments used in the field to color coatings and sealants. EPA identified examples of pigments that contains DEHP and could be used for commercial/consumer applications and colorants used to color products used in building/roofing maintenance and traffic applications (The Sherwin-Williams Company, 2019). The colorants that have been incorporated into the coating/sealant would be applied to the building material. Another example of a type of coating product that contains DEHP is used to protect metals and concrete from UV, weathering, and abrasion. It can be applied by brush, roller, mitt or spray methods (Wasser Corporation, 2021). EPA expects that such products would be purchased by commercial operations and applied by professional contractors in various commercial settings to protect concrete from weathering and abrasion.

In addition, EPA identified a sealant containing DEHP, used to prevent vegetation growth as well as create a stain and water-resistant barrier to prevent weathering of concrete (Eagle I.F.P. Company, 2015a, b). EPA identified undercoat primer and multi-surface gray primer products containing DEHP (Axalta Coating Systems LLC, 2024; Axalta Coating Systems, 2023).

Examples of CDR Submissions

The commercial use of DEHP in paints and coatings was reported by two companies in the 2016 CDR cycle (U.S. EPA, 2019b).

One company reported the use of DEHP in solvent-based paint as Not Known or Reasonably Ascertainable (NKRA), and another reported the commercial and consumer use of DEHP in solvent-based paint in the 2020 CDR cycle. One company reported the commercial and consumer use of DEHP in water-based paint in the 2020 CDR cycle (U.S. EPA, 2020a).

E.20 Commercial Use – Furnishing, Cleaning, Treatment Care Products – All-Purpose Waxes and Polishes

This COU refers to the commercial use of DEHP of in waxes and polishes that incorporated DEHP into the formulation (as a binder).

All-purpose waxes and polishes are typically waxes and other semi-solids and are applied to surfaces, such as furniture (generally wooden furniture), to improve shine and/or impart stain resistance. EPA would expect that commercial users of these products would apply them via hand or mechanical equipment without aerosolization or spray as they are semi-solid and/or wax in nature. EPA recognizes that these products may be used in a similar way in an industrial setting and are included in a different COU.

Example of CDR Submissions
In the 2020 CDR cycle, one company reported the commercial use of DEHP as a binder in waxes and polishes (U.S. EPA, 2020a).

E.21 Commercial Use – Furnishing, Cleaning, Treatment Care Products – Fabric Enhancer

This COU refers to the commercial use of DEHP already incorporated into fabric enhancers. EPA notes that the CDR use code for "fabric enhancers" includes the following examples: liquid products added to washing machines or sheets added to driers, bleach, film, lime and rust removers.

Examples of CDR Submissions
In the 2020 CDR cycle, one company reported the commercial use of fabric enhancers containing DEHP as a plasticizer (U.S. EPA, 2020a).

E.22 Commercial Use – Furnishing, Cleaning, Treatment Care Products – Fabric, Textile, and Leather Products; Furniture and Furnishings

This COU refers to the commercial use of DEHP already incorporated as a plasticizer in fabric, textile, and synthetic leather materials and articles. This COU includes workers cutting and shaping of textiles and workers who wear DEHP-containing textiles. This COU is also referring to the commercial use of DEHP already incorporated into furniture and furnishings. EPA expects this COU to include use of DEHP in furniture upholstery or in plastic materials used to make furniture.

DEHP is used as a plasticizer in the PVC dots that are incorporated into canvas gloves for workers performing tasks related to farming, ranching, oil, or gas. The PVC dots are used to improve grip (Kinco, 2024). EPA recognizes that gloves can be included in the "Other articles with routine direct contact during normal use including rubber articles; plastic articles (hard)" COU; however, EPA believes this glove to be better captured within this COU, as the glove is not a plastic glove.

Examples of CDR Submissions
In the 2016 CDR cycle, one company reported the commercial and consumer use of DEHP in fabric, textile, and leather products not covered elsewhere (U.S. EPA, 2019b). In the 2016 CDR cycle, one company reported the commercial and consumer use of DEHP in furniture and furnishings not covered elsewhere in the CDR (U.S. EPA, 2019b).

The commercial use of fabric, textile, and leather products or furniture and furnishings were not reported in the 2020 CDR cycle.

E.23 Commercial Use – Furnishing, Cleaning, Treatment Care Products – Floor Coverings; Construction and Building Materials Covering Large Surface Areas Including Stone, Plaster, Cement, Glass and Ceramic Articles; Fabrics, Textiles, and Apparel

This COU refers to the commercial installation of floor covering containing DEHP as construction and building materials covering large surface areas including stone, plaster, cement, glass and ceramic articles; fabrics, textiles, and apparel. DEHP is expected to be already incorporated into the floor covering, and the COU describes the workers handling and installing the construction materials, tiles, carpeting, etc.

DEHP is present in the polyurethane binder attached to cork that is laid under tile, marble, and hardwood floors for sound control (WE Cork, 2001). DEHP may also be found in vinyl tile, planks, and accessories (DEHP Use Report). DEHP is also present in a waterproof and weather resistant fabric used to make connections between outdoor air handers and ducts and air conditioning and heating systems, and the fabric is used in industrial/commercial settings and is not for consumer use. EPA notes that in the newest revision of the safety data sheet for this product, it seems to be no longer formulated with DEHP. However, DEHP can still be found within conditioning and heating systems that have already been installed with the DEHP-containing fabric. (Duro Dyne Corporation, 2024).

Examples of CDR Submissions

Two companies reported the commercial use of DEHP, including one company reporting it as a plasticizer, in construction and building materials covering large surface areas including stone, plaster, cement, glass and ceramic articles; fabrics, textiles, and apparel in the 2020 CDR cycle (U.S. EPA, 2020a).

E.24 Commercial Use – Packaging, Paper, Plastic, Toys, Hobby Products – Ink, Toner, and Colorants

This COU refers to the commercial use of DEHP in inks (including those used for stamps), pigments, toner, and colorants, that can be used in packaging, paper, plastic, toys, hobby products and articles.

EPA identified a DEHP-containing product which is "intended for use in the manufacturing of pre-inked handstamps for the purpose of marking/printing on porous substrates such as paper or paper board." (Identity Group, 2016). Workers could be exposed to DEHP during the use of the stamp that contains DEHP. It is assumed that the stamps could be used for commercial and consumer purposes. Additionally, this COU includes DEHP found within the color cartridge used in inkjet printing of markers and placards for use in proprietary specifications within federal, military, industry and company settings (EPA-HQ-OPPT-2018-0433-0004).

The commercial use of DEHP in ink, toner, and colorants (including pigment) was not reported during the 2016 and 2020 CDR cycles.

E.25 Commercial Use – Packaging, Paper, Plastic, Toys, Hobby Products – Packaging (Excluding Food Packaging) and Other Articles with Routine Direct Contact During Normal Use, Including Rubber Articles; Plastic Articles (Hard); Plastic Articles (Soft)

This COU refers to the commercial use of DEHP as a plasticizer in various packaging, plastic, and hobby articles. EPA notes that the CDR use code for "packaging (excluding food packaging), including rubber articles; plastic articles (hard); plastic articles (soft)" includes examples such as phone covers, personal tablets covers, styrofoam packaging, and bubble wrap. In addition, the CDR use code for "other articles with routine direct contact during normal use including rubber articles; plastic articles (hard)" in the 2020 CDR cycle includes examples such as gloves, boots, clothing, rubber handles, gear lever, steering wheels, handles, pencils, and handheld device casing.

An example of a commercial use covered by this COU is use of DEHP-containing packaging during the final stages of assembly, such as putting art supplies or tennis balls in DEHP-containing packaging material for sale (Washington Department of Ecology, 2021). . Examples of rubber articles and soft and hard plastic articles included in this COU that EPA identified are a DEHP-containing vinyl banner used in digital printing (BriteLine, 2018); helmets and vinyl aprons with sleeves listed for sale with

Proposition 65 warnings for DEHP content (Quad City Safety Inc, 2024a, b); and DEHP-containing Tygon® tubing (EPA-HQ-OPPT-2018-0433-0004).

Examples of CDR Submissions
In the 2016 CDR cycle, multiple companies reported the commercial use of DEHP in plastic and rubber products not covered elsewhere (U.S. EPA, 2019b).

In the 2020 CDR cycle, one company reported the use of DEHP as a plasticizer in packaging (excluding food packaging), including rubber articles; plastic articles (hard); plastic articles (soft) (U.S. EPA, 2020a). Multiple companies reported commercial as well as consumer use of DEHP as a plasticizer in packaging (excluding food packaging), including rubber articles; plastic articles (hard); plastic articles (soft). One company reported use of DEHP as a plasticizer in other articles with routine direct contact during normal use including rubber articles; plastic articles (hard) (U.S. EPA, 2020a).

E.26 Commercial Use – Packaging, Paper, Plastic, Toys, Hobby Products – Packaging (Excluding Food Packaging), Including Paper Articles

This COU refers to the commercial use of DEHP as a plasticizer in paper packaging, excluding food packaging. The expected users of articles under this category would be during completion of the final packaging of the article for commercial and consumer applications. EPA expects that the workers could be exposed to DEHP through the handling of DEHP-containing packaging during the final stages of product completion.

Examples of CDR Submissions
In the 2020 CDR, one company reported both the commercial and consumer use of DEHP as a plasticizer in packaging (excluding food packaging), including paper articles (U.S. EPA, 2020a).

E.27 Commercial Use – Packaging, Paper, Plastic, Toys, Hobby Products – Toys, Playground, and Sporting Equipment

This COU refers to the commercial use of DEHP in toys, playground, and sporting equipment. The COU includes the commercial installation, use, and maintenance of toys, playgrounds, and sporting equipment that contain DEHP (such as in daycare or school environments by workers, *e.g.*, teachers or providers). Exposure to DEHP could occur during the final product manufacture such as when workers would be anticipated to mold or otherwise fabricate the products for commercial and consumer applications, as well as during installation of sporting or playground equipment. DEHP is reported to be found downstream in tire crumb applications for playgrounds and turf (Armada et al., 2022; U.S. EPA, 2019e).

The use of DEHP in playground and sporting equipment would be as a general-purpose plasticizer for PVC in various applications under this subcategory, including tires with incorporated DEHP being used for tire crumb in playground settings (U.S. EPA, 2019e).

DEHP can be used as a plasticizer to provide flexibility to toys. The Consumer Product Safety Improvement Act (CPSIA) of 2008 limited manufacturers' use of DEHP in children's toys to 0.1 percent (16 CFR Part 1307). Toys containing higher concentrations of DEHP that were manufactured and/or processed prior to the CPSIA restriction in 2008 may still be in use.

Examples of CDR Submissions
In the 2016 CDR cycle, one company reported the commercial use of DEHP in toys, playground, and sporting equipment (U.S. EPA, 2019b).

In the 2020 CDR cycle, another company reported the commercial and consumer use of DEHP in toys, playground, and sporting equipment (U.S. EPA, 2020a).

E.28 Commercial Use – Other – Laboratory Chemicals

This COU refers to the commercial use of DEHP as a laboratory chemical.

DEHP can be used as a laboratory chemical, such as a chemical standard or reference material during analyses. Commercial use of laboratory chemicals may involve handling DEHP by hand-pouring or pipette and either adding to the appropriate labware in its pure form to be diluted later or added to dilute other chemicals already in the labware. EPA expects that laboratory DEHP products are pure DEHP in neat liquid form or DIDP present as an impurity in other products. The Agency notes that the same applications and methods used for quality control can be applied in industrial and commercial settings. DEHP is also used as a laboratory chemical in applications such as analytical standards, research, equipment calibration, sample preparation (EPA-HQ-OPPT-2018-0501-0043). EPA identified laboratory chemicals including DEHP used as reference materials (Chem Service Inc, 2018; Phenova, 2018).

The commercial use of DEHP as a laboratory chemical does not have CDR data reported during the 2016 and 2020 CDR cycles.

E.29 Commercial Use – Other Uses – Automotive Articles and Products

This COU refers to the commercial use of DEHP in automotive articles, which already have DEHP incorporated into them, as well as automotive care products including DEHP. This is a use of DEHP-containing automotive articles in a commercial setting, such as an automotive parts business or a worker driving a vehicle, as opposed to upstream use of DEHP (*e.g.*, when DEHP-containing products are used in the manufacturing of the automobile) or use in an industrial setting.

EPA identified references indicating automotive upholstery may contain DEHP (Reddam and Volz, 2021). EPA identified insertable floor liners for automobiles listed for sale with a Proposition 65 warning for DEHP content (Westin Automotive Products Inc, 2024). Additionally, this COU includes DEHP used in a number of automotive parts, both in current production and replacement parts, including electrical system wiring, seat assemblies, radiator assemblies, hoses in chassis assembly, and hardware modules in the automobile doors (EPA-HQ-OPPT-2019-0131-0022).

DEHP is contained within a one-step rust converter, used primarily for rust on automotives (3M, 2017).

DEHP is reported to be found downstream in tire crumb applications for playgrounds and turf (Armada et al., 2022; U.S. EPA, 2019e). Commercial users may be exposed to tires when handling tires for replacement on automobiles, or when performing maintenance and repair on automobiles.

Examples of CDR Submissions
This specific COU was not reported in the 2016 and 2020 CDR cycles. However, in the 2016 CDR cycle, one company reported the commercial and consumer use of DEHP in fabric, textile, and leather products not covered elsewhere (U.S. EPA, 2019b). EPA recognizes that use in fabric, textile, and

leather products not covered elsewhere may be in reference to fabric or leather products used in automotive interiors.

E.30 Consumer Use – Automotive, Fuel, Agriculture, Outdoor Use Products – Lawn and Garden Care Products

This COU refers to the consumer use of DEHP in lawn and garden care products which contain DEHP.

Use of lawn and garden care products containing DEHP in consumer settings would typically be handled by consumers. EPA was unable to identify any products in the marketplace containing DEHP.

Examples of CDR Submissions
In the 2020 CDR cycle, one company reported the consumer use of DEHP for use in lawn and garden care products (U.S. EPA, 2020a).

E.31 Consumer Use – Construction, Paint, Electrical, and Metal Products – Adhesives and Sealants

This COU refers to the consumer use of DEHP in adhesives and sealants. This COU includes one-component caulks, as well as fillers and putties.

DEHP is present in “lazing putty red,” which is used to repair scratches and other imperfections on the exterior of the automotive body (U.S. Chemical & Plastics, 2020).

Examples of CDR Submissions
In the 2020 CDR cycle, one company reported the consumer use of DEHP in one-component caulks (U.S. EPA, 2020a).

E.32 Consumer Use – Construction, Paint, Electrical, and Metal Products – Batteries

This COU refers to the consumer use of batteries with DEHP already included in them, for articles such as digital cameras.

In the *Final Scope of the Risk Evaluation for DEHP* (U.S. EPA, 2020c), EPA identified DEHP in a replacement digital camera battery, which was available for purchase on Amazon at some point in 2023 but appears to be no longer available for purchase. EPA has identified battery products listing California Proposition 65 warnings for DEHP content, including battery replacements for trail cameras, and digital camera batteries (Kastar, 2024; Spypoint, 2024; Thumper Massager Inc, 2024).

The consumer use of DEHP in batteries was not reported during the 2016 or 2020 CDR cycles.

E.33 Consumer Use – Construction, Paint, Electrical, and Metal Products – Construction and Building Materials Covering Large Surface Areas, Including Paper Articles; Metal Articles; Stone, Plaster, Cement, Glass and Ceramic Articles

The COU refers to the consumer use of DEHP in household use of solid flooring, including vinyl and vinyl-backed flooring, and other building materials, such as cement and ceramic tiles. EPA identified references indicating DEHP may be used in wallpaper (Hsu et al., 2017).

Example of CDR Submissions
In the 2020 CDR cycle, one company reported use of DEHP as Not Known or Reasonably Ascertainable under this COU, and another company reported use of DEHP as a plasticizer under this COU (U.S. EPA, 2020a).

E.34 Consumer Use – Construction, Paint, Electrical, and Metal Products – Machinery, Mechanical Appliances, Electrical/Electronic Articles

This COU refers to the consumer use of DEHP already incorporated as a plasticizer in machinery, mechanical appliances, and electrical and electronic articles.

EPA identified the use of DHEP in PVC formulations for wire and cable insulation. The Danish EPA identifies use of DEHP in electrical and electronic articles in Denmark. EPA was not able to verify if DEHP is still used in these articles in the U.S.

DEHP may be used as a hydraulic fluid in machinery or machinery parts (Just In Time Chemical, 2015).

Example of CDR Submissions
In the 2016 CDR cycle, one company reported the commercial and consumer use of DEHP as a plasticizer in electrical and electronic products (U.S. EPA, 2019b).

E.35 Consumer Use – Construction, Paint, Electrical, and Metal Products – Paints and Coatings

This COU refers to the consumer use of DINP in paints and coatings. This COU includes the consumer DIY and bystander exposure to the paint and coating products during the application of paints and coatings. This COU includes solvent- and water-based paints.

DEHP is found in pigments used in the field to color coatings and sealants. EPA identified examples of pigments that contain DEHP and could be used for consumer applications (The Sherwin-Williams Company, 2019). The colorants that have been incorporated into the coating/sealant would be applied to the building material.

In addition, EPA identified a sealant containing DEHP, used to prevent vegetation growth as well as create a stain and water-resistant barrier to prevent weathering of concrete (Eagle I.F.P. Company, 2015a, b).

Consumers could be exposed to DEHP during the DIY application to decorative concrete at their residential home(s).

Examples of CDR Submissions
In the 2016 CDR cycle, one company reported the use of DEHP in paints and coatings, for both commercial and consumer use (U.S. EPA, 2019b).

In the 2020 CDR cycle, one company reported the use of DEHP in solvent-based paint as NKRA, but another company reported the commercial and consumer use of DEHP as a plasticizer in solvent-based paint, and a third company reported the commercial and consumer use of DEHP as a plasticizer in water-based paint (U.S. EPA, 2020a).

E.36 Consumer Use – Furnishing, Cleaning, Treatment Care Products – Fabric, Textile, and Leather Products; Furniture and Furnishings

This COU refers to the consumer use of DEHP already incorporated as a plasticizer in fabric, textile, and synthetic leather materials and articles, as well as DEHP already incorporated into furniture and furnishings. Consumers may be exposed during the wearing of the clothing or use of the product. DEHP can be found in the soles of shoes (Mandal et al., 2022). DEHP is used as the plasticizer in the PVC dots that are incorporated into canvas gloves for workers performing tasks related to farming, ranching, oil, or gas. The PVC dots are used to improve grip (Kinco, 2024). EPA recognizes that gloves can be included in the "Other articles with routine direct contact during normal use including rubber articles; plastic articles (hard)" COU; however, EPA believes this glove product to be better captured within this COU, as the glove is not a plastic glove. Additionally, EPA identified a rain jacket listed for sale with a Proposition 65 warning for DEHP content (Equifit, 2024).

Examples of CDR Submissions

In the 2016 CDR cycle, one company reported the commercial and consumer use of DEHP in fabric, textile, and leather products not covered elsewhere (U.S. EPA, 2019b). In the 2016 CDR cycle, one company reported the commercial and consumer use of DEHP in fabric, textile, and leather products not covered elsewhere (U.S. EPA, 2019b).

This COU was not reported in the 2020 CDR cycle.

E.37 Consumer Use – Furnishing, Cleaning, Treatment Care Products – Floor Coverings; Construction and Building Materials Covering Large Surface Areas Including Stone, Plaster, Cement, Glass and Ceramic Articles; Fabrics, Textiles, and Apparel

This COU refers to the consumer use of DEHP in floor coverings and construction and building materials including various types of flooring. The COU includes consumers using flooring containing DEHP in an indoor environment and DIYers handling the construction materials, tiles, carpeting, etc. that have DEHP incorporated into the products and may involve cutting and shaping the products for installation.

DEHP is present in the polyurethane binder attached to cork that is laid under tile, marble, and hardwood floors for sound control (WE Cork, 2001). DEHP may also be found in vinyl tile, planks, and accessories (DEHP Use Report).

Example of CDR Submissions

In the 2020 CDR cycle, one company reported both commercial and consumer use of DEHP as a plasticizer in Construction and building materials covering large surface areas including stone, plaster, cement, glass and ceramic articles; fabrics, textiles, and apparel, as a plasticizer (U.S. EPA, 2020a).

E.38 Consumer Use – Packaging, Paper, Plastic, Toys, Hobby Products – Inks, Toner, and Colorants

This COU refers to the consumer use of DEHP in inks (including those used for stamps), pigment, toners, and colorants, that can be used in packaging, paper, plastic, toys, and hobby products and articles.

EPA identified a DEHP-containing product, which is "intended for use in the manufacturing of pre-inked handstamps for the purpose of marking/printing on porous substrates such as paper or paper board." (Identity Group, 2016). Workers could be exposed to DEHP during the use of the stamp that contains DEHP. It is assumed that the stamps could be used for commercial and consumer purposes.

The consumer use of DEHP in inks, toner, pigments, and colorants was not reported during the 2016 or 2020 CDR cycles.

E.39 Consumer Use – Packaging, Paper, Plastic, Toys, Hobby Products – Packaging (Excluding Food Packaging) and Other Articles with Routine Direct Contact During Normal Use, Including Rubber Articles; Plastic Articles (Hard); Plastic Articles (Soft)

This COU refers to the consumer use of DEHP in various packaging, plastic, and hobby articles.

EPA notes that the CDR use code for "packaging (excluding food packaging), including rubber articles; plastic articles (hard); plastic articles (soft)" in the 2020 CDR cycle includes examples such as phone covers, personal tablets covers, styrofoam packaging, and bubble wrap. In addition, the use code for "other articles with routine direct contact during normal use including rubber articles; plastic articles (hard)" in the 2020 CDR cycle includes examples such as gloves, boots, clothing, rubber handles, gear lever, steering wheels, handles, pencils, handheld device casing.

The type of articles being reported under this code could be both commercial and consumer in nature. EPA expects that the consumers could be exposed to DEHP through the handling of DEHP-containing packaging during use. DEHP is used in packaging for toys and other articles, which consumers may be exposed to during handling (Washington Department of Ecology, 2021). EPA identified a DEHP-containing vinyl banner used in digital printing (BriteLine, 2018). EPA also identified helmets and vinyl aprons with sleeves listed for sale with Proposition 65 warnings for DEHP content (Quad City Safety Inc, 2024a, b). Additionally, DEHP was identified in Tygon® tubing (EPA-HQ-OPPT-2018-0433-0004).

Examples of CDR Submissions

In the 2016 CDR cycle, one company reported the commercial and consumer use of DEHP in plastic and rubber products not covered elsewhere (U.S. EPA, 2019b).

In the 2020 CDR cycle, one company reported the use of DEHP as a plasticizer in packaging (excluding food packaging), including rubber articles; plastic articles (hard); plastic articles (soft). They reported the use as NKRA (U.S. EPA, 2020a). Another company reported the consumer and commercial use of DEHP as a plasticizer in packaging (excluding food packaging), including rubber articles; plastic articles (hard); plastic articles (soft) (U.S. EPA, 2020a). A third company reported the NKRA use of DEHP as a plasticizer in other articles with routine direct contact during normal use including rubber articles; plastic articles (hard) (U.S. EPA, 2020a).

E.40 Consumer Use – Packaging, Paper, Plastic, Toys, Hobby Products – Packaging (Excluding Food Packaging) Including Paper Articles

This COU refers to the consumer use of DEHP in paper packaging, excluding food packaging. The expected users of products under this category would be consumers handling products with paper packaging.

Example of CDR Submissions

In the 2020 CDR, one company reported both the commercial and consumer use of DEHP as a plasticizer in Packaging (excluding food packaging), including paper articles (U.S. EPA, 2020a).

E.41 Consumer Use – Packaging, Paper, Plastic, Toys, Hobby Products – Toys, Playground, and Sporting Equipment

This COU refers to the consumer use of DEHP in toys, playgrounds, and sporting equipment that contain DEHP. The use also refers to the do-it-yourself building of home playground equipment. In addition, a plastisol coating is commonly used on sporting equipment, such as fitness balls and hand weights. EPA recognizes tires with incorporated DEHP are used for tire crumb in playground and athletic field settings (Armada et al., 2022; U.S. EPA, 2019e). Consumers are expected to use playgrounds and athletic fields.

DEHP can be used as a plasticizer to provide flexibility to toys. The Consumer Product Safety Improvement Act (CPSIA) of 2008 limited manufacturers' use of DEHP in children's toys to 0.1 percent (16 CFR Part 1307). Toys containing higher concentrations of DEHP that were manufactured and/or processed prior to the CPSIA restriction in 2008 may still be in use.

The consumer use of DEHP in toys, playground and sporting equipment was not reported to EPA during the 2016 and 2020 CDR cycles.

E.42 Consumer Use – Other Uses – Novelty Articles

This COU refers to the consumer use of DEHP in adult novelty articles. This COU is describing adult sex toys that are available for consumer use in the United States. Although the U.S. Food and Drug Administration (FDA) classifies certain sex toys (such as vibrators) as obstetrical and gynecological therapeutic medical devices, many manufacturers label these products "for novelty use only" and are not subject to FDA regulations (Stabile, 2013). This same study indicated tested concentrations of phthalates between 24 and 49 percent of the tested sex toys for creating a softer, more flexible plastic (Stabile, 2013). The Agency would expect the concentration of DEHP to be analogous to the overall content of the mix of phthalates tested and found in this study for these articles.

The consumer use of DEHP in novelty articles was not reported to EPA during the 2016 CDR and 2020 CDR cycles.

E.43 Consumer Use – Other Uses – Automotive Articles

This COU refers to the consumer use of DEHP in automotive articles. This COU includes the use of DEHP-containing automotive articles in a consumer DIY setting or by consumers driving a vehicle. EPA identified references indicating automotive upholstery products may contain DEHP (Reddam and Volz, 2021). EPA identified insertable floor liners for automotives listed for sale with a Proposition 65 warning for DEHP content (Westin Automotive Products Inc, 2024). Additionally, this COU includes DEHP used in a number of automotive parts, both in current production and replacement parts, including electrical system wiring, seat assemblies, radiator assemblies, hoses in chassis assembly, and hardware modules in the automobile doors (EPA-HQ-OPPT-2019-0131-0022).

DEHP is reported to be found downstream in tire crumb applications for playgrounds and turf (Armada et al., 2022; U.S. EPA, 2019e). Consumers use tires containing DEHP when handling tires for replacement on automobiles.

Examples of CDR Submissions

This specific COU was not reported during the 2016 and 2020 CDR cycles. However, in the 2016 CDR cycle, one company reported the commercial and consumer use of DEHP in fabric, textile, and leather products not covered elsewhere (U.S. EPA, 2019b). EPA recognizes that use in fabric, textile, and leather products not covered elsewhere may be in reference to fabric or leather products used in automotive interiors.

E.44 Disposal

For purposes of the DEHP risk evaluation, this COU refers to the DEHP in a waste stream that is collected from facilities and households and are unloaded at and treated or disposed at third-party sites. Each of the COUs of DEHP may generate waste streams of the chemical. This COU also encompasses DEHP contained in wastewater discharged by consumers or occupational users to POTW or other, non-POTW for treatment, as well as other wastes. DEHP 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 DEHP, plastic and rubber products, textiles, and transport containers). Disposal may also include destruction and removal by incineration (U.S. EPA, 2021b). Additionally, DEHP has been identified in *EPA's Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States*, December 2016 document to be a chemical reported to be detected in produced water, which is subsequently disposed (U.S. EPA, 2016b). Recycling of DEHP and DEHP-containing products is considered a different COU. Activities and releases associated with the use of DEHP in propellants in articles, or components of articles subject to Section 4181 of the Internal Revenue Code of 1954, which are outside the scope of the definition of "chemical substance" TSCA section 3(2)(B)(v), are not considered as part of the disposal COU. Environmental releases from industrial sites are assessed in each condition of use and are not considered as part of the disposal COU.

Appendix F OCCUPATIONAL EXPOSURE VALUE DERIVATION

EPA has calculated a 8-hour existing chemical occupational exposure value to summarize the occupational exposure scenario and sensitive health endpoints into a single value. This calculated value may be used to support risk management efforts for DEHP under TSCA section 6(a), 15 U.S.C. §2605. EPA calculated the value rounded to 0.31 mg/m^3 for inhalation exposures to DEHP as an 8-hour time-weighted average (TWA) and for consideration in workplace settings (Appendix F.1) based on the acute non-cancer human equivalent concentration (HEC) for adverse effects on the developing male reproductive system consistent with phthalate syndrome.

TSCA requires risk evaluations to be conducted without consideration of costs and other non-risk factors; thus, this occupational exposure value represents a risk-only number. If risk management for DEHP follows the final 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 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 value for DEHP 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.*, developing male reproductive system) and exposure duration (*i.e.*, acute) relative to benchmarks and a standard occupational scenario assumptions of an 8-hour workday.

EPA expects that at the occupational exposure value of 0.019 ppm (0.31 mg/m^3), a worker or ONU also would be protected against developmental and reproductive toxicity from intermediate and chronic duration occupational exposures if ambient exposures are kept below this occupational exposure value. EPA has not separately calculated a short-term (*i.e.*, 15-minute) occupational exposure value because the Agency did not identify hazards for DEHP associated with this very short duration.

OSHA has set a permissible exposure limit (PEL) of 5 mg/m^3 as an 8-hour TWA for DEHP (https://www.osha.gov/annotated-pels), which was established in August 1994. Similarly, in 1996 ACGIH also set an 8-hour TWA threshold limit value (TLV) of 5 mg/m^3; however, ACGIH has subsequently issued a notice of intended change, with 8-hour TWA TLV being updated to 0.1 mg/m^3 (https://www.acgih.org/di2-ethylhexyl-phthalate-notice-of-intended-change/). EPA located several occupational exposure limits for DEHP (CASRN 117-81-7) in other countries (https://ilv.ifa.dguv.de/limitvalues/18036). Identified 8-hour TWA values range from 0.8 mg/m^3 in Poland to 10 mg/m^3 in South Africa. Additionally, EPA found that New Zealand and the United Kingdom have an established occupational exposure limit of 2 and 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.

Validated air monitoring methods are available for DEHP, including OSHA Method 104 (OSHA, 1994), and NIOSH Method 5020, which is partially validated for DEHP (https://www.cdc.gov/niosh/docs/2003-154/pdfs/5020HEX.pdf).

F.1 Occupational Exposure Value Calculations

This appendix presents the calculations used to estimate occupational exposure values using inputs derived in this risk evaluation. Multiple values are presented below for hazard endpoints based on different exposure durations. For DEHP, the most sensitive occupational exposure value is based on non-cancer developmental effects and the resulting 8-hour TWA is rounded to 0.31 mg/m^3.

Inhalation Rate Adjustment

When an HEC derived from non-occupational epidemiological studies is used, an adjustment is made to account for the difference between the occupational inhalation rate ($IR_{workers}$ = 1.25 m^3/h) and the general population inhalation rate ($IR_{resting}$ = 0.6125 m^3/h). The adjustment ratio is the general population inhalation rate (0.6125 m^3/h) over the occupational inhalation rate (1.25 m^3/h). The general population inhalation rate (0.6125 m^3/h) is based on an average of the mean inhalation rates (m^3/day, men and women combined) for adults (U.S. EPA, 2011a) over 21 years of age which is converted to m^3/h.

Acute Non-Cancer Occupational Exposure Value

The 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.

$$\mathrm{EV_{acute}} = \frac{\mathrm{HEC_{acute}}}{Benchmark\ MOE_{acute}} * \frac{\mathrm{AT_{HECacute}}}{ED} * \frac{\mathrm{IR_{resting}}}{\mathrm{IR_{workers}}} =$$

$$\frac{0.39\ \mathrm{ppm}}{30} * \frac{\frac{24h}{d}}{\frac{8h}{d}} * \frac{0.6125\frac{\mathrm{m^3}}{h}}{1.25\frac{\mathrm{m^3}}{h}} = 0.019\ \mathrm{ppm}$$

$$EV_{acute}\left(\frac{\mathrm{mg}}{\mathrm{m^3}}\right) = \frac{EV\ ppm\ * MW}{Molar\ Volume} = \frac{0.019\ \mathrm{ppm} * 390.56\frac{g}{mol}}{24.45\ \frac{L}{mol}} = 0.31\ \frac{\mathrm{mg}}{\mathrm{m^3}}$$

Intermediate Non-Cancer Occupational Exposure Value

The 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.

$$\mathrm{EV_{intermediate}} = \frac{\mathrm{HEC_{intermediate}}}{Benchmark\ MOE_{\mathrm{intermediate}}} * \frac{\mathrm{AT_{HEC\ intermediate}}}{ED*EF} * \frac{\mathrm{IR_{resting}}}{\mathrm{IR_{workers}}}$$

$$= \frac{0.39\ \mathrm{ppm}}{30} * \frac{\frac{24h}{d} * 30d}{\frac{8h}{d} * 22d} * \frac{0.6125\frac{\mathrm{m^3}}{hr}}{1.25\frac{\mathrm{m^3}}{hr}} = 0.026\ \mathrm{ppm} = 0.42\ \frac{\mathrm{mg}}{\mathrm{m^3}}$$

Chronic Non-Cancer Exposure Value

The 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.

$$\mathrm{EV_{chronic}} = \frac{\mathrm{HEC_{chronic}}}{Benchmark\ MOE_{chronic}} * \frac{\mathrm{AT_{HEC\ chronic}}}{ED*EF*WY} * \frac{\mathrm{IR_{resting}}}{\mathrm{IR_{workers}}}$$

$$= \frac{0.39\ \mathrm{ppm}}{30} * \frac{\frac{24h}{d}*\frac{365d}{y}*40\ y*0.6125\frac{\mathrm{m}^3}{hr}}{\frac{8h}{d}*\frac{250d}{y}*40\ y*1.25\frac{\mathrm{m}^3}{hr}} = 0.028\ \mathrm{ppm} = 0.45\ \frac{\mathrm{mg}}{\mathrm{m}^3}$$

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
$\mathrm{EV_{chronic}}$	=	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 for the general population)
Molar Volume	=	24.45 L/mol, the volume of a mole of gas at 1 atm and 25 °C
MW	=	Molecular weight of DEHP (390.56 g/mole)
WY	=	Working years per lifetime at the 95th percentile (40 years).

Unit conversion:

1 ppm = 15.97 mg/m^3 (see equation associated with the EV_{acute} calculation