

Product Category Rules (PCR) For Asphalt Mixtures

Version 2.01

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Foreword

Midstream Update [final publication date: XX/XX/2025]: A midstream update was issued in response to the Environmental Protection Agency's review of the asphalt mixture Product Category Rule against the EPA – PCR Criteria as published within the Construction Materials Opportunities to Reduce Emissions (C-MORE) program. In response, NAPA, the PCR Committee, was convened to discuss and address the review with the following changes:

- Expanded the geographic applicability of the PCR to include Mexico in addition to Canada, and the United States, following the same roadmap of regionalizing upstream datasets and harmonizing with Mexican standardizing organization, Organismo Nacional de Normalización y Certificación de la Construcción y Edificación (ONNCCE).
- Updated definitions: Red-lined definitions have been provided in the attached PCR document. Updated definitions include old numbering 3.9.17, 3.9.28 (new numbering 3.9.29) and 3.9.41 (new numbering 3.9.44). New definitions added for Facility and product-specific EPD (3.9.18), Producer-average EPD (3.9.42), Product-average EPD (3.9.43), and Supply-chain specificity (3.9.55).
- Updates to section 5.3, reflecting changes in definitions, outlining the types of EPDs that this PCR can be used to develop.
- References added to the underlying LCA (Mukherjee, 2021) highlighting Assumptions and Limitations in this section and in section 5.2.2; and to the tabular representation of background LCI in Annex I, version2, in sections 7.1.7.2.2, 7.1.7.2.3 and 7.1.7.2.4.
- Updates to use of PCRs and EPDs for upstream materials use in section 7.1.9.2.
- Updates to sections 10.6, 10.1 and 11, providing clarity on how the underlying LCA and the Emerald Eco-Label tool has been independently verified, and recent updates including the addition of Simulator tool and the Quality Control program, that add to the transparency and veracity of the EPDs.

When the Product Category Rules (PCR) for Asphalt Mixtures was published in February 2017, NAPA became one of the first organizations in the United States to offer a simple, easy to use software tool for developing and publishing verified environmental product declarations (EPDs). At the time, there was growing interest in EPDs among various stakeholders, with the most significant being the U.S. Green Building Council's (USGBC) LEED v4 green construction rating system and the Federal Highway Administration (FHWA) Sustainable Pavements Technical Working Group (SPTWG). Since then, every major green construction rating system and green building code has introduced a credit for EPDs. Additionally, several state and local agencies are implementing EPD policies that require asphalt paving contractors to submit EPDs and, in some cases, demonstrate that asphalt mixtures meet established global warming potential (GWP) limits.

As interest in EPDs for asphalt mixtures grows, version 2 of the PCR for Asphalt Mixtures will enable NAPA to continue its tradition of offering an easy, cost-effective software tool for asphalt mix producers to develop and publish verified EPDs.

The underlying life cycle assessment (LCA) by Mukherjee (2021), which serves as the foundation for this PCR and informs many of the technical requirements provided in the PCR, has been substantially revised to support this updated PCR. [All assumptions and limitations of the LCA model supporting this PCR are discussed on page 48 of the LCA \(Mukherjee, 2021\) in the Assumptions and Limitations section.](#) The primary changes in the underlying LCA, compared to the previous one, are:

- Improvements in recommended upstream datasets.
 - o Inclusion of a variety of fuels sourced from the U.S. Life Cycle Inventory (USLCI) database and other available public datasets.
 - o Electricity consumption data updated to reflect Department of Energy National Energy Technology Laboratory (NETL) electricity baseline inventories, regionalized to the level of balancing authority.
 - o Inclusion of system level cradle to terminal inventory data from Wildnauer et al. (2019) for asphalt binder, asphalt binder with varying amounts and types of polymer modifiers, asphalt binder with 0.5% polyphosphoric acid (PPA) and asphalt binder with 8% ground tire rubber (GTR).
 - o Inclusion of EPA's transportation and heavy equipment life cycle inventory.
- Inclusion of portable asphalt mixture plants.
- Enhanced reporting of trends in life cycle impact assessment indicators based on foreground data collected through the NAPA EPD program since 2015.
- Extended sensitivity analysis.

Version 2 of this PCR has been updated in accordance with the newly-revised underlying LCA and also to reflect changing conditions surrounding LCA and EPDs for construction materials. Key changes to this PCR, compared to version 1 published in 2017, include the following:

- Changed the core PCR from EN 15804 to ISO 21930 to be more consistent with other EPD programs in North America.
- Expanded the geographic applicability of the PCR to include Canada in addition to the United States.
- Revised Annex 1 to use the latest available upstream (secondary) datasets for energy and materials.
- Clarified guidance regarding comparability of EPDs for asphalt mixtures.
- Added new requirements to enable development of EPDs for portable asphalt plants.
- Clarified system boundaries for secondary (recycled) materials and added a requirement to use foreground (plant-specific) data for transportation of reclaimed asphalt pavement (RAP) and recycled asphalt shingles (RAS) instead of using a generic pre-determined variable.

- Added new requirements to enable development of EPDs for asphalt mixtures produced using cold central plant recycling (CCPR) technology.
- Added new requirements to account for disposal of waste materials produced during asphalt mixture production (e.g., baghouse fines).
- Improved transparency regarding asphalt mixture materials and content of regulated hazardous substances.
- Enhanced the additional environmental information provided in EPDs, including:
 - Indicating potential greenhouse gas (GHG) emission reductions from the procurement of clean energy through market-based instruments such as on-site renewables and renewable energy certificates (RECs) and is not accounted for in the reported global warming potential (GWP-100).
 - Additional inventory indicators describing emissions and removals of carbon that are accounted for in the GWP-100.
 - Biogenic carbon uptake associated with biofuels that is not accounted for in GWP-100.
 - Indicating a company's participation in ENERGY STAR programs.
 - Indicating a company's implementation of an environmental management system (EMS).
 - Providing a recommended default transportation distance at end-of-life (C2) for RAP when asphalt mixture EPDs are used as a data source for pavement LCA studies.
 - Providing information related to release of dangerous substances from construction products as defined in ISO 21930.
- Clarified requirements for verification of software-based EPD development tools.

Introduction

Program Operator

The program operator is the National Asphalt Pavement Association (NAPA), based in Greenbelt, Maryland, United States of America.

NAPA is a 501(c)(6) non-profit organization. It is the only trade association exclusively representing the interests of asphalt pavement material producers and paving contractors on the national level with Congress, governmental agencies, and other national trade and business organizations. NAPA supports an active research program designed to answer questions about environmental issues and to improve the quality of asphalt pavements and paving techniques used in the construction of roads, streets, highways, parking lots, airports, and environmental and recreational facilities. The association provides technical, educational, and marketing materials and information to its members, and supplies technical information to users and specifiers of paving materials. The association, which counts more than 1,200 companies among its members, was founded in 1955.

The General Program Instructions and contact information for the Emerald Eco-Label EPD Program are available at <https://www.asphaltpavement.org/programs/napa-programs/emerald-eco-label>.

PCR Committee

NAPA assembled a PCR Committee consisting of various stakeholders including industry, academia, and government agencies to review and revise this PCR. A listing of the PCR Committee members is provided in Appendix A. Their hard work and dedication were instrumental in revising this PCR.

PCR Development

Version 2.0 of this PCR was developed to be consistent with the principles and guidelines established in the FHWA Pavement Life Cycle Assessment Framework (FHWA, 2016b) and the American Center for Life Cycle Assessment (ACLCA) ISO 21930 Guidance (ACLCA, 2019).

PCR Review

This PCR was subject to a public review period from August 9 through September 9, 2021. A total of 94 public comments were received from 16 individuals. A compendium NAPA's response to the public comments is provided in Appendix D.

This PCR was also reviewed by an independent panel to ensure that it meets the requirements of ISO 14025, ISO 21930, and NAPA's General Program Instructions. The review panel members consisted of the following individuals:

- Joep Meijer, theRightEnvironemnt, Review Panel Chair
- John Harvey, Ph.D., independent consultant
- Trisha Montalbo, John Beath Environmental, LLC

How to Read this PCR

This PCR for Asphalt Mixtures is a sub-category PCR under ISO 21930, which serves as the core PCR for construction materials. This PCR follows the same format as ISO 21930, with all headings and section

numbers remaining the same. The two documents are intended to be read together. Sections of ISO 21930 that apply without modification are indicated with an ellipsis (...). Sections of ISO 21930 that are not relevant are indicated with a brief rationale. Additional elements and specifications for developing EPDs for asphalt mixtures are provided in this document.

PCR for Asphalt Mixtures

1. Scope

ISO 21930:2017, Section 1 is adopted with the following additions:

...

1.1. Scope of this Sub-category PCR

The Product Category Rules (PCR) for Asphalt Mixtures establishes the principles, specifications, and requirements to develop facility-specific and industry average EPDs for plant-produced paving asphalt mixtures that are produced in the United States of America (U.S.), ~~and~~ Canada ~~and~~ Mexico and sold without packaging. This PCR is a sub-category to the core PCR, Sustainability in Buildings and Civil Engineering Works – Core Rules for Environmental Product Declarations of Construction Products and Services (ISO 21930).

This PCR applies to United Nations Standard Products and Services Code (UNSPSC) 30111509: Asphalt Based Concrete. For informational purposes, the corresponding MasterFormat numbers and titles that asphalt mixtures are typically used for are provided in ~~Table 1~~ [Table 1](#).

Table 1. MasterFormat Numbers and Titles that Asphalt Mixtures Are Typically Used For.

Number	Title
32 11 26	Asphaltic Base Courses
32 11 26.13	Plant Mix Asphaltic Base Courses
32 12 16	Asphalt Paving
32 12 16.13	Plant-Mix Asphalt Paving
32 12 16.19	Cold-Mix Asphalt Paving
32 12 16.23	Reinforced Asphalt Paving
32 12 16.26	Fiber-Modified Asphalt Paving
32 12 16.27	Fiber-Reinforced Asphalt Paving
32 12 16.29	Polymer-Modified Asphalt Paving
32 12 16.33	Granulated Rubber-Modified Asphalt Paving
32 12 16.36	Athletic Asphalt Paving
32 12 19	Asphalt Paving Wearing Courses
32 12 19.19	Porous Friction Asphalt Paving Wearing Courses
32 12 43	Porous Flexible Paving
32 16 13.33	Asphalt Curbs

An asphalt mixture is defined as a plant-produced composite material of aggregates, an asphaltic binder, and other materials (see Section 3.9). Asphalt mixtures are typically incorporated as part of the structure of a roadway, parking lot, driveway, airfield, bike lane, pedestrian path, railroad trackbed, or recreational surface. The scope of this PCR includes asphalt mixtures produced by

stationary plants as well as portable plants, including hot mix asphalt (HMA), warm mix asphalt (WMA), and cold central plant recycling (CCPR) technologies.

The scope of this PCR does not include asphalt mixtures or pavements that are recycled in-place using processes such as cold in-place recycling (CIR), hot in-place recycling (HIR), and full-depth reclamation (FDR). It also does not include asphalt surface treatments such as sealcoats, slurry seals, chip seals, cape seals, fog seals, microseals, surface-applied rejuvenators, and other similar products; nor does it include asphaltic roofing products, pipe sealants, or other products that are not typically used as pavements. It does not include asphalt mixtures that are sold with packaging.

EPDs developed under this PCR are intended for business-to-business (B2B) communications.

Product Specifications

An asphalt mixture is primarily identified by its specification. Specifications are generally provided by the pavement owner and establish the requirements related to mix ingredients, mix design method, and mix performance. Specifications may include a combination of volumetric and performance-based tests of asphalt mixtures and their ingredients, and may also include process-related requirements such as mix production temperatures or the use of specific mix production technologies. Numerous parameters are used to specify asphalt mixtures, including aggregate gradation, nominal maximum aggregate size, mix design method, performance grade (PG) of the asphalt binder, and others. The specification identifies the required parameters and acceptable values that an asphalt mixture must meet for a given use or application, which is generally a function of pavement design considerations such as the intended use of the pavement, the expected traffic volume in equivalent single-axle loads (ESALs) or the load spectrum of the pavement, condition of the pavement base, expected climate conditions, permeability, and other requirements.

2. Normative references

ISO 21930:2017, Section 2 is adopted with the following additions:

...

General Program Instructions for Emerald Eco-Label EPD Program, Version 2. National Asphalt Pavement Association, Greenbelt, Maryland. <https://www.asphaltpavement.org/epd>.

GHG Protocol Scope 2 Guidance. Greenhouse Gas Protocol, 2015. World Resources Institute, Washington, D.C. https://ghgprotocol.org/scope_2_guidance.

ISO 21930:2017 *Sustainability in buildings and civil engineering works – Core rules for environmental product declarations of construction products and services.*

3. Terms and definitions

ISO 21930:2017, Section 3 is adopted with the following additions:

...

3.1. Terms relating to environmental labeling and declarations

...

3.2. Terms relating to construction works and construction products

...

3.3. Terms relating to life cycle assessment

...

3.4. Terms relating to product systems

...

3.5. Terms relating to data and data quality

...

3.6. Terms relating to resources and materials

...

3.7. Terms relating to biogenic material and land use

...

3.8. Miscellaneous terms

...

3.9. Terms specific to the PCR for Asphalt Mixtures

3.9.1. additive

a material that is added to an asphalt binder or asphalt mixture with the objective of altering its performance characteristics, workability, or ease of placement

3.9.2. aggregate

a collective term for mineral materials that vary in size and source, such as sand, gravel, and crushed stone, used with a binding medium, such as asphalt binder, to form asphalt mixtures or other compound materials

3.9.3. asphalt binder

also called liquid asphalt, asphalt cement, or bitumen, a highly viscous liquid or semi-solid residue from petroleum refining used as the principal binding agent in asphalt mixtures, may include materials added to modify its original properties

3.9.4. asphalt mixture

a plant-produced composite material consisting of asphalt binder, emulsified asphalt, or cutback asphalt and aggregates; the mixture may also include other materials (see Table 1 in Annex 1 for a list of other materials)

[Source: ASTM D8-21, modified to specify plant-produced composite material]

3.9.5. asphalt plant

a manufacturing facility for producing paving asphalt mixtures

[Source: Asphalt Institute Glossary of Terms, modified from the definitions of batch plant and drum mix plant]

3.9.6. baghouse fines

dust particles captured from the exhaust gases of asphalt mixing plants

[Source: FHWA-RD-97-148]

3.9.7. binder additive

any material capable of being dissolved, dispersed, or reacted to in asphalt binder with the objective of altering its performance characteristics, workability, or ease of placement

[Source: ASTM D8-21, definition of Asphalt Modifier]

3.9.8. brown grease

waste vegetable oil, animal fat, grease, etc. that is recovered from a grease trap and that may be converted to biodiesel or renewable diesel or combusted directly for energy recovery with minimal processing

3.9.9. cement

a hydraulic binder – a finely ground inorganic material which, when mixed with water, forms a paste that sets and hardens by means of hydration reactions and processes; and which after hardening, retains its strength and stability even under water

[Source: EN 197-1:2011]

3.9.10. coarse aggregates

a collective term for the large aggregate components, generally those that are larger than the $\frac{3}{8}$ -inch sieve or No. 4 sieve. Aggregates smaller than $\frac{3}{8}$ inch are referred to as “fine aggregates.”

3.9.11. cold central plant recycling (CCPR)

a process in which RAP is processed and stabilized using foamed asphalt or emulsified asphalt at a plant and then placed using conventional asphalt paving equipment

[Source: NCHRP Research Report 960, Appendix B]

3.9.12. cold in-place recycling (CIR)

a process in which a portion of existing asphalt pavement layers is pulverized, stabilized, and repaved in-place that is commonly performed using foamed asphalt or emulsified asphalt as the primary stabilizing additive

[Source: NCHRP Research Report 960, Appendix B, modified to remove the reference to how the existing pavement layer is prepared]

3.9.13. dust

see “fines”

3.9.14. emulsified asphalt

(1) a suspension of minute (typically less than 100 microns in diameter) globules of asphalt material in water or in an aqueous solution, or (2) a suspension of minute (typically less than 100 microns in diameter) globules of water or of an aqueous solution in a liquid asphalt material and conforming to standard specifications for use in the production of asphalt mixtures for pavement construction; the phrase “emulsified asphalt” may be used interchangeably with “asphalt emulsion”

[Source: ASTM D8-21 and D977]

3.9.15. environmental management system (EMS)

part of an organization’s management system used to develop and implement its environmental policy and manage its environmental aspects

[Source: ISO 14001:2014]

3.9.16. equivalent single-axle loads (ESALs)

wheel loads of various magnitudes and repetitions (“mixed traffic”) converted to an equivalent number of standard loads that a pavement is expected to encounter, calculated as part of the specified mix-design method

3.9.17. facility-specific EPD

~~a product-specific EPD in which the environmental impacts can be attributed to a single manufacturer and manufacturing facility; when multiple asphalt plants are located at the same physical location, each asphalt plant is considered a separate facility~~

~~{Source: Lewis et al., 2021; modified to add clarity for situations in which multiple asphalt plants are at the same location}~~

~~An EPD that covers a single manufacturer and a single facility for the last facility in the production chain.~~

3.9.18. facility and product-specific EPD

~~An EPD that represents a specific mix design for a specific production facility; when multiple asphalt plants are located at the same physical location, each asphalt plant is considered a separate facility.~~

~~3.9.18.~~**3.9.19. fibers**

cellulose, mineral fibers, or synthetic fibers added to asphalt mixtures to improve cracking resistance or prevent drain-down

3.9.19.3.9.20. fine aggregates

a collective term for the small aggregate components, generally those that pass through a $\frac{3}{8}$ -inch sieve or No. 4 sieve. Aggregates larger than $\frac{3}{8}$ inch are referred to as “coarse aggregates.”

3.9.20.3.9.21. fines

a general term referring to the smallest of the aggregate components, generally those that pass through a No. 200 sieve

3.9.21.3.9.22. foamed asphalt

asphalt binder which has been combined with water via direct injection or by treatment with sand or water-liberating minerals like zeolite to form foam, which depending on a number of factors such as asphalt binder composition, surface tension, temperature, quantity of water, steam droplet size distribution, and atmospheric conditions, may display half-life and expansion ratio properties suitable for production of asphalt mixtures at reduced temperatures

[Source: NASEM, 2015]

3.9.22.3.9.23. full depth reclamation (FDR)

those processes in which all of the asphalt pavement layers and some portion of the underlying bound and unbound layers are pulverized, stabilized, and compacted in place that is commonly performed using hydraulic cement, lime, foamed asphalt, or asphalt emulsion as the primary stabilizing additive

[Source: NCHRP Research Report 960, Appendix B]

3.9.23.3.9.24. glass cullet

recycled broken or waste glass

3.9.24.3.9.25. ground tire rubber (GTR)

scrap tires that are ground to small particles and used as a binder additive to modify asphalt binder or as a mix additive to supplement a portion of the fine aggregate

3.9.25.3.9.26. hot in-place recycling (HIR)

an in-place pavement maintenance and rehabilitation method which consists of heating, softening, scarifying, mixing (with rejuvenating oil, rejuvenating emulsion, an asphalt binder, new plant-mixed HMA or WMA, and/or new aggregate), placing, and compacting the existing pavement; there are three sub-disciplines: surface recycling, remixing, and repaving

[Source: ARRA (2015), modified for clarity and brevity]

~~3.9.26~~3.9.27. **hot-mix asphalt (HMA) technologies**

conventional methods of producing asphalt mixtures that involve heating and drying aggregates, followed by mixing of aggregates with asphalt binder and other materials

~~3.9.27~~3.9.28. **hydrated lime**

a dry white powder consisting essentially of calcium hydroxide ($\text{Ca}(\text{OH})_2$) that is produced by adding water to crushed lime and is added to asphalt mixtures to improve moisture susceptibility; see “lime”

~~3.9.28~~3.9.29. **industry average EPD**

~~EPD for a representative mix design, or group of mix designs, that meet the requirements of one or more specification(s), developed by a group of manufacturers for a specified region~~
(Also called “sector-average EPD”) An EPD that reports the impacts for a product which is an average of data provided by multiple manufacturers in a clearly defined sector and/or geographical area.

~~3.9.29~~3.9.30. **job-mix formula**

a document that states what the ingredients of an asphalt mixture are, at what proportions they will be used in the mixture, and how the mixture with those proportions meets the relevant specifications, typically submitted to an agency to confirm that a mix design meets the required specifications

~~3.9.30~~3.9.31. **lime**

also referred to as quicklime, lime is calcium oxide (CaO) which is derived from heating (calcining) limestone; this term is commonly applied to hydrated lime ($\text{Ca}(\text{OH})_2$) in the asphalt mixture production industry, but the materials are chemically distinct from each other

~~3.9.31~~3.9.32. **liquid antistrip**

a binder additive that improves adhesion between aggregates and asphalt binder and reduces the moisture susceptibility of asphalt mixtures

~~3.9.32~~3.9.33. **liquid biofuels**

liquid fuels that are derived from biomass, including biodiesel, ethanol, and renewable diesel

~~3.9.33~~3.9.34. **location-based method for scope 2 accounting**

a method to quantify scope 2 GHG emissions based on average energy generation factors for defined locations, including local, subnational, or national boundaries

[Source: GHG Protocol Scope 2 Guidance]

~~3.9.34~~3.9.35. **market-based method for scope 2 accounting**

a method to quantify scope 2 GHG emissions based on GHG emissions emitted by the generators from which the reporter contractually purchases electricity bundled with instruments, or unbundled instruments on their own

[Source: GHG Protocol Scope 2 Guidance]

3.9.35.3.9.36. mineral filler

finely divided mineral matter such as rock dust, slag dust, hydrated lime, hydraulic cement, fly ash, loess, or other material predominantly passing the 75- μ m (No. 200) sieve

[Source: ASTM D8-21]

3.9.36.3.9.37. mix design

a specific blend of aggregates, asphalt binder, and other ingredients that typically includes material proportions and characteristics as well as select mixture properties (volumetrics, strength tests, etc.)

[Source: NAPA, 2001]

3.9.37.3.9.38. mix additive

any material that is blended with an asphalt mixture with the objective of altering its performance characteristics, workability, or ease of placement

3.9.38.3.9.39. perpetual pavement

a long-lasting structural design, construction, and maintenance concept for asphalt pavements, typically designed and built to last longer than 50 years without requiring major structural rehabilitation or reconstruction, and needing only periodic surface renewal in response to distresses confined to the top of the pavement

[Source: Pavement Interactive Reference Desk, edited for brevity]

3.9.39.3.9.40. polymer additive

a binder additive which may be an elastomer or a plastomer

[Note: See Table 1 in Annex 1 for a list of specific polymer additives]

3.9.41. portable plant

an asphalt plant that changes location during the EPD's period of validity

3.9.40.3.9.42. producer average EPD

An EPD that covers a product or products from a single manufacturer, and that reports environmental impacts based on an average of data from multiple facility locations for the last facilities in the production chain.

3.9.41.3.9.43. product average EPD

An EPD that covers a group of similar products from one or more sites of one company or multiple companies, or an EPD that groups similar products using averaged environmental performance data across modules A1 - A3. Products included in an average EPD should be within $\pm 10\%$ of the mean impact per reported environmental impact category [from ISO 21930:2017, Section 5.3].6 A product-average EPD shall also include a product description explaining the variation in the composition or performance of the products that the EPD represents.

3.9.42.3.9.44. product-specific EPD

~~an EPD that represents the impacts for a specific mix design and manufacturer across multiple facilities~~

~~{Source: Lewis et al., 2021; modified to provide additional specificity for the asphalt mixture production industry}~~

An EPD that covers a single product. Given that the distinguishing benefit of a product-specific EPD is its accuracy of environmental impact results (by avoiding product-to-product variability), an EPD may also be considered product-specific if it covers a group of similar products that share equivalent material and performance characteristics such that their environmental impacts per declared unit are sufficiently equivalent. (As described below, it is the role of a PCR to further define “sufficiently equivalent” in its category’s context.)

3.9.43.3.9.45. reclaimed asphalt pavement (RAP)

asphalt pavement or paving mixture removed from its original location for use in recycled asphalt mixture [Source: ASTM D8-21]

3.9.44.3.9.46. recycled asphalt mixture

a mixture of RAP or RAS with the inclusion, if required, of asphalt binder, aggregates, recycling agents, emulsified asphalt, foamed asphalt, and mineral filler

3.9.45.3.9.47. recycled asphalt shingles (RAS)

asphalt shingle manufacturer waste or asphalt shingles removed during re-roofing or roof removal projects that are ground into fine particles and added to asphalt mixtures to replace a portion of the asphalt binder and fine aggregates

3.9.46.3.9.48. recycled fiber

a natural or manufactured substance, derived from waste materials, that is significantly longer than it is wide and may be used as a mix additive

3.9.47.3.9.49. recycled fuel oil

used oil that has been collected and processed for utilization as a fuel oil

3.9.48.3.9.50. recycling agent

additive with chemical and physical characteristics designed to restore the rheological properties of aged asphalt binders in recycled asphalt mixtures; recycling agents may be classified as either rejuvenators or softeners

[Source: NASEM, 2020]

3.9.49.3.9.51. rejuvenator

a recycling agent, as defined in 3.9.47, with strongly polar compounds that help polarize asphaltene clusters in recycled binders and compatibilize them with maltenes, thus breaking up the large asphaltene clusters; the addition of these strongly polar compounds reduces stiffness and increases the phase angle

[Source: NASEM, 2020]

3.9.50.3.9.52. renewable natural gas (RNG)

anaerobically generated biogas that has been upgraded (or refined) for use in place of fossil natural gas, typically derived from municipal solid waste (MSW) landfills, anaerobic digestion (AD) at municipal water resource recovery facilities, AD at livestock farms, and at stand-alone organic waste management operations

[Source: EPA 456-R-20-001]

3.9.51.3.9.53. residual fuel oil

a general classification for the heavier oils, known as No. 5 and No. 6 fuel oils, that remain after the distillate fuel oils and lighter hydrocarbons are distilled away in refinery operations

[Source: EIA Glossary, <https://www.eia.gov/tools/glossary/index.php>]

3.9.52.3.9.54. scope 2 emissions

indirect emissions from the generation of purchased or acquired electricity, steam, heat, or cooling consumed by the reporting company

[Source: GHG Protocol Scope 2 Guidance]

3.9.53.3.9.55. supply-chain specificity

The portion of an EPD's A1-A3 unit processes represented by specific data, calculated as the percent contribution of those processes to the total A1-A3 GWP.

3.9.54.3.9.56. slag aggregate

aggregate material derived from steel slag or blast furnace slag and used in asphalt mixtures

3.9.55.3.9.57. softener

A recycling agent, as defined in 3.9.47, that is distinct from a rejuvenator, as defined in 3.9.48, because it decreases the stiffness of recycled asphalt binder without sufficiently reducing the phase angle

[Source: NASEM, 2020]

~~3.9.56~~**3.9.58.** **used oil**

sometimes referred to as recycled fuel oil, any oil that has been refined from crude oil, or any synthetic oil, that has been used and, as a result of such use, is contaminated by physical or chemical impurities

[Source: 40 CFR 279.1]

~~3.9.57~~**3.9.59.** **warm-mix additive**

a chemical or organic additive that aids compaction and allow producers of asphalt mixtures to reduce the temperature at which the material is mixed and placed on the road

~~3.9.58~~**3.9.60.** **warm-mix asphalt (WMA) technologies**

technologies, including the use of warm-mix additives and asphalt binder foaming processes, that reduce the temperature needed to produce and compact asphalt mixtures for the construction of pavements

[FHWA, 2016, modified to add generic examples of WMA technologies]

~~3.9.59~~**3.9.61.** **yellow grease**

also referred to as used cooking oil, used vegetable oil, recycled vegetable oil, or waste vegetable oil, a liquid waste material recovered from businesses and industry that use the oil for cooking and that may be converted to biodiesel or renewable diesel or combusted directly for energy recovery with minimal processing

4. Abbreviated terms

ISO 21930:2017 Section 4 is adopted with the following additions:

...

AASHTO American Association of State Highway and Transportation Officials

AD Anaerobic digestion

ARRA Asphalt Recycling and Reclaiming Association

ASTM American Society of Testing and Materials

Btu British thermal unit

CCPR Cold central plant recycling

CFR Code of Federal Regulations

CIR Cold in-place recycling

CO₂eq Carbon dioxide equivalents

EPD Environmental product declaration

EMS Environmental management system

ESALs Equivalent single-axle loads

FDR Full depth reclamation

GHG Greenhouse gas

GHG_{LUC} Greenhouse gas emissions associated with land use change
ΔGHG_{RE} GHG emission reductions associated with renewable energy purchases
GTR Ground tire rubber
REET Greenhouse gases, Regulated Emissions, and Energy use in Transportation
HIR Hot in-place recycling
HMA Hot-mix asphalt
kWh Kilowatt hour
LCA Life cycle assessment
LCI Life cycle inventory
Mcf One thousand cubic feet
MMBtu One million British thermal units
NAPA National Asphalt Pavement Association
NASEM National Academies of Sciences, Engineering, and Medicine
NREL National Renewable Energy Laboratory
NRSF Non-renewable secondary fuels
PCA Portland Cement Association
PCR Product category rules
RAP Reclaimed asphalt pavement
RAS Recycled asphalt shingles
RSF Renewable secondary fuels
RSL Reference service life
SM Secondary materials
WMA Warm-mix asphalt

5. General aspects

ISO 21930, Section 5 is adopted with the following additions:

...

5.1. Objectives of this core PCR

...

5.1.1. Objectives of this sub-category PCR

As a sub-category PCR, this document provides the rules, requirements, and guidelines that shall be applied to the development of an EPD for asphalt mixtures produced in the United States and Canada.

In addition to the requirements of this document, the principles and procedures set out in the General Program Instructions for Emerald Eco-Label EPD Program, along with the principles set out in ISO 21930 and references therein, shall apply. Where this document contains more specific requirements, it seeks to complement ISO 21930 for EPDs of asphalt mixtures. However, where the requirements of this document go beyond the requirements of ISO 21930 for the development of PCR for asphalt mixtures, the requirements of this document shall apply.

The objectives of this sub-category PCR are to provide consistent rules to:

- Accurately assess the emissions and environmental aspects associated with asphalt mixture production.
- Provide a means for asphalt mix producers and other stakeholders to use EPDs as a tool to benchmark the environmental aspects and potential environmental impacts of asphalt mixture production.
- Encourage the publication and use of upstream LCA data associated with materials used in asphalt mixtures.
- Promote consistency of EPDs for asphalt mixtures with applicable guidance related to PCRs and EPDs for pavement materials.
- Ensure that EPDs for asphalt mixtures are eligible to earn credit under green rating systems and green construction codes.
- Enable the use of EPDs for asphalt mixtures as a data source for conducting LCA of pavements to compare potential life cycle environmental impacts of either asphalt mixtures with different performance expectations or alternative asphalt pavement designs that use asphalt mixtures.

5.2. Life cycle stages and their information modules and module D

5.2.1. General

...

5.2.2. Types of EPD with respect to life cycle stages covered

...

This sub-category PCR accounts for processes that are within the bounds of Modules A1: Raw Material Supply, A2: Transport, and A3: Manufacturing ([Figure 1](#)~~Figure 4~~).

The scope of the underlying LCA of asphalt mixtures [as discussed in the supporting LCA](#) (Mukherjee, 2021) is strictly cradle to gate, with the gate being defined as the point at which the asphalt mixture is transferred from the silo at an asphalt mixture plant to a truck for transport to the customer. [All assumptions and limitations of the LCA model supporting this PCR are discussed on page 48 of the LCA \(Mukherjee, 2021\) in the Assumptions and Limitations section.](#) Additional life cycle stages or information modules shall not be included in EPDs developed under this sub-category PCR.

Construction Works Assessment Information														
Construction Works Life Cycle Information Within the System Boundary													Optional supplementary information beyond the system boundary	
A1-A3			A4-A5		B1-B7					C1-C4				D
Production Stage			Construction Stage		Use Stage					End-Of-Life Stage				
A1	A2	A3	A4	A5	B1	B2	B3	B4 ^a	B5	C1	C2	C3	C4	
Extractional upstream production	Transport to factory	Manufacturing	Transport to site	Installation	Use	Maintenance (incl. production, transport, and disposal of necessary materials)	Repair (incl. production, transport, and disposal of necessary materials)	Replacement (incl. Production, transport, and disposal of necessary materials)	Refurbishment (incl. Production, transport, and disposal of necessary materials)	Deconstruction / Demolition	Transport to waste processing or disposal	Waste processing	Disposal of waste	Potential net benefits from reuse, recycling, and/or energy recovery beyond the system boundary
			Scenario	Scenario	Scenario	Scenario	Scenario	Scenario	Scenario	Scenario	Scenario	Scenario	Scenario	Scenario
					B6 Operational Energy Use Scenario									
					B7 Operational Water Use Scenario									

^a Replacement information module (B4) not applicable at the product level

Figure 1. Common life cycle stages and their information modules for construction products and construction works. Life cycle stages included in this sub-category PCR are in the green box. Adapted from ISO 21930.

5.2.3. Use of scenarios for assessment of information modules beyond the production stage

Section 5.2.3 does not apply because the scope of this sub-category PCR only includes the cradle to gate stages.

5.3. Average EPDs for groups of similar products

...

~~This PCR is intended for facility-specific EPDs and industry average EPDs, but not product-specific EPDs as these terms are defined in Section 3.9. Therefore, facility-specific EPDs shall not be based on a representative or average mix design produced by a single asphalt plant. Additionally, facility-specific EPDs shall not be developed for a mix design produced by multiple plants owned by the same company.~~

This PCR is intended for Facility and Product Specific EPDs, and Industry Average EPDs as defined in Section 3.9.

This PCR is not intended to be used for developing Product-Specific EPDs (as defined in Section 3.9), as this PCR does not define any criteria for functional equivalence. Therefore, Facility-Specific EPDs (as defined in Section 3.9) shall not be based on a representative or average mix design produced from a single asphalt plant.

Additionally, this PCR is not intended to be used for developing Facility-Specific EPDs, i.e., EPDs shall not be developed for an average or representative mix design produced by a plant.

A summary of allowable EPDs from this PCR can be summarized in a table as follows:

Table 2: Types of EPDs this PCR can be applied to

EPD Type	Does this PCR Apply to the EPD Type Described?	
	Yes	No
<u>Industry-average EPD</u> <u>(Also called 'sector-average EPD')</u>	<u>X</u>	
<u>Producer-average EPD</u>		<u>X</u>
<u>Facility-specific EPD</u>		<u>X</u>
<u>Product-average EPD</u>		<u>X</u>
<u>Product-specific EPD</u>		<u>X</u>
<u>Facility and Product-specific EPD</u>	<u>X</u>	

5.3.1. Industry Average EPDs

One of the objectives of any EPD program is “to assist purchasers and users to make informed comparisons between products” (ISO 14025, Section 4.b). Under this context, industry average EPDs must support this objective by providing sufficient information to enable informed comparisons between industry average EPDs and facility-specific EPDs.

In addition to the requirements listed in ISO 21930, Section 5.3, the technical description of the average product group included in an industry average EPD shall indicate the specification(s) that are covered by the product(s). The technical description of the product may include additional parameters that are relevant to specification(s) for which the industry average EPD has been developed such as:

- The asphalt mixture classification (e.g., dense graded, open graded, gap graded).
- The nominal maximum aggregate size (e.g., 12.5 mm, ½”).
- The performance grade of the asphalt binder (e.g., PG 64-22).
- A generic description of any additives included in the asphalt mixtures (e.g., polymers, anti-strip, recycling agents, WMA, etc.).
- An indication of the mix production technologies included (e.g., HMA, WMA, CCPR).
- Other parameters that are informative to potential end users of the industry average EPD.

Generally, averages can be calculated by either of two methods. The first method involves compiling representative input data, such as the average resource consumption for a group of asphalt plants or an average mix design that meets a given specification, and calculating the LCA

results for the appropriate information module. The second method involves computing LCA results for individual plants or individual mix designs and reporting the average of those results. Industry average EPDs shall indicate which method was used to calculate each information module (A1–A3).

When the first method is used, variability should be assessed by calculating the LCA results for product-specific or facility-specific input data representing the upper and lower bounds and comparing those to the LCA results for the representative input dataset. When the LCA results for the upper and lower bounds differ by more than 10% from the LCA results of the representative input dataset for the corresponding impact category and information module, the industry average EPD shall indicate the variability.

When the second method is used for some (but not all) information modules, variability should be assessed for each impact category and within each information module (A1–A3) by comparing the minimum and maximum LCA results to the average of the LCA results. When these differ by more than 10% from the average of the LCA results for the corresponding impact category and information module, the industry average EPD shall indicate the variability.

When the second method is used for all three information modules, variability can be assessed by comparing the sum of the information modules ($A1 + A2 + A3$) for each impact category. When these differ by more than 10% from the sum of the average LCA results for the corresponding impact category, the industry average EPD shall indicate the variability.

5.4. Use of EPDs for construction products

...

5.5. Comparability of EPDs for construction products

...

EPDs in conformance with this program for asphalt mixtures are comparable if the mixtures are expected to meet similar functional and design performance criteria as specified by the customer.

Comparability may be limited by the presence of data gaps. EPDs with data gaps should not be compared to each other unless the composition and quantity of material ingredients with data gaps are known to be the same for all products being compared.

When asphalt mixtures have different performance expectations, the asphalt mixtures can only be compared by using EPDs as a data input for an LCA that includes additional life cycle stages relevant to the functional unit defined in the LCA study.

5.6. Documentation

...

6. PCR development and use

ISO 21930, Section 6 is adopted with the following additions:

6.1. Core PCR structure

...

6.2. Relation between core PCR and sub-category PCR

...

This sub-category PCR follows the convention of including only the headings from and references to the core PCR (ISO 21930) and supplementary text describing the additional elements and specifications.

6.3. Development of sub-category PCR

...

See Section 1.1 for a description of the product group covered by this sub-category PCR.

7. PCR for LCA

ISO 21930, Section 7 is adopted with the following additions:

7.1. Methodological Framework

7.1.1. Overarching principles for LCA modelling and calculation

...

7.1.2. Functional unit

...

A functional unit has not been established for this sub-category PCR because pavement performance characteristics are inherently a function of the pavement design. When an EPD for asphalt mixtures is used as a data source for a more holistic LCA, it is expected that the LCA will define an appropriate functional unit.

7.1.3. Declared unit

...

The declared unit shall be one metric tonne (one short ton) of asphalt mixture. The secondary declared unit of one short ton of asphalt mixture (in parentheses) was added because the common unit of measure for asphalt mixtures in the U.S. market is short tons. One short ton is equivalent to 0.907185 metric tonne. EPDs for asphalt mixtures shall report all relevant data in terms of metric tonne of asphalt mixture, followed by short tons in parentheses. For example, if the global warming potential (GWP) for an asphalt mixture is 50.00 kg CO₂eq per metric tonne of asphalt mixture, this would be reported as 50.00 (45.36) kg CO₂eq.

7.1.4. Requirements for the use of RSL

Section 7.1.4 does not apply because EPDs developed under this sub-category PCR do not include the use stage.

7.1.5. System boundary with nature

...

7.1.6. System boundary between product systems

...

Secondary materials (SM), renewable secondary fuels (RSF), and non-renewable secondary fuels (NRSF) are commonly used in the asphalt mixture production process. A detailed explanation of the system boundaries for each of these materials is provided below. For secondary materials and fuels not listed in this section, the system boundaries and reporting requirements shall be assigned in accordance with Section 7.1.6 and Table 1 of ISO 21930.

Using the cut-off method, the system boundary for SM and secondary fuels begins at the point where they are processed for use in an asphalt mixture. In general, upstream processes associated with collection and transportation of waste materials to a central storage or processing location are considered part of the previous product system and are not within the system boundaries of the asphalt mixture product system. In some cases, upstream data sources include these processes and cannot be disaggregated, resulting in the potential for double-counting. While not ideal, this is considered a conservative approach and is acceptable if the upstream datasets, including those specified in Annex 1, include these processes.

In some cases, upstream datasets for processing SM and secondary fuels are not available. When these datasets are not available, they shall be reported as data gaps unless proxy data is identified in Annex 1.

7.1.6.1. Secondary materials – aggregate and asphalt binder replacements

Baghouse fines that are used as an asphalt mixture ingredient (e.g., as a mineral filler) shall be declared as SM only when they are transported to the plant from other sites. Baghouse fines that are sourced directly from the asphalt plant for which an EPD is being developed are not considered SM since they originate from within the product system of a given asphalt plant. SM baghouse fines are generally not processed and A1 processes are assumed to have zero impacts. The environmental impacts associated with transportation of baghouse fines to the asphalt plant, where necessary, shall be included in A2.

Glass cullet shall be declared as use of SM. The environmental impacts associated with processing glass cullet shall be calculated using the upstream dataset prescribed in Annex 1 and included in A1. Transportation from the processing site to the asphalt plant shall be included in A2. Other processes, including collection and transportation of waste glass to the recovery facility, are part of the previous product system and shall not be included in A1 or A2.

RAP shall be declared as use of SM. The environmental impacts associated with processing RAP for use in asphalt mixtures shall be calculated as prescribed in Section 7.2.1.1 and included in A1. Transportation from the central stockpiling or processing location to the plant shall be included in A2. Other processes, including removal of RAP from the previous pavement structure and transporting RAP from the milling or excavation jobsite to the central stockpiling or processing location, are part of the previous product system and shall not be included in A1 or A2.

RAS shall be declared as use of SM. The environmental impacts associated with processing RAS for use in asphalt mixtures shall be calculated as prescribed in Section 7.2.1.1 and included in A1. Transportation from the RAS processing site to the plant shall be included in A2. Other processes, including waste recovery (removal from the building demolition or renovation site) and transportation (from either the building demolition or renovation site or the shingle manufacturing site to the RAS processing site), are part of the previous product system and shall not be included in A1 or A2.

7.1.6.2. Secondary materials – additive replacements

GTR shall be declared as use of SM. The environmental impacts associated with processing GTR for use in asphalt mixtures shall be calculated using the upstream dataset prescribed in Annex 1 and included in A1. Transportation from the processing location to the plant (if GTR is added directly at the plant) is included in A2. Transportation from the processing location to the asphalt terminal (if GTR is added at the terminal) shall be included in A1. Transport of asphalt binder that has been modified with GTR at the terminal is included in A2. Other processes, including collection and transportation of waste tires to the recovery facility, are part of the previous product system and shall not be included in A1 or A2.

Recycled Fibers shall be declared as use of SM. The environmental impacts associated with processing recycled fibers for use in asphalt mixtures shall be calculated using the upstream dataset prescribed in Annex 1 and included in A1. The environmental impacts associated with transporting recycled fibers from the processing location to the plant shall be included in A2. Other processes, including collection and transportation of waste fibers to the recovery facility, are part of the previous product system and shall not be included in A1 or A2.

7.1.6.3. Secondary fuels

Landfill gas shall be declared as use of RSF. The environmental impacts associated with collecting, processing, and transporting landfill gas to the asphalt plant and combustion shall be included in A3.

Liquid biofuels shall be declared as use of RSF only if they are derived from waste materials (e.g., yellow grease or brown grease). The environmental impacts associated with

processing secondary liquid biofuels, transportation from the processing location to the plant, and combustion shall be included in A3.

Recycled fuel oil or **used oil** shall be declared as use of NRSF. The environmental impacts associated with processing used oil, transporting it from the processing location to the plant, and combustion shall be included in A3.

Renewable natural gas (RNG) shall be declared as use of RSF. The environmental impacts associated with processing and transporting RNG to the asphalt plant, along with combustion, shall be included in A3.

7.1.6.4. Waste materials and other outputs from asphalt mixture production

For waste materials produced during asphalt mixture production, the system boundary extends to final disposal. For other outputs produced during asphalt mixture production that are recycled, the system boundary extends to transportation to the recycling or end-use destination. These impacts should be included in A3, as specified in Section 7.1.7.2.7.

7.1.6.5. Co-products from other product systems that are not considered secondary materials

The following materials are manufactured using upstream processes that generate co-products that are not part of the asphalt mixture product system. They are not considered secondary materials under this PCR and should not be reported as SM for the reasons described below.

Asphalt binder is a co-product of petroleum refining and shall not be reported as use of SM unless it's a component of RAP or RAS. For virgin asphalt, the upstream impacts associated with petroleum extraction, transportation to refineries, and asphalt binder production shall be allocated using appropriate allocation factors and included in A1, along with transportation of asphalt binder to asphalt terminals and asphalt terminal operations using the upstream dataset(s) specified in Annex 1. Transportation of asphalt binder from the asphalt terminal to the asphalt plant shall be included in A2.

Slag aggregate, including steel slag and blast furnace slag, is considered a co-product of steel and iron production according to the PCR for Construction Aggregates: Natural Aggregates, Crushed Concrete, and Iron/Steel Furnace Slag (ASTM 2017). As such, it shall not be reported as use of SM. The upstream environmental impacts associated with iron and steel production shall be allocated to slag aggregates using appropriate economic allocation factors and included in A1, along with transportation to the slag aggregate processing facility and any subsequent processing of slag aggregates using the dataset(s) specified in Annex 1. Transportation of slag aggregates from the processing facility to the asphalt plant shall be included in A2.

7.1.7. System boundaries and technical information for scenarios

7.1.7.1. General

...

A diagram of the system boundaries for the information modules covered under this sub-category PCR is provided in [Figure 2](#).

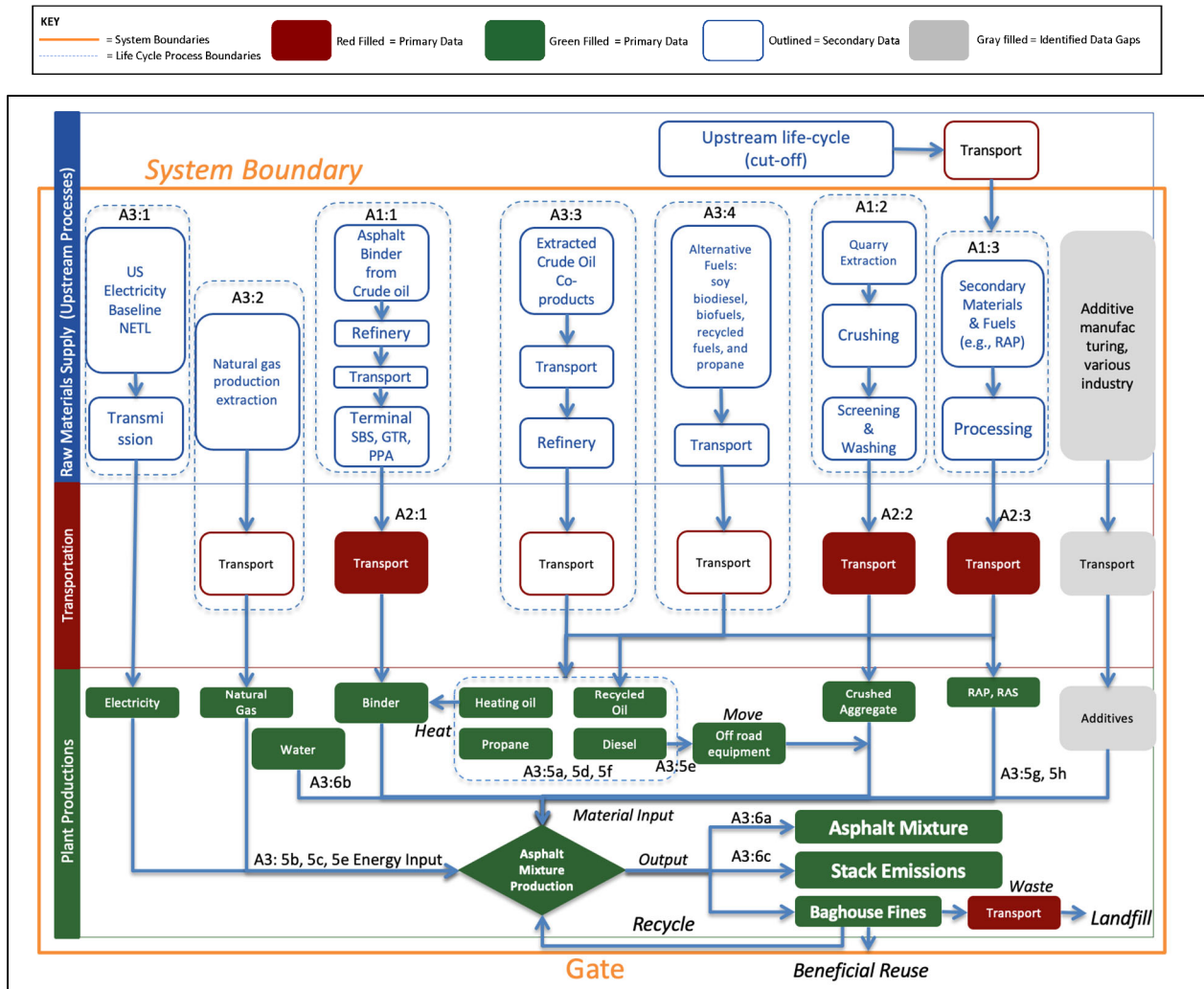


Figure 2. System boundary process diagram.

7.1.7.2. A1 to A3, production stage

7.1.7.2.1. General

...

7.1.7.2.2. A1, extraction and upstream production

...

The prescribed background data in chart form can be found in Annex I, version 2 for the background data LCI specification.

The A1 information module relies on background/upstream data sources that are specified in Annex 1. It includes impacts associated with the following processes:

- Extraction and transportation of crude oil, refining and production of asphalt binder, transportation of asphalt binder to the asphalt terminal, and asphalt terminal operations. This also includes the addition of various binder additives (polymers) and their transportation to the asphalt terminal.
- Mining, extraction, and production of aggregates.
- Extraction and production of mix additives.
- Extraction and production of slag aggregates, including appropriate allocation of iron and steel production to slag aggregates.
- Secondary (recycled) materials. See Section 7.1.6 for system boundaries between product systems and information regarding which processes should be included in A1 for secondary materials.

7.1.7.2.3. A2, transport to factory

...

The prescribed background data in chart form can be found in Annex I, version 2 for the background data LCI specification.

Transportation modes and distances to the asphalt plant are considered foreground data. One-way transportation distances should be multiplied by 1.35 to account for empty back hauls. Module A2 shall include the following processes:

- Transportation of asphalt binder from the asphalt terminal to the asphalt plant. If asphalt binder is sourced directly from a refinery, transportation from the refinery to the asphalt plant shall be included in A2. (Transportation of asphalt binder from the refinery to the asphalt terminal is part of the supply chain and is included in module A1).
- Transportation of aggregates from the source (e.g., quarry, mine, gravel pit,) to the asphalt plant. If virgin aggregates are purchased from an aggregate terminal, A2 shall include the entire transport distance from the extraction or mining site to the asphalt plant.
- Transportation of mix additives from the additive manufacturer to the asphalt plant.
- Transportation of SM from the initial processing or storage location to the asphalt plant. See Section 7.1.6 for system boundaries between product systems for secondary materials.
 - o If the initial processing or storage location for SM such as RAP and RAS is on-site, the A2 transport distance is assumed to be zero. Internal (on-site)

transportation of RAP and RAS is accounted for through on-site mobile equipment fuel consumption (see Sections 7.1.7.2.4 and 7.2.1.2).

7.1.7.2.4. A3, manufacturing

...

The prescribed background data in chart form can be found in Annex I, version 2 for the background data LCI specification.

A3 includes the following unit processes:

- Impacts associated with the regionalized production of electricity and its transmission to the asphalt plant.
- Impacts associated with extraction and production of natural gas for combustion, including transportation of natural gas to the plant – typically via pipeline, included in upstream data sources.
- Impacts from production of co-products of petroleum refining, including extraction, refining, transportation, and storage, for petroleum products used at the asphalt plant. The co-products of interest to this PCR include the following:
 - o For plant operations (stationary and portable): coal (anthracite, bituminous, and lignite), diesel, liquidized petroleum gas (propane), and residual fuel oil.
 - o For heavy construction equipment: compressed natural gas, diesel, gasoline, liquified petroleum gas (propane), and recycled fuel oil.
- Impacts associated with production, transport, and combustion of alternative fuels such as biodiesel, other biofuels, and recycled fuel oil used at the plant.
- Burner fuel consumption, including the upstream impacts associated with fuel extraction, processing, and transportation.
- Hot oil heater fuel consumption, including the upstream impacts associated with fuel extraction, processing, and transportation.
- Mobile equipment fuel consumption, including the upstream impacts associated with fuel extraction, processing, and transportation.

7.1.7.2.5. Input of secondary materials or recovered energy

The system boundaries and applicable information modules for common SM and secondary fuels used in the production of asphalt mixtures are provided in Section 7.1.6. Generally, the cut-off boundary is defined as the point beginning after SM and secondary fuels are transported to a central storage or processing location (module C2 from the previous product system). For SM, any subsequent processing for use in asphalt mixtures and transport to the asphalt plant are included in modules A1 and A2 of EPDs for asphalt mixtures. For secondary fuels, processing and transport to the asphalt plant are included in module A3 of EPDs for asphalt mixtures.

7.1.7.2.6. Co-products leaving the system

...

7.1.7.2.7. Output of waste

...

Waste materials (as defined by ISO 21930) that leave the product system can include baghouse fines (if not recycled back into mix production), wet scrubber fines, and off-spec production materials generated during plant startup/shutdown operations and during other aspects of mix production. In most cases, these materials are recycled or beneficially used, either on-site or off-site. When they are not recycled or beneficially used, they are considered waste. Output flows and environmental impacts are not allocated to waste materials that leave the product system. When baghouse fines, wet scrubber fines, or off-spec production materials are transported off-site for disposal or recycling, they shall be declared as hazardous waste, non-hazardous waste, or materials for recycling in a manner that reflects the actual disposition of these materials by the asphalt mixture producer and in accordance with Section 7.2.14. Transportation and disposal of waste materials generated during asphalt mixture production shall be included in module A3.

7.1.7.2.8. End-of-Life Scenarios for Packaging

Section 7.1.7.2.8 does not apply because asphalt mixtures are normally sold in bulk, without any associated packaging materials.

7.1.7.3. A4 to A5, construction stage

Section 7.1.7.3 does not apply because the scope of this sub-category PCR only includes cradle to gate stages.

7.1.7.4. Use stage

Section 7.1.7.4 does not apply because the scope of this sub-category PCR only includes the cradle to gate stages.

7.1.7.5. C1 to C5, end-of-life stage

Section 7.1.7.5 does not apply because the scope of this sub-category PCR only includes the cradle to gate stages.

7.1.7.6. Benefits and loads beyond the system boundary in optional supplementary module D

Section 7.1.7.6 does not apply because the scope of this sub-category PCR does not include module D.

7.1.8. Criteria for the inclusion and exclusion of inputs and outputs

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7.1.8.1. Data gaps for asphalt mixture materials

Reliable upstream life cycle inventories for asphalt mixture additives, asphalt binder additives, and other specialty materials are often not publicly available. Such materials include, but are not limited to, the following:

- Mix additives (added directly to the mix)
 - o Liquid antistrip additives
 - o Warm-mix additives
 - o Recycling agents, rejuvenators, and softeners
 - o Fibers
 - o GTR (As a terminal blend binder additive, GTR is *not* a data gap and is included in the asphalt binder dataset identified in Annex 1)
 - o Pigments
- Binder additives (blended with the binder at the terminal)
 - o Polymers, including elastomers and plastomers
 - o Pigments
 - o Binder extenders
 - o Odor neutralizers
- Asphalt emulsions
- Slag aggregates, including steel slag and blast furnace slag

In general, this sub-category PCR discourages the use of proxy data when data gaps exist for the upstream impacts of raw material extraction and manufacturing. Proxy data shall not be used unless specifically authorized in Annex 1.

In many cases, mix additives and binder additives comprise less than 1% of the mix by mass but are potentially environmentally significant (e.g., more than 1% of impacts reported in the EPD). For transparency and to encourage additive manufacturers to publish upstream data, additives with no available upstream (background) data or proxy data that comprise more than 0.01% of the mix by mass shall be declared on the EPD as a data gap as prescribed in Section 9. An alternative minimum threshold for binder additives with no available upstream (background) data or proxy data is 0.1% of the asphalt binder by mass to be declared on the EPD as a data gap as prescribed in Section 9.

See Section 5.5 for more information on comparability of EPDs for asphalt mixtures that contain materials with data gaps.

Pursuant to Section 7.1.8 of ISO 21930, when these materials comprise more than 1% (individually) or more than 5% (combined) of the total mass input of an asphalt mixture (module A1), an EPD cannot be developed. Additionally, regulated hazardous substances shall be declared pursuant to Section 8.4.1 of this PCR regardless of weight.

7.1.8.2. Packaging Materials

For raw materials that are delivered to the asphalt plant in packaging, such as additives, it is reasonably assumed that the impact of packaging is included in upstream inventories. Moreover, since additives typically comprise less than 1% of a mix by mass, the associated impacts due to packaging will likely fall within the cut-off threshold. This will be re-evaluated as the quality of upstream data for additives improves.

7.1.8.3. Asphalt Mixture Plant Infrastructure and Maintenance

Upstream impacts of extraction, production, and manufacturing of any material or equipment that is not consumed during production of the asphalt mixture is considered part of the asphalt mixture plant infrastructure. Examples of asphalt mixture plant infrastructure include the following:

- Asphalt mixture production equipment and machinery and its upkeep and maintenance, including lubricants and any other substances used to facilitate the smooth functioning of the plant.
- Machinery and equipment for the recycling of RAP and RAS.
- Machinery and equipment for blending GTR or other polymers.
- Any equipment used for on-site generation of electricity, heat, or mechanical power.
- General management, office, and headquarters operations.
- Impacts from plant personnel, including their commuting to and from the plant.

While maintenance items (e.g., lubricants) and other components that undergo wear and tear, (e.g., conveyor belts) are technically consumed during the production of asphalt mixtures, the annualized quantities are well below the cut-off criteria of 1% of the total mass input per unit (metric tonne or short ton) of asphalt mixture.

Given the goal of the EPD Program – to facilitate comparison of environmental impacts of products within the category of asphalt mixtures – infrastructure and consumables are excluded from the system boundary as asphalt mixture producers use similar capital goods and consumables to produce the same product. Hence, capital goods are considered non-essential to the comparison and are not relevant to the decisions that are anticipated to be supported by EPDs for asphalt mixtures. This also includes consumables (e.g., lubricants and conveyor belts) used in operating and maintaining the equipment.

7.1.9. Selection of data and data quality requirements

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7.1.9.1. Foreground data

Time period: Plant-specific datasets associated with asphalt mixture production (A3) shall include 12 consecutive months of data beginning in 2017 or thereafter. Mix-specific datasets associated with extraction, upstream production, and transportation of raw materials (A1

and A2) shall reflect the materials in the mix design for the asphalt mixture. In other words, plant-specific foreground (primary) data for A3 will always be historical. On the other hand, mix-specific foreground (primary) data for A1 and A2 will be based on the mix design for a specific asphalt mixture formulation that the plant has either produced in the past or is planning to produce in the future.

NOTE: This PCR specifies that all EPDs expire when the PCR expires. Therefore, a mix producer who publishes an EPD in 2026 may, for example, use foreground (primary) data from 2017. However, that EPD will only be valid until January 2027. Thus, the temporal representativeness of the data is no different from an EPD that is published in 2022 and is valid until January 2027. This reflects and supports the practice of using software-based tools to develop EPDs in which plant-specific data need not be updated as EPDs for new asphalt mixtures are developed.

For transparency, the time period for collection of primary data associated with asphalt mixture production should be reported in EPDs as specified in Section 9.2.

If the market-based method for Scope 2 accounting is used to quantify potential GHG emission reductions associated with electricity consumption and reported as additional environmental information (see Section 8.2.1), documentation shall meet the Scope 2 Quality Criteria in the GHG Protocol Scope 2 Guidance.

Documents on file: Foreground data should be based on utility and energy bills, sales records, mix designs, and similar records, all of which should be kept on file and easily accessible.

Correctness check: Statistical trends in fuel and electricity consumption are provided in the underlying LCA by Mukherjee (2021). These trends shall be used to create checks and balances to ensure data quality and to identify possible errors or anomalies in reporting. Data reported by plants that are outliers based on these trends shall be checked for reporting errors.

Geography: Foreground data for a facility-specific EPD shall be specific to the plant and mix design being evaluated. Company averages are not allowed. Foreground data for industry average EPDs shall be specific to the participating plants and the mix designs that meet the applicable specification(s).

Data gaps: Efforts should be made to ensure data gaps for primary data are limited only to those items for which a predetermined parameter has been provided in Section 7.2.1.1.

7.1.9.2. Background data

Prioritization of data for upstream processes: Use of upstream data associated with production of commodities and raw materials shall follow this hierarchy:

- The first priority is valid facility-specific and product-specific EPDs with impact categories modeled according to TRACI 2.1 for the specific inputs associated with the EPD. [The EPDs must conform to PCRs that are operating in the geographical region that the product is manufactured in. In the United States, only the following PCRs can be used for the following materials:](#)
 - [Smart EPD® Part B PCR for Asphalt Binder, 1000-006, v.1.01.](#)
 - [NSF/ASTM 1126-23 with Errata, PCR for Construction Aggregates.](#)
 - [UL Solutions, Asphalt Emulsion, Part B PCR – In development.](#)
 - [UL Solutions, Liquid Asphalt Additives, Part B PCR – In development.](#)
 - [UL Solutions, Asphalt Recycling & Reclaiming, Part B PCR – In development.](#)
 - [Ground Tire Rubber, dry process at the plant – planned.](#)
- If the upstream product is not covered by any of the above PCRs, then ISO 21930 or EN 15804+A2 core PCRs could be used as an alternative.
- The second priority is either of the following:
 - Valid industry average EPDs with impact categories modeled according to TRACI 2.1 as prescribed in Annex 1 [of the PCR for Asphalt Mixtures using the PCRs listed above; or](#)
 - Freely available public datasets as prescribed in Annex 1, including critically reviewed LCA studies that are compliant with ISO 14040/14044 that have been published to the USLCI.

The prioritization scheme for upstream data provides three choices for upstream suppliers who would like to integrate their data into EPDs for asphalt mixtures:

1. Develop and publish a facility and product specific EPD and then work with NAPA to integrate the data into the Emerald Eco-Label software;
2. Collaborate with other manufacturers to develop and publish an industry average EPD, then work with NAPA to add the industry average EPD to Annex 1 of the PCR for Asphalt Mixtures and integrate the data into the Emerald Eco-Label software; or
3. Develop and publish (in collaboration with other manufacturers) a critically reviewed LCA study, publish the LCA dataset to the USLCI through the Federal LCA Commons, ensure that the third party LCA report is publicly available, and work with NAPA to add the LCA to Annex 1 of the PCR for Asphalt Mixtures and integrate the data into the Emerald Eco-Label software.

Uniformity in use of life cycle inventories: Manufacturers who develop product specific EPDs, industry average EPDs, or public datasets that could be used as upstream data for

asphalt mixtures (as described above) are *strongly encouraged* to use the public datasets prescribed in Annex 1 for common upstream energy and materials to improve the consistency and comparability of EPDs developed under this PCR.

Transparency of life cycle inventories: The NAPA EPD program intends to respect the spirit of transparency in environmental performance reporting. Therefore, it is of critical importance to this program for upstream data sources to be *freely and publicly available* to anybody who wishes to reproduce the results of the impact assessment. Excepting the proprietary mix and plant data generated by producers, the program intends to remove barriers to providing access to processes and calculations supporting the underlying LCA. Where proprietary data is involved, system-level inventories have been used as they obscure unit process information while providing detailed input-output inventories useful for LCA calculation.

Geography and regionalization: The upstream data specified in Annex 1 are specific to North America. U.S. baseline inventories for electricity as published by the Department of Energy regionalized at the balancing authority level are used.

Data gaps: Given the emphasis on transparency and uniform use of the same upstream inventories, a trade-off is that public datasets are not readily available for all mixture components and fuel types – particularly chemical additives and bio-based fuels.

Dependence on LCI data from allied industries: The life cycle inventory of asphalt mixtures is dependent on upstream data from various other industries, including but not limited to the petroleum refining industry, aggregate industry, and materials hauling industry. The upstream data sources specified in Annex 1 are intended to reflect the best available from each of these industries. As new upstream data become available, Annex 1 will be updated as appropriate. Any revisions to the upstream datasets specified in Annex 1 shall include an effective date no fewer than 30 days from publication of the revision. Deviations from this 30-day period shall be suitably justified.

7.1.10. Units

Section 7.1.10 of ISO 21930 is adopted with additional exceptions noted below:

- The declared unit shall be one metric tonne (one short ton) of asphalt mixture. See Section 7.1.3.
- The asphalt mixture production temperature is expressed in degrees Celsius (degrees Fahrenheit). For example, the asphalt mixture production temperature could be reported as 149-160 °C (300-320 °F).

7.2. Inventory analysis

7.2.1. Data collection

7.2.1.1. Pre-determined parameters

The following pre-determined parameters shall be used:

- Energy consumption for processing RAP and RAS is 0.4 L of diesel fuel per metric tonne (0.1 gallon of diesel fuel per short ton) of RAP processed.
- The weight of a portable plant and associated equipment is 653 metric tonne (720 short tons).
- The percentage of feedstock material for biodiesel and renewable diesel sourced from waste materials (i.e., brown grease and yellow grease) shall be a default of zero unless documented by the fuel supplier in accordance with Section 7.2.1.2.

7.2.1.2. Plant-specific data

Primary (plant-specific) data must be specific to the plant for which an EPD is being developed. For utilities such as electricity and natural gas, the goal is to collect data that is submetered within the plant at the unit process level. However, utilities are not always submetered at the unit process level (e.g., a plant that consumes natural gas for both the burner and the hot oil heater may only have a single meter that measures total natural gas consumption for the plant). In such cases, it's acceptable to collect utility consumption at the whole plant level rather than the unit process level. The exception to this rule is for conventional asphalt plants that also produce asphalt mixtures at ambient temperature using CCPR technology, which requires submetering of burner fuel consumption to subdivide HMA/WMA production from CCPR production. See section 7.2.5.2 for further explanation of subdividing burner fuel consumption for HMA/WMA production from CCPR production.

Asphalt plants are commonly located on larger sites that are co-located with other operations, such as quarries, ready-mix concrete plants, central maintenance facilities, and the like. If utilities are not separately metered to the asphalt plant, utility consumption may be allocated according to the company's established allocation procedures used for financial accounting purposes, provided that the data fall within the limits identified in Section 10.6.

Data for grid-supplied electricity shall be calculated using the location-based method for Scope 2 accounting established in the GHG Protocol Scope 2 Guidance using the data sources specified in Annex 1. Market-based instruments, such as renewable energy certificates (RECs), power purchase agreements (PPAs), and the like shall not be used to reduce or offset electricity inputs. Similarly, on-site renewables for grid-connected electrical systems shall not be used to reduce or offset electricity inputs. Optionally, potential GHG emission reductions associated with the use of these market-based instruments to purchase renewable energy may be reported as additional environmental information (see Section

8.2.1) provided they meet the Scope 2 Quality Criteria in the GHG Protocol Scope 2 Guidance.

The following plant-specific data shall be collected:

Energy Inputs

- Electricity consumption.
 - Line power consumption in kWh and ZIP code or postal code to identify the balancing authority in which the plant is located. Asphalt plants with on-site renewable power generation (solar or wind) should report gross power consumption *before* any reductions from on-site renewable energy generation. Any offsets or reductions in electricity consumption from on-site renewable energy generation should be reported separately as GHG emission reductions associated with renewable energy purchases in accordance with Section 8.2.1.
 - If the market-based method for Scope 2 accounting is used to calculate potential GHG emission reductions associated with renewable energy consumption per Section 8.2.1, whether through on-site renewables or market-based instruments like purchase of RECs, the following data shall be provided:
 - Quantity of market-based renewable energy instruments (kWh).
 - Supplier or utility-specific emission factors.
 - Date of renewable energy generation.
 - Documentation that renewable energy instruments are designated for use by the mix production facility and cover the same time period as the other foreground data collected for the EPD.
 - Documentation that renewable energy instruments have been retired
 - Any other documentation necessary to meet the data quality requirements specified in Section 7.1.9.
- On-site fuel consumption by unit process, including the type and volume of fuel consumed:
 - Generator fuel consumption.
 - Diesel fuel (liters or gallons).
 - Liquid biofuel (liters or gallons).
 - Compressed natural gas (MMBtu, liters, or gallons).
 - Burner fuel consumption, including the primary burner, secondary burner, hot oil heater, direct-fire asphalt tank heaters, and ancillary combustion equipment such as on-site asphalt-rubber blending plants, as applicable
 - Natural gas (Mcf, MMBtu, or therms).
 - Propane (liters or gallons).
 - Diesel fuel (liters or gallons).
 - Recycled fuel oil (liters or gallons).
 - Residual fuel oil (liters or gallons).

- Liquid biofuels (liters or gallons).
 - Landfill gas (units).
 - Renewable natural gas (MMBtu, liters, or gallons).
 - Coal (metric tonne or tons).
- Mobile equipment fuel consumption, including loaders, skid-steers, on-site trucks, etc.
 - Diesel fuel (liters or gallons).
 - Liquid biofuel (liters or gallons).
 - Compressed natural gas (MMBtu, liters, or gallons).
 - Propane (liters or gallons).
- If biodiesel or renewable diesel are consumed at the plant, the percentage of the fuel's feedstock that is sourced from waste materials (i.e., yellow grease or brown grease), if this information is available from the fuel supplier.
- Additional energy-related data collection requirements for portable plants:
 - The number of times the plant was relocated during the 12-month data collection period. If the plant did not relocate during the 12-month data collection period, the date of the last relocation.
 - The one-way distance and transportation mode(s) for each plant relocation event identified above. For a newly acquired portable plant, the initial location is the first location where the plant is operated by the company that is developing the EPD.
 - Weight of the plant is a predetermined parameter (see Section 7.2.1.1).

Other Physical Inputs

- Consumption of freshwater includes water used for the following purposes:
 - Dust control.
 - Foaming for WMA or CCPR.
 - Irrigation (landscaping).
 - Slurry for wet scrubber operations.
 - Slurry for removing excess baghouse fines.
 - Slurry for adding hydrated lime.

In instances where asphalt plants do not meter freshwater consumption, freshwater consumption may be estimated based on company records such as daily water truck deliveries, flow rates, operational usage of water pumps, etc.

Outputs

- Total asphalt mixtures sold, reported in metric tonne (short tons for plants located in the U.S.).

- Quantity of asphalt mixtures sold that were produced using HMA or WMA technologies.
 - Quantity of asphalt mixtures sold that were produced using CCPR technologies.
- Materials for recycling, reported in metric tonne (short tons for plants located in the U.S.), for waste materials that were sent off-site for recycling or beneficial use.
 - Baghouse fines.
 - Wet scrubber slurry fines.
 - Off-spec production materials, such as start-up/shut-down waste.
- Non-hazardous waste, reported in metric tonne (short tons for plants located in the U.S.), for waste materials that were sent to a landfill for disposal.
 - Baghouse fines.
 - Wet scrubber slurry fines.
 - Off-spec production materials, such as start-up/shut-down waste.
- Hazardous waste, reported in metric tonne (short tons for plants located in the U.S.), for hazardous waste as defined in Section 7.2.14.

7.2.1.3. Mix-specific data

Mix-specific data shall be based on the asphalt mix design or job-mix formula.

Raw Material Inputs

- Asphalt mixture ingredients shall be collected as percentage of total asphalt mixture by weight, unless otherwise specified.
 - Virgin aggregates (coarse and fine).
 - Slag aggregates.
 - Recycled materials (to calculate SM).
 - RAP.
 - RAS.
 - Recycled fibers.
 - Baghouse fines (if imported from other plants).
 - Coal combustion residue.
 - Recycled aggregates.
 - Other recycled materials.
 - Virgin asphalt binder, asphalt emulsion, or cutback asphalt.
 - Asphalt mixture additives.
 - Asphalt binder additives, by weight of total asphalt binder.
 - GTR.
 - Styrene-butadiene-rubber (SBR).
 - Styrene-butadiene-styrene (SBS).
 - Polyphosphoric acid (PPA).
 - Other binder additives.

- Transportation distances and modes shall be collected separately for each mix ingredient. Transportation distances shall be calculated as *actual distance traveled* (km or miles), based on typical travel routes; point to point distances are not acceptable.
 - Source locations for generic upstream data are specified in Section 7.1.7.2.3.
 - Source locations for product-specific or facility-specific upstream data (e.g., EPDs) shall be based on the gate/entrance of the manufacturing facility identified in the EPD or other upstream data source.
 - The transportation distance for RAP and RAS is the distance from the initial RAP or RAS storage or processing location to the asphalt plant. If the initial processing or storage location is on-site, the transport distance is assumed to be zero. Internal (on-site) transportation of RAP and RAS is accounted for through on-site mobile equipment fuel consumption (see Section 7.2.1.2).
 - For portable plants, the transportation distance and mode for raw materials shall be updated when the plant changes its location.

Technical Description of the Product

- Specification.
 - Specification owner/agency.
 - Specification name/description.
 - Mix design name (unique identifier).

Additional Environmental Information

- Mix production temperature.
 - Minimum and maximum mix production temperatures to account for seasonal variations, haul distance, etc., reported in °C (°F).
 - Whether the mix was produced using warm-mix asphalt technologies.
 - Whether the mix was produced using CCPR technologies.
- Safety Data Sheet (SDS) for the mix.
 - Website link to the applicable SDS.

7.2.2. Calculation procedures

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Common conversion factors are provided in [Table 3](#)~~Table 2~~.

Table 32. Conversion factors.

1 short ton =	907.185	kg
1 tonne =	1000	kg
1 tonne =	1.102310995	short ton
1 gallon =	0.00378541	m ³
1 m ³ =	35.3147	cf

1 km =	0.621371	miles
1 tonne-km =	0.684944085	ton-miles
1 ton-mile =	1.459973188	tonne-km
1 Mcf =	28.31681991	m ³
1 Btu =	0.00105587	MJ
1 kWh =	3.6	MJ
1 m ³ =	0.0353147	Mcf

Lower heating values shall be used to convert physical units into inputs and outputs of energy according to [Table 4Table-3](#).

Table 43. Lower heating value (LHV) and density for energy carriers.

Material	LHV (MJ/kg)	Density (kg/m ³)
Asphalt binder (no additives)	41.00	N/A
Asphalt binder (8% GTR)	40.30	N/A
Asphalt binder (0.5% PPA)	40.80	N/A
Asphalt binder (3.5% SBS)	39.50	N/A
Gasoline	44.15	748
Distillate Fuel Oil No. 2 (Diesel)	42.91	875
Residual Fuel Oil	40.87	905
Propane/LPG	46.28	510
Coal	25.75	N/A
Natural Gas	52.35	0.8

7.2.3. Allocation situations

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7.2.4. Principles for allocation for both allocation situations

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In general, the primary purpose of an asphalt plant is to produce asphalt mixtures. All materials and resources associated with asphalt mixture production shall be allocated to asphalt mixtures based on the mass (tonnage) of asphalt mixture sold, rather than the mass of asphalt mixture produced, to ensure that no burdens are allocated to waste materials or co-products that leave the product system. Thus, any waste materials or co-products that leave the asphalt mixture product system are burden-free. The impacts associated with transportation and disposal of waste materials that leave the product system are duly accounted for within the appropriate module (A1–A3).

Numerous upstream (background) product systems for input materials and energy resources are manufactured using processes that produce one or more co-products. Examples include asphalt

binder, fuels, other petroleum-based co-products associated with refinery operations, and slag aggregates. For these materials and energy resources, allocation approaches and methodologies used in the upstream (background) datasets prescribed in Annex 1 are adopted by reference. As a general rule, any dataset selected for Annex 1 shall follow the principles for allocation prescribed in Section 7.2.4 of ISO 21930.

7.2.5. Allocation for co-products

7.2.5.1. General

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7.2.5.2. Co-product allocation procedure

Various asphalt mixtures produced by a given asphalt plant are distinguished from each other by the material ingredients (mix design) and the mix production temperature. These are considered sequentially produced co-products, since they are not jointly produced.

Material inputs for different asphalt mixtures shall be subdivided based on each product's mix design to reflect the underlying use of materials (A1) and associated transportation (A2) for each mix design.

Warm-Mix Asphalt (WMA) Technologies. Using WMA technologies to reduce mix production temperatures can reduce energy requirements and may reduce the environmental impacts of asphalt mix production. Numerous WMA technologies are available; however, actual mix production temperatures can vary according to a number of factors. These factors include but are not limited to the use of RAP, use of polymer-modified asphalt binders, ambient weather conditions, and the transportation distance from the asphalt plant to the jobsite. In some cases, WMA technologies are employed as a compaction aid to improve construction quality without reducing the mix production temperature. Furthermore, energy consumption for asphalt mix production is not typically recorded separately for each mix design. Field experiments to characterize the reduction in burner fuel consumption as a function of mix production temperature are limited to relatively few plants and show a high degree of variability that depends on site-specific equipment, technologies, and other factors (see NASEM, 2014). Therefore, the reduced energy consumption of asphalt mixtures using WMA technologies cannot be reliably allocated or subdivided based on production temperatures. For this reason, **inputs of energy and fresh water shall be equally allocated to each asphalt mixture on a mass basis using total HMA and WMA mixtures sold as the denominator.** For example, if a hypothetical asphalt plant produces and sells 100,000 tons of HMA and WMA mixtures and consumes 200,000 gallons of diesel fuel during the 12-month data collection period, fuel consumption would be allocated at a rate of 2 gallons of diesel fuel per ton of asphalt mixture produced, regardless of the mix ingredients or mix production temperature.

Cold Central Plant Recycling (CCPR). CCPR is a process that produces asphalt mixtures with high quantities of RAP (typically at least 85% by weight of total mix) at ambient temperatures, significantly reducing the environmental impacts associated with asphalt mix production by eliminating the need to dry and heat aggregates and leveraging the use of recycled materials to reduce the upstream impacts associated with raw materials. CCPR mixtures can be produced in a purpose-built plant such as a pugmill that only produces CCPR mixtures, or in a conventional asphalt plant that also produces HMA and WMA. When a conventional asphalt plant (one that produces HMA and/or WMA) uses CCPR technology to produce asphalt mixtures at ambient temperature, **CCPR mixtures can be subdivided from HMA and WMA mixtures by segregating burner fuel consumption from CCPR mixtures.** This approach is feasible since CCPR technology allows asphalt mixtures to be produced without application of heat (FHWA, 1997). For example, if a conventional asphalt plant produces and sells 100,000 tons of HMA and/or WMA mixtures and 50,000 tons of CCPR mixtures during the 12-month data collection period and consumes 200,000 gallons of diesel fuel for burner operations, burner fuel consumption for the HMA and WMA asphalt mixtures would be 2 gallons of diesel per ton of HMA and WMA mixtures and 0 gallons of diesel fuel per ton of CCPR mixtures. This approach requires burner fuel consumption to be separately measured from other plant processes. Consumption of energy for other unit processes, including electricity, hot oil heating, and on-site equipment, should not be subdivided in this manner for conventional asphalt plants that use CCPR technology to produce asphalt mixtures at ambient temperature.

7.2.5.3. Avoiding allocation generally

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7.2.5.4. Avoiding allocation by system expansion

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7.2.5.5. Allocation by subdivision

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7.2.6. Allocation between product systems (across the system boundary)

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7.2.7. Accounting of biogenic carbon uptake and emissions during the life cycle

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Bio-based materials tend to be used in small quantities in asphalt mixtures (<1% by weight of the mix) and biofuels are rarely used for asphalt mixture production, although the market for bio-based asphalt additives has seen significant increases in volume over the past decade with much of that volume consisting of vegetable oil-based products. ISO 21930 requires inputs and outputs of biogenic carbon to be fully accounted for on a net-zero basis. However, the available

public inventories for upstream energy and materials specified in Annex 1 do not adequately account for biogenic carbon uptake and emissions.

Until upstream datasets adequately account for biogenic carbon uptake and emissions, a negative flow of CO₂ should not be assigned to GWP-100 when biogenic CO₂ enters the product system through biofuels or bio-based materials. However, there should be a positive flow of CO₂ to GWP-100 when biogenic CO₂ is emitted, such as through the combustion of biofuels. This is a conservative approach that may over-estimate GWP-100, although the impact should be minimal in most cases.

See also Section 7.2.12 for more information about accounting for biogenic carbon.

For transparency, upstream uptake of biogenic carbon into biodiesel, brown grease, yellow grease, and renewable diesel (if combusted as a fuel) may be reported as Additional Environmental Information in accordance with Section 8.2.2. As indicated by Mukherjee (2021), this calculation should use a factor for upstream carbon uptake of 2.823 kg CO₂e per kg of soy biodiesel per the USLCI inventory.

7.2.8. Carbonation

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Carbonation of hydrated lime and portland cement, which may be used as additives for asphalt mixtures, does not occur during the production stages (A1–A3) of asphalt mixtures, and therefore is not included in EPDs for asphalt mixtures.

7.2.9. Accounting of delayed emissions

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7.2.10. Inventory indicators describing resource use

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EPDs shall report the resource use indicators according to the acronyms provided in [Table 54](#).

Table 54. Resource Use Indicators.

Acronym	Description	Units
RPR _E	Renewable primary resources used as an energy carrier (fuel)	MJ
RPR _M	Renewable primary resources with energy content used as material	MJ
NRPR _E	Non-renewable primary resources used as an energy carrier (fuel)	MJ
NRPR _M	Non-renewable primary resources with energy content used as material	MJ
SM	Secondary materials	kg
RSF	Renewable secondary fuels	MJ
NRSF	Non-renewable secondary fuels	MJ
RE	Recovered energy	MJ

ADP _{fossil}	Abiotic depletion potential for fossil resources	MJ
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7.2.11. Greenhouse gas emissions from land-use change

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GHG emissions from land-use change associated with the production stage (A3) of asphalt mixtures is considered negligible due to the relatively small footprint of an asphalt plant (typically five acres or less).

Available upstream inventories either lack data for GHG emissions from land use change or indicate very low contributions to this indicator. For example, the asphalt binder dataset from Wildnauer et al. (2019) indicates GHG emissions of 0.564 kg CO₂/kg binder and GHG emissions from land use change of 0.000245 kg CO₂/kg asphalt binder, representing just 0.04% of GHG emissions for that material.

For transparency, GHG emissions from land-use change shall be reported as additional environmental information using the nomenclature provided in [Table 6](#)~~Table 5~~, along with a short narrative as provided in Appendix E.

Table 65. Indicator for GHG Emissions Associated with Land Use Change

Acronym	Description	Units	Characterization Method
GHG _{LUC}	GHG emissions from land use change	kg CO ₂ eq	TRACI 2.1

GHG_{LUC} should be reported in modules A1 and A2 as provided in upstream inventories. This indicator should be reported for module A3 as zero.

7.2.12. Additional inventory indicators describing emissions and removals of carbon

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For transparency, the following indicators shall be reported where relevant to demonstrate the extent to which they contribute to the GWP-100 indicator in Section 7.3.

Table 76. Additional Indicators Describing Emissions and Removals of Carbon

Acronym	Description	Units	Characterization Method
GHG _{LUC}	GHG emissions from land use change	kg CO ₂ eq	TRACI 2.1
BCPR	Biogenic carbon removals associated with biogenic carbon content contained within bio-based products	kg CO ₂	N/A
BCPE	Biogenic carbon emissions associated with biogenic carbon content contained within bio-based products	kg CO ₂	N/A
BCKR	Biogenic carbon removals associated with biogenic carbon content contained within bio-based packaging	kg CO ₂	N/A

BCKE	Biogenic carbon emissions associated with biogenic carbon content contained within bio-based packaging	kg CO ₂	N/A
BCWR	Biogenic carbon emissions from combustion of waste from renewable resources used in production processes	kg CO ₂	N/A
BCWN	Carbon emissions from combustion of waste from non-renewable resources used in production processes	kg CO ₂	N/A
CCAL	Carbon emissions from calcination	kg CO ₂	N/A
CCAR	Carbon removals from carbonation	kg CO ₂	N/A

BCPR and BCPE, if applicable, should be reported in module A1 as provided in upstream inventories. This indicator is not applicable to modules A2 and A3. Because asphalt pavements are generally recycled back into new asphalt pavements at end-of-life (Williams et al., 2020) and do not cross the system boundary between product systems, any negative flow of biogenic carbon into the product system in module A1 does not need to be characterized as a positive flow of biogenic carbon in modules C1-C4.

BCKR and BCKE are not applicable because this subcategory PCR does not apply to asphalt mixtures sold with packaging.

BCWR, if applicable, should be reported in modules A1 and A2 as provided in upstream inventories. This indicator should be reported in module A3 for processes that consume brown grease, yellow grease, landfill gas, and RNG. It may also be reported for processes that consume biodiesel and renewable diesel if the feedstock of the fuel is known to be sourced from secondary materials (i.e., yellow grease or brown grease) in accordance with Sections 7.2.1.1 and 7.2.1.2.

BCWN, if applicable, should be reported in module A1 as provided in upstream inventories. This indicator should be reported in module A3 for processes that consume used oil or recycled fuel oil. This indicator is not applicable to module A2.

CCAL, if applicable, should be reported in module A1 as provided in upstream inventories. This indicator is not applicable to modules A2 and A3.

CCAR is not applicable to modules A1-A3 of the asphalt mixture product system.

7.2.13. Inventory indicator describing consumption of freshwater

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Consumption of freshwater for upstream materials shall be reported under module A1 only when the available upstream (background) data includes this information. For example, the consumption of freshwater reported in an EPD for aggregates used in the mix design shall be included in the calculation of consumption of freshwater under module A1. When upstream (background) datasets include separate parameters for consumption of freshwater both

including and excluding rainwater, the value that includes rainwater shall be used for calculating module A1.

When some, but not all, upstream (background) datasets include consumption of freshwater, EPDs for asphalt mixtures shall indicate the percentage (by weight) of material inputs for which data is provided in module A1. EPDs should also include a brief discussion of how the lack of upstream data affects modules A2 and A3, as provided in Appendix E.

Within the foreground system of asphalt plant operations (A3), residual aggregate moisture associated with rainfall shall not be included as consumption of freshwater. Consumption of freshwater shall include water used for the purposes listed below:

- Dust control
- Foaming for WMA or CCPR production
- Irrigation (landscaping)
- Slurry for wet scrubber operations
- Slurry for removing excess baghouse fines
- Slurry for adding hydrated lime

7.2.14. Environmental information describing waste categories and output flows

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EPDs shall report the waste category and output flow indicators provided in [Table 8Table-5](#).

Upstream (background) datasets have limited and inconsistent data with respect to waste categories and output flows, which limits the completeness and comparability of EPDs. To avoid confusion, reporting of waste categories and output flows shall be based only on foreground data associated with asphalt plant operations for the modules indicated in [Table 8Table-5](#).

Determination of whether a waste is considered hazardous waste shall be based on the applicable national regulatory requirements to which the plant is subject. For plants located in the United States, the applicable regulatory framework is the Resource Conservation and Recovery Act (RCRA). For plants located in Canada, the applicable regulatory framework is the Canadian Environmental Protection Act (CEPA).

Table 87. Waste Categories and Output Flows.

Acronym	Description	Units	Modules to Report		
			A1	A2	A3
Waste Categories					
HWD	Hazardous waste disposed	kg	N/A	N/A	Foreground Data Only ¹
NHWD	Non-hazardous waste disposed	kg	N/A	N/A	Foreground Data Only ¹

RWD-HL	High-level radioactive waste disposed	kg or m ³	N/A	N/A	Zero ²
RWD-LL	Intermediate- and low-level radioactive waste disposed	kg or m ³	N/A	N/A	Zero ²
Other Material Flows					
CRU	Components for reuse	kg	N/A	N/A	Zero ³
MFR	Materials for recycling	kg	N/A	N/A	Foreground Data Only ¹
MFER	Materials for energy recovery	kg	N/A	N/A	Zero ³
REE	Recovered energy exported from the product system	MJ	N/A	N/A	Zero ³

N/A – This module is not reported due to inconsistencies in upstream datasets.

1. EPDs shall indicate that this module only includes wastes and outputs generated by asphalt plant operations.
2. Waste materials from asphalt plant operations are not radioactive. EPDs shall indicate that this module only includes wastes and outputs generated by asphalt plant operations.
3. Waste materials from asphalt plant operations are inert and do not involve energy recovery. EPDs shall indicate that this module only includes wastes and outputs generated by asphalt plant operations.

7.3. Impact assessment indicators describing main environmental impacts derived from LCA

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EPDs shall report the impact indicators according to the characterization methods provided in [Table 9Table-6](#).

Table 98. Impact indicators and characterization methods.

Acronym	Description	Units	Characterization Method
GWP-100	Global warming potential, incl. biogenic CO ₂ ¹	kg CO ₂ eq	TRACI 2.1
ODP	Ozone depletion potential	kg CFC-11 eq	TRACI 2.1
EP	Eutrophication potential	kg N eq	TRACI 2.1
AP	Acidification potential	kg SO ₂ eq	TRACI 2.1
POCP	Photochemical oxidant creation potential (smog)	kg O ₃ eq	TRACI 2.1

1. The location-based accounting method is used for calculating upstream impacts of purchased electricity. Potential GHG emission reductions associated with the market-based accounting method are provided as Additional Environmental Information as prescribed in Section 8.2.

8. Additional environmental information

8.1. General

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8.2. Additional LCA-related environmental information not included in the pre-set LCIA indicators

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The following additional LCA-related environmental information may be provided:

8.2.1. GHG emission reductions associated with renewable energy purchases

If renewable energy is purchased through either the use of on-site renewables or market-based instruments such as RECs, the GHG emission reductions associated with these purchases may be reported as $\Delta\text{GHG}_{\text{RE}}$. This value shall be calculated as the difference between GHG emissions associated with the location-based and the market-based methods for Scope 2 accounting. For example, if the location-based and market-based methods for Scope 2 accounting are 2.0 and 1.5 kg CO₂e/ton, respectively, $\Delta\text{GHG}_{\text{RE}}$ would be -0.5 kg CO₂e/ton. See Sections 7.1.9 and 7.2.1.2 for more information regarding data quality and data collection requirements.

8.2.2. Biogenic carbon associated with consumption of liquid biofuels

If biodiesel, brown grease, yellow grease, or renewable diesel or is consumed during asphalt mixture production (A3), the upstream GHG emission reductions associated with uptake of biogenic carbon into the fuel may be reported using the sequestration factor provided in Section 7.2.7.

8.2.3. End-of-life considerations for pavement LCA studies

EPDs for asphalt mixtures are cradle to gate and do not include life cycle stages beyond the gate of the plant. According to the cut-off rules, transportation of RAP from the pavement rehabilitation jobsite to the initial storage or processing location (module C2) is not included. When an EPD for asphalt mixtures is used as a data input for an LCA study that includes the end-of-life stage, the recommended default value for transportation of RAP from the pavement rehabilitation site to the initial storage or processing location is 53 km (33 miles) per Mukherjee (2021).

8.3. Additional environmental information not derived from or related to LCA

EPDs for asphalt mixtures may include the following additional environmental information:

8.3.1. NAPA Awards and Commendations

NAPA's Diamond Commendation Program documents and recognizes the use of best practices for asphalt plant operations through a self-assessment process that helps companies benchmark their operations against a national standard, identify areas for improvement, and earn national recognition for their commitment to quality.

8.3.1.1. Diamond Achievement Commendation

The Diamond Achievement Commendation covers operations in the asphalt plant and around the plant site. Aspects addressed include appearance, operations, environmental practices, safety, permitting and regulatory compliance, and community relations.

An EPD for asphalt mixtures may indicate that an asphalt plant has earned the Diamond Achievement Commendation within the allowable data collection period identified in Section 7.1.9.1. The following information shall be provided:

- The year(s) in which the asphalt plant earned the Diamond Achievement Commendation.
- Website link to documentation that the company earned the Diamond Achievement Commendation.

8.3.1.2. Diamond Achievement Sustainable Commendation

NAPA's Diamond Achievement Sustainable Commendation is an optional level for asphalt plants that have earned the Diamond Achievement Commendation. The expanded level assesses the social, economic, and environmental efforts of an asphalt production facility to gauge how well it puts the principles of sustainability and community engagement into action.

An EPD for asphalt mixtures may indicate that an asphalt plant has earned the Diamond Achievement Sustainable Commendation within the allowable data collection period identified in Section 7.1.9.1. The following information shall be provided:

- The year(s) in which the asphalt plant earned the Diamond Achievement Sustainable Commendation.
- Website link to documentation that the company earned the Diamond Achievement Sustainable Commendation.

8.3.1.3. Environmental Leadership Award

The Environmental Leadership Award is the pinnacle award for asphalt plants in the United States, recognizing the highest-rated plants from the Diamond Achievement Sustainable Commendation.

An EPD for asphalt mixtures may indicate that an asphalt plant has earned the Environmental Leadership Award within the allowable data collection period identified in Section 7.1.9.1. The following information shall be provided:

- The year(s) in which the asphalt plant earned the Environmental Leadership Award.
- Website link to documentation that the company earned the Environmental Leadership Award.

8.3.2. ENERGY STAR

The U.S. EPA's ENERGY STAR program facilitates several activities recognizing companies and plants that have demonstrated noteworthy accomplishments in managing and reducing energy use in their operations.

NAPA is working with the ENERGY STAR program to develop the Energy Performance Indicator and Plant Certification program for asphalt plants. Although not currently available, Plant Certification (section 8.3.3.1) and Energy Performance Score (Section 8.3.3.2) are expected to become available within the period of validity for this PCR.