NAPA
NATIONAL ASPHALT PAVEMENT ASSOCIATION

Emerald ECO LABEL

Product Category Rules (PCR)
For Asphalt Mixtures

Version 2.0 Public Review Draft

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Foreword

When the PCR for Asphalt Mixtures was first 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 EPDs. At the time, there was growing interest in EPDs among various stakeholders, with the most significant being the introduction of the U.S. Green Building Council's (USGBC) LEED v4. 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. The primary changes in the underlying LCA, compared to the previous one, are:

- Improvements in recommended upstream datasets.
  - Inclusion of a variety of fuels sourced from the U.S. Life Cycle Inventory (USLCI) database and other available public datasets.
  - Electricity consumption data updated to reflect Department of Energy National Energy Technology Laboratory (NETL) electricity baseline inventories, regionalized to the level of balancing authority.
  - 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, and asphalt binder with 8% ground tire rubber (GTR).
  - 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).

    - 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 Review
[This section will be completed after the public review period]

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 an EPD for plant-produced paving asphalt mixtures that are produced in the United States of America (U.S.) and Canada 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. 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, asphalt 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 cold-mix asphalt that is 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 the pavement design and the intended use of the pavement, such as the expected traffic volume in equivalent single-axle loads (ESALs) or the load spectrum of the pavement for which the asphalt mixture is intended.

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

3.9.13. 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

3.9.14. 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

3.9.15. asphalt

also called bitumen, a dark brown or black cement-like residuum obtained from the distillation of suitable crude oils or derived from naturally occurring deposits, used to produce asphalt binder

3.9.16. asphalt binder

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

3.9.17. asphalt mixture

a plant-produced composite material consisting of aggregates and asphalt binder, emulsified asphalt, or cutback asphalt that 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]

3.9.18. 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]

3.9.19. baghouse fines
dust particles captured from the exhaust gases of asphalt mixing plants
[Source: FHWA-RD-97-148]

3.9.20. 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]

3.9.21. 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

3.9.22. 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]

3.9.23. coarse aggregates
a collective term for the large aggregate components, generally those that are larger than the ⅜-inch sieve or No. 4 sieve

3.9.24. 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]

3.9.25. cold in-place recycling

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]

3.9.26. emulsified asphalt
(1) a suspension of minute globules of asphalt material in water or in an aqueous solution, or (2) a suspension of minute globules of water or of an aqueous solution in a liquid asphalt material
[Source: ASTM D8-21]

3.9.27. 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]

3.9.28. 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

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

3.9.30. fine aggregates
a collective term for the small aggregate components, generally those that pass through a ⅜-inch sieve or No. 4 sieve. Aggregates larger than ⅜ inch are referred to as "coarse aggregates"

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

3.9.32. foamed asphalt
asphalt binder that has been combined with a small amount of cold water that turns to steam and becomes trapped in tiny asphalt binder bubbles, creating a thin-film asphalt foam that aids the coating of aggregate with asphalt binder while improving workability and allowing reduction of the temperature at which the asphalt mixture is mixed and placed on the road

3.9.33. 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]

3.9.34. glass cullet
recycled broken or waste glass

3.9.35. 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

3.9.36. hot in-place recycling (HIR)
a process in which an existing asphalt pavement is processed with heat, surface material is scarified or mechanically removed and mixed with a recycling agent, asphalt binder, or new asphalt mixture, and repaved in place
[Source: FHWA-SA-98-042, Chapter 9, modified for clarity and brevity]

3.9.37. 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

3.9.38. hydrated lime
a dry white powder consisting essentially of calcium hydroxide ($Ca(OH)_2$) that is added to improve the moisture susceptibility of asphalt mixtures and is processed by adding water to crushed lime (water accounts for approximately 1% of raw hydrate)

3.9.39. 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

3.9.40. job-mix formula
a mixture of aggregate, asphalt binder, and other ingredients, typically submitted to an agency to confirm that a mix design meets the required specifications

3.9.41. landfill gas
a byproduct of the decomposition of organic material in landfills, composed of roughly 50 percent methane, 50 percent carbon dioxide, and a small amount of non-methane organic compounds

3.9.42. lime
a mineral derived from heating (calcining) limestone, which is added to improve the moisture susceptibility of asphalt mixtures

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

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

3.9.45. 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]

3.9.46. 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]

3.9.47. 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-µm (No. 200) sieve
[Source: ASTM D8-21]

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

3.9.49. 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]

3.9.50. 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]

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

3.9.52. product specific EPD
EPD for a specific mix design or job-mix formula produced by a single asphalt plant that meets the requirements of a given specification, developed by a manufacturer for a specific asphalt mixture plant

3.9.53. reclaimed asphalt pavement (RAP)
asphalt pavement or paving mixture removed from its original location for use in recycled asphalt mixture
[Source: ASTM D8-21]

3.9.54. 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

3.9.55. 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

3.9.56. 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

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

3.9.58. recycling agent
a blend of hydrocarbons with or without minor amounts of other materials used to alter or improve the properties of the aged asphalt in an asphalt paving mixture that contains RAP or RAS
[Source: ASTM D8-21, modified to include RAS]

3.9.59. rejuvenator
a hydrocarbon material that reduces the stiffness and can help to partially restore chemical balance, reduce brittleness, and/or improve aging sensitivity of a blend of virgin and recycled asphalt binder

[Source: NAPA QIP-131]

3.9.60. 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]

3.9.61. 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]

3.9.62. 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]

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

3.9.64. softener
a low-viscosity oil that reduces the stiffness of a blend of virgin and recycled asphalt binder
[Source: NAPA QIP-131]

3.9.65. 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]

3.9.66. 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

3.9.67. warm-mix asphalt (WMA) technologies
methods that aid compaction of asphalt mixtures and allow asphalt mixtures to be mixed and placed at lower temperatures than conventional asphalt mixtures, e.g., warm-mix additives or foaming

3.9.68. 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
Btu British thermal unit
CCPR Cold central plant recycling
CO_2eq Carbon dioxide equivalents
EPD Environmental product declaration
EMS Environmental management system
ESALs Equivalent single-axle loads
GTR Ground tire rubber
GREET Greenhouse gases, Regulated Emissions, and Energy use in Transportation
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
NREL National Renewable Energy Laboratory
PCA Portland Cement Association
PCR Product category rules
RAP Reclaimed asphalt pavement
RAS Recycled asphalt shingles
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. Note: Due to the high level of uncertainty and lack of consensus within the scientific literature associated with modeling use phase impacts of different pavement materials, ***EPDs for asphalt mixtures should not be compared to EPDs for non-asphaltic pavement materials even within the context of a cradle to grave LCA*****.**

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).

The scope of the underlying LCA of asphalt mixtures (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. 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 defines a product specific EPD as an "EPD for a specific mix design or job-mix formula produced by a single asphalt plant that meets the requirements of a given specification, developed by a manufacturer for a specific asphalt mixture plant" (Section 3.9). Therefore, product specific EPDs shall not be based on a representative or average mix design produced by a single asphalt plant. Additionally, this PCR is not intended for development of an average EPD for a group of asphalt mixtures produced by a single asphalt plant or for the same asphalt mixture produced by multiple plants owned by the same company. Only industry average EPDs (as defined in Section 3.9) are allowed.

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 product 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), and
- 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 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. For example, when comparing a conventional asphalt mixture to an asphalt mixture with an additive that is expected to extend the service life of the pavement, a more complete LCA study might also include the construction phase, maintenance, and rehabilitation activities over a defined period of time.

EPDs for asphalt mixtures can also be used as input data for LCA studies to compare different asphalt pavement designs or maintenance strategies if the LCA study includes additional life cycle stages relevant to the functional unit defined in the LCA study. For example, when comparing a conventional pavement design with a 20-year designed service life to a perpetual pavement design, EPDs are useful data inputs for LCA studies that include additional relevant life cycle stages, such as the construction phase, maintenance, and rehabilitation activities over a defined period of time.

Due to the high level of uncertainty and lack of consensus within the scientific literature associated with modeling use phase impacts of different pavement materials, **EPDs for asphalt mixtures should not be compared to EPDs for non-asphaltic pavement materials even within the context of a cradle to grave LCA.**

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 CO_2Equiv per metric tonne of asphalt mixture, this would be reported as 50.00 (45.36) kg CO_2Equiv.

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 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 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 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 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 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 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 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.

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.

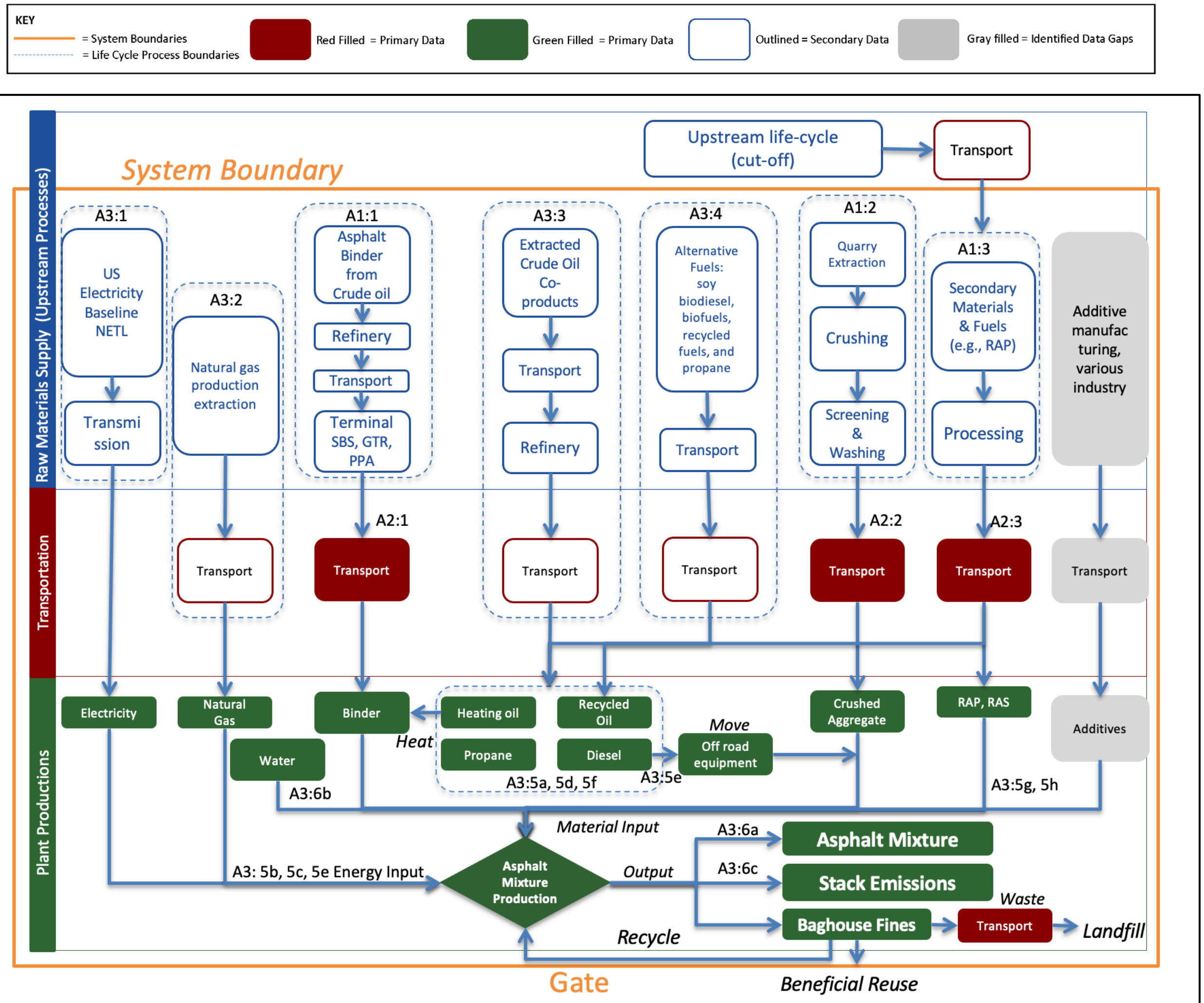

Figure 2. System boundary process diagram.

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 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

…

Transportation modes and distances to the asphalt plant are considered foreground data. 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, the refinery shall be used as the source destination for 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 processing location to the asphalt plant. See Section 7.1.6 for system boundaries between product systems for secondary materials.
    - When RAP is processed or stored on site, the internal transportation distance shall be included (e.g., the distance from the RAP stockpile to the asphalt plant).

7.1.7.2.4. A3, manufacturing

…

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:
    - For plant operations (stationary and portable): coal (anthracite, bituminous, and lignite), diesel, liquidized petroleum gas (propane), and residual fuel oil.

   - 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

…

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)
  - Liquid antistrip additives
  - Warm-mix additives
  - Recycling agents and rejuvenators
  - Fibers
  - 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)
  - Pigments
- Binder additives (blended with the binder at the terminal)
  - Polymers, including elastomers and plastomers
  - Pigments
  - Binder extenders
  - 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

…

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.

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 product 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 product specific EPDs with impact categories modeled according to TRACI 2.1 for the specific inputs associated with the EPD.
- 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.
  - 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.

Uniformity in use of life cycle inventories: Manufacturers who develop product specific EPDs, industry average EPDs, or public datasets 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).

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.

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 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).
    - One-way transport distance and mode for the following fuels:
        - Recycled fuel oil.
- 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 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 Annex 1.
    - Source locations for product-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 RAP or RAS is processed on-site, the internal transportation distance shall be provided.
    - 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

…

Common conversion factors are provided in Table 2.

Table 2. 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 3.

Table 3. 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

…

7.2.4. Principles for allocation for both allocation situations

…

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

…

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 thus 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 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

…

7.2.5.4. Avoiding allocation by system expansion

…

7.2.5.5. Allocation by subdivision

…

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

…

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

…

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. 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 CO_2 should not be assigned to GWP-100 when biogenic CO_2 enters the product system through biofuels or bio-based materials. However, there should be a positive flow of CO_2 to GWP-100 when biogenic CO_2 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.

7.2.8. Carbonation

…

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

…

7.2.10. Inventory indicators describing resource use

…

EPDs shall report the resource use indicators according to the acronyms provided in Table 4.

Table 4. 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

7.2.11. Greenhouse gas emissions from land-use change

…

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 CO_2/kg binder and GHG emissions from land use change of 0.000245 kg CO_2/kg asphalt binder, representing just 0.04% of GHG emissions for that material. Therefore, GHG emissions from land use change are not required to be reported. This will be re-evaluated as additional data become available for other materials and upstream processes.

7.2.12. Additional inventory indicators describing emissions and removals of carbon

…

The available public inventories for upstream energy and materials specified in Annex 1 do not provide the information necessary to calculate and report the additional inventory indicators described in Section 7.2.12. These indicators shall not be reported in EPDs for asphalt mixtures.

7.2.13. Inventory indicator describing consumption of freshwater

…

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 inputs for which data is provided in the relevant module (A1–A3).

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 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

…

EPDs shall report the waste category and output flow indicators provided in Table 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 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 5. 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]
MET	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

…

EPDs shall report the impact indicators according to the characterization methods provided in Table 6.

Table 6. Impact indicators and characterization methods.

Acronym	Description	Units	Characterization Method
GWP 100	Global warming potential	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

8. Additional environmental information

8.1. General

…

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

…

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 ΔGHG_{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 CO_2e/ton, respectively, ΔGHG_{RE} would be -0.5 kg CO_2e/ton. See Sections 7.1.9 and 7.2.1.2 for more information regarding data quality and data collection requirements.

8.2.2. 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 51 km (32 miles).

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.

Companies should disclose any relevant activities in the following order:

8.3.2.1. Plant Certification

ENERGY STAR certifies manufacturing plants that are the most energy efficient plants in their sector. An ENERGY STAR Certified Plant is in the top quartile of energy efficiency, when compared to similar plants, as evidenced by having an ENERGY STAR score of 75 or higher out of 100 on the Energy Performance Indicator. ENERGY STAR Certified Plants are subject to additional criteria defined in the ENERGY STAR program and verification by EPA.

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

- Asphalt plant name and location.
- The year(s) in which the asphalt plant achieved ENERGY STAR certification.
- Website link to documentation that the company achieved ENERGY STAR certification.

8.3.2.2. Energy Performance Score

ENERGY STAR Energy Performance Scores measure how efficiently a manufacturing plant produces its products when compared to similar plants, using a 1-100 scale. A score of 50 reflects average performance, 1 reflects lowest performance, and 100 reflects highest performance.

An EPD for asphalt mixtures may indicate the ENERGY STAR energy performance score for the asphalt plant where the product is produced. The following information shall be provided:

- Asphalt plant name and location.
- ENERGY STAR Energy Performance Score.
- Reporting period: ENERGY STAR scores are based on 12 consecutive months of energy and production related data. Include the period end date when reporting an Energy Performance Score on the EPD. To the extent possible, the end date should align with the data period used for producing the EPD or include a more recent 12-month period.
- Model version: The model used to calculate Energy Performance Scores is periodically updated. Include the version number found at the top of the Energy Performance Indicator used to calculate the score.

8.3.2.3. Challenge for Industry

The Challenge for Industry recognizes manufacturers that have achieved a reduction of 10% or more in energy intensity within a five-year period.

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

- Asphalt plant name and location.
- The year in which the Challenge for Industry was achieved.
- The percent reduction in energy intensity that was achieved.

- Website link to documentation that the company achieved ENERGY STAR Challenge for Industry.

8.3.2.4. Partner of the Year Award

Partner of the Year Award recipients are businesses recognized by EPA for having made outstanding contributions to protecting the environment through superior energy efficiency achievements, documented proven energy savings, and established a corporate energy management program that encompasses key elements identified by ENERGY STAR.

An EPD for asphalt mixtures may indicate that the company has achieved the ENERGY STAR Partner of the Year 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 ENERGY STAR Partner of the Year Award was achieved.
- Website link to documentation that the company achieved ENERGY STAR Partner of the Year Award.

8.3.3. Environmental management system (EMS)

An EMS is a framework that helps an organization achieve its environmental goals through consistent review, evaluation, and improvement of its environmental performance. The EMS is tailored to a company’s own objectives and targets.

An EPD for asphalt mixtures may indicate that the asphalt plant operates under an EMS, and whether the EMS has been certified to conform to the requirements of ISO 14001. The following information shall be provided:

- A link to the organization’s environmental policy.
- If the EMS has been certified to conform to the requirements of ISO 14001:
    - The date of the EMS certification or most recent renewal.
    - A website link to the EMS certification document.

8.3.4. Safety Data Sheet (SDS)

A SDS is a document produced in alignment with the United Nations’ Globally Harmonized System of Classification and Labelling of Chemicals (GHS) that the manufacturer, importer, or distributor of a chemical product is required to provide to downstream users. The purpose of an SDS is to ensure that all workers who handle chemicals have the hazard information they need to safely use, handle, and store those chemicals.

An EPD for asphalt mixtures may include a link to the SDS associated with the asphalt mixture.

8.4. Mandatory additional environmental information

8.4.1. Content of regulated hazardous substances

…

Regulated hazardous substances, if applicable, are listed on the SDS associated with an asphalt mixture. An EPD for asphalt mixtures shall include a list of any materials identified on the SDS associated with the asphalt mixture. For example, if the SDS identifies crystalline silica as a hazardous component of the asphalt mixture, that substance shall be reported on the EPD. If the asphalt mix producer has not developed an SDS for the asphalt mixture, the EPD shall indicate that an SDS is not available and that the asphalt mixture may contain unknown regulated hazardous substances.

8.4.2. Release of dangerous substances from construction products

EPDs for asphalt mixtures shall include the following statement:

> *The National Institute for Occupational Safety and Health (NIOSH) has established a recommended exposure limit (REL) for asphalt fumes of 5 mg/m^3 over a 15-minute time weighted average. Studies of worker exposure to asphalt fumes during asphalt paving operations indicate that exposures are well below the REL during typical asphalt paving operations (NASEM, 2014). In some applications, for example when paving in an enclosed or semi-enclosed area like a tunnel or subterranean parking garage, personnel involved with asphalt paving operations may potentially be exposed to asphalt fumes in excess of the REL. In these situations, paving contractors should consider either using WMA technologies to reduce paving application temperatures or implementing additional engineering controls or personal protective equipment to reduce occupational exposures below the REL*.

9. Content of an EPD

9.1. General

…

The EPD template is provided in Appendix E.

9.2. Declaration of general information

…

The following general information shall be declared in addition to the requirements in Section 9.2 of ISO 21930:

- For industry average EPDs, the name and address of the EPD holders shall include a listing of companies that participated in development of the industry average EPD.
- The description of the asphalt mixture's intended application and use shall include the UNSPSC and the following statement:

  > *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 construction product identification shall include the following information:

    - The relevant specification that the asphalt mixture meets (e.g., Level 2 ½" Dense Graded Mix, Mix I-4, etc.)
    - The specification owner/agency (e.g., Oregon DOT, City and County of Honolulu, Port Authority of New York and New Jersey)
    - A unique product code, such as a mix design or job-mix formula identification number (not required for industry average EPDs)
    - Mix production temperature range
    - One of the following statements, as applicable:
        - "The mix producer classifies this product as hot-mix asphalt."
        - "The mix producer classifies this product as warm-mix asphalt."
        - "The mix producer classifies this product as a cold-produced asphalt mixture."
- The description of materials that make up the asphalt mixture shall indicate any materials for which a data gap exists for background (upstream) impacts.
- The reference to the sub-category PCR shall include the relevant PCR Annex 1 version number.
- The end of the period of validity shall be no later than five years from the effective date of this sub-category PCR.
    - For portable plants, the period of validity shall indicate that the EPD is valid only when the mix is produced at the location listed on the EPD.
- The comparability statement shall include the following:

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, such as meeting the same customer specification.

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 is 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 a life cycle assessment (LCA) that includes additional life cycle stages relevant to the functional unit defined in the LCA study. For example, when comparing a conventional dense graded asphalt mixture to an asphalt mixture with an additive that is expected to extend the service life of the pavement, a more complete LCA study might also include the pavement construction phase as well as maintenance and rehabilitation activities over a defined period of time.

EPDs for asphalt mixtures can also be used as input data for LCA studies to compare different asphalt pavement designs or maintenance strategies to each other only if the LCA study includes additional life cycle stages relevant to the functional unit defined in *the LCA study. For example, when comparing a conventional pavement design with a 20-year designed service life to a Perpetual Pavement design, EPDs are useful data inputs for LCA studies that include additional relevant life cycle stages such as the pavement construction phase and maintenance and rehabilitation activities over a defined period of time.*

Due to the high level of uncertainty and lack of consensus within the scientific literature associated with modeling use phase impacts of different pavement materials, ***EPDs for asphalt mixtures should not be compared to EPDs for non-asphaltic pavement materials for road and highway applications even within the context of a cradle to grave LCA.***

- Data Gaps:
  - Data gaps for upstream materials and processes shall be clearly indicated.

EPDs may optionally include the following additional information:
- The asphalt mixture classification (dense graded, gap graded, or open graded).
- Mix design method (Superpave, Marshall, Hveem, Performance Based, etc.).
- Nominal maximum aggregate size, reported in standard or metric units appropriate to the applicable specification(s) (e.g., 12.5 mm, ½”).
- The performance grade of the asphalt binder (e.g., PG 64-22).
- A reference to the customer’s project number or contract number.
- Additional identifying information that may be useful to potential end users of the EPD, as appropriate.

9.3. Declaration of the methodological framework

…

EPDs for asphalt mixtures shall indicate the following:
- The declared unit is one metric tonne (one short ton) of asphalt mixture.
- The type of EPD is cradle to gate.
- The included life cycle stages are extraction and upstream production (A1), transportation to factory (A2), and manufacturing (A3).
- For industry average EPDs, a description of the declared product, including the specification(s) that the product meets.
- Life cycle inventory:
  - This EPD was created using plant-specific data for asphalt mix production of the production stage (A1–A3). Potential variations due to asphalt mixture design, supplier locations, manufacturing processes, efficiencies, and energy consumption are accounted for in this EPD. All upstream data sources are prescribed in the PCR and are publicly available and freely accessible to enhance transparency and comparability. Use of the prescribed data sources improves comparability among

the EPDs developed by limiting variability due to differences in the upstream data within the system boundaries.

- Allocation procedures:
    - Impacts from upstream production and transportation of raw materials are subdivided based on the relative material quantities (percentages) in the mix design. For conventional asphalt plants that produce both HMA and WMA mixtures, allocation of energy and other resources for asphalt mix production is on a mass basis. Mix-specific production temperatures are not used to separately allocate energy inputs to HMA and WMA mixtures. For conventional asphalt plants that also produce asphalt mixtures at ambient temperatures using CCPR technologies, HMA and WMA mixtures are subdivided from CCPR mixtures by segregating burner fuel consumption from CCPR mixtures.
    - For input materials that are manufactured using processes that produce one or more co-products, the prescribed upstream datasets allocate the material production impacts according to principles outlined in the PCR for Asphalt Mixtures and ISO 21930. Examples of these processes include petroleum refining (which produces multiple co-products including asphalt binder, petroleum fuels, and other products) and iron and steel manufacturing (which produces iron and steel along with slag aggregates).
    - Waste materials and other outputs, such as by-products generated during asphalt mixture production, exit the asphalt mixture product system burden free. Materials, energy, and environmental impacts are not allocated to waste materials or by-products.
- Cut-off procedures:
    - Secondary (recycled) materials are evaluated using the cut-off approach. The cut-off boundary is defined as the point where secondary materials are transported to a central storage or processing location. Material flows and potential environmental impacts associated with the previous product system, including deconstruction, demolition, disposal, and transport to the processing location, are not accounted for in this EPD because they enter the asphalt mixture product system burden-free. In some cases, limitations in upstream datasets require these recovery and transportation processes to be included, which is a conservative approach.
    - Processing of secondary materials for use in asphalt mixtures and transport to the asphalt plant are included in modules A1 and A2, respectively. Processing and transport of secondary fuels to the asphalt plant are included in module A3.

9.4. Declaration of technical information and scenarios

Section 9.4 does not apply because this PCR does not apply to processes that occur beyond the factory gate and module D is not included.

9.5. Declaration of environmental indicators derived from LCA

9.5.1. LCA results from LCIA

…

The impact indicators described in Section 7.3 shall separately include modules A1, A2, A3, and the total (A1–A3). See Appendix E.

9.5.2. LCA results from LCI

…

The impact indicators described in Section 7.2 shall separately include modules A1, A2, A3, and the total (A1–A3). See Appendix E.

9.6. Declaration of additional environmental information

…

The following additional environmental information is required:

- End-of-Life Considerations for Pavement LCA Studies
    - This is a cradle to gate EPD and does 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 this EPD 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 51 km (32 miles).
- Release of Dangerous Substances from Construction Products (See Section 8.4.2 and Appendix E).

The following additional environmental information is optional:

- GHG Emission Reductions Associated with Renewable Energy Purchases (see Section 8.2.1 and Appendix E).
- NAPA Awards and Commendations (see Section 8.3.1 and Appendix E).
    - Diamond Achievement Commendation.
    - Diamond Achievement Sustainable Commendation.
    - Environmental Excellence Award.
- ENERGY STAR (see Section 8.3.2 and Appendix E).
    - Plant Certification.
    - Energy Performance Score.
    - Challenge for Industry.
    - Partner of the Year.
- Environmental Management Systems (EMS) (See Section 8.3.3 and Appendix E).
- Safety Data Sheet (SDS) (See Section 8.3.4 and Appendix E).

9.6.1. References

…

10. Project report

10.1. General

…

EPDs for asphalt mixtures that are developed using a verified software tool do not need an individual project report for each EPD. Instead, the underlying project report for the software tool may serve as the project report for the EPD. The underlying project report for the software tool shall conform to the requirements of Section 10 of this sub-category PCR and ISO 21930.

10.2. LCA-related elements of the project report

…

10.3. Rules for data confidentiality

…

10.4. Documentation of additional environmental information

…

10.5. Data availability for verification

…

10.6. Additional data verification requirements

Benchmarking of the total process energy and electricity per ton of asphalt mixture shall be used to assess the accuracy of the primary (plant-specific) data collected. Primary data should follow the statistical trends identified in the underlying LCA by Mukherjee (2021). Data reported by plants that do not fall within the error margins based on these trends should be checked for reporting errors and explained.

Software tools that are used to develop EPDs for asphalt mixtures may use additional data collected within the software tool to supplement the statistical analysis in the underlying data by Mukherjee (2021). Software tools shall incorporate a documented process by which primary (plant-specific) data that do not fall within the identified statistical parameters are reviewed and verified.

…

11. Verification and validity of an EPD

…

EPDs for portable asphalt plants are only valid for the location indicated in the EPD. When a portable plant changes location, the transport distances and modes for raw materials shall be updated to reflect the conditions at the new location.

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Appendix A: PCR Committee

Name	Title	Organization
James Mertes, Chair	Director of Environmental Affairs	Walbec Group
Imad Al-Qadi, Ph.D., P.E.	Bliss Professor of Engineering	University of Illinois at Urbana-Champaign
Mark Buncher, Ph.D., P.E.	Director of Engineering	Asphalt Institute
Heather Dylla, Ph.D.	Sustainable Pavement Engineer	Federal Highway Administration
Breixo Gómez Mejide, Ph.D.	Technical Director	European Asphalt Pavement Association
John Hickey, P.E., Esq.	Executive Director	Asphalt Pavement Association of Oregon
Matthew Hinck	Director of Environmental Affairs	CalPortland
Amanda Ingmire	Architect, Policy Analyst	Oregon Department of Environmental Quality
Bob Klutz	Research Scientist	Kraton Polymers
Susan Listberger	Global Product Line Manager	Cargill
Ron Sines, P.E.	Vice President, Asphalt Performance	CRH Americas Materials
Curt Turgeon, P.E.	Pavement Engineer	Minnesota Department of Transportation
Tom Walbom	Environmental Director (retired)	Granite Construction

Appendix B: Conformity Assessment Form

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Appendix C: Involvement of Interested Parties

Stakeholders Notified by Direct Email
AASHTO Committee on Environment and Sustainability
AASHTO Committee on Materials and Pavements
American Center for Life Cycle Assessment (ACLCA) PCR Committee
American Public Works Association (APWA)
American Road and Transportation Builders Association (ARTBA)
American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)
Asphalt Emulsion Manufacturers Association (AEMA)
Asphalt Institute
Associated General Contractors of America (AGC) Environmental Forum Steering Committee
Association of Modified Asphalt Producers (AMAP)
ASTM International, D04.99 Sustainable Asphalt Pavements Subcommittee
Australian Flexible Pavement Association
Building Transparency
Caltrans
Canadian Construction Association
Canadian LCA^2 Initiative
Carbon Leadership Forum
Carbon Neutral Cities Alliance
Colorado DOT
Colorado Office of the State Architect
ENERGY STAR
Envision
Eurobitume
European Asphalt Pavement Association (EAPA)
Eurovia
Federal Highway Administration (FHWA) Sustainable Pavements Technical Working Group
Federal Aviation Administration (FAA)
FP^2
Green Building Initiative
Greenroads
Heavy Civil Association of Newfoundland and Labrador
Lafarge Holcim
Lehigh Hanson, Inc.
National Slag Association
New Brunswick Road Builders and Heavy Construction Association
Nova Scotia Road Builders Association
Ontario Asphalt Pavement Council
Oregon Department of Environmental Quality
Oregon DOT

Stakeholders Notified by Direct Email
Port Authority of New York and New Jersey
Prince Edward Island Road Builders and Heavy Construction Association
Quebec Road Builders and Heavy Construction Association
State Asphalt Pavement Associations (SAPAs)
Sustainable States Network
Transportation Association of Canada - Environment and Climate Change Council
Transportation Research Board (TRB), AKP00(2) Sustainable Pavements Subcommittee
Urban Sustainability Directors Network
US Army Corps of Engineers
US Green Building Council
Western Canada Roadbuilders and Heavy Construction Association

Other Methods of Notification

- Direct emails to registered users of the NAPA Emerald Eco-Label software (39 organizations)
- NAPA *ActionNews* email newsletter
- NAPA Website

Appendix D: Response to Public Comments

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Appendix E: EPD Template

[Company Logo]

An Environmental Product Declaration (EPD) for Asphalt Mixtures

Company Information

[company_name] is an asphalt mixture producer.
[plant_name] asphalt plant
[plant_street_address]
[plant_city], [plant_state] [plant_zip_code]
[USA/Canada]
[contact_email_address]

[Image of Asphalt Pavement]

Product Description

This EPD reports the potential environmental impacts and additional environmental information for an asphalt mixture. Asphalt mixtures are typically incorporated as part of the structure of a roadway, parking lot, driveway, airfield, bike lane, pedestrian path, railroad track bed, or recreational surface.
Mix Name: [mix_design_code]
Mix Type: [dense graded/gap graded/open graded friction course/permeable friction course graded/porous]
Specification Entity: [mix_spec_agency]
Specification: [mix_spec]

This mix producer categorizes this product as [warm-mix asphalt/hot-mix asphalt/a cold-produced asphalt mixture] [optional additional language if classified as a warm-mix asphalt: that is produced using [WMA_technology]]. This asphalt mixture was produced within a temperature range of XX to XX°C (XX to XX °F).

EPD Summary Table

Impact Category	**Potential impact per metric tonne asphalt mixture (per ton asphalt mixture)**
Global warming potential (GWP-100)	XX.XX (XX.XX) kg CO_2 Equiv.
Ozone depletion potential (ODP)	XX.XX (XX.XX) kg CFC-11 Equiv.
Eutrophication potential (EP)	XX.XX (XX.XX) kg N Equiv.
Acidification potential (AP)	XX.XX (XX.XX) kg SO_2 Equiv.
Photochemical ozone creation potential (POCP)	XX.XX (XX.XX) kg O_3 Equiv.

Product Ingredients

The product ingredients as identified in the mix design are provided in the table below.

Component	Material	Weight %
Aggregate	Crushed stone, sand, and gravel (if applicable)	[XX]
Aggregate	*Slag aggregates (if applicable)	[XX]
Aggregate	Recycled aggregates (if applicable)	[XX]
Binder	Asphalt binder	[XX]
Aggregate + binder	Reclaimed asphalt pavement (RAP) (if applicable)	[XX]
Aggregate + binder	Recycled asphalt shingles (RAS) (if applicable)	[XX]
Mix additive*	[Indicate generic additive type or brand name] (if applicable)	[XX]
Binder additive*	[Indicate generic additive type or brand name] (if applicable)	[XX]
Binder additive*	Trade secret (if applicable)	[XX]

*Indicates that this material is a data gap. Upstream data associated with extraction and processing is not accounted for in this EPD. [NOTE 1: this symbol will not be used for materials with background data identified in Annex 1. NOTE 2: EPDs cannot be developed for asphalt mixtures that contain data gaps for individual ingredients >1% of the mix by mass, or a cumulative quantity of >5% of the mix by mass].

Regulated Hazardous Substances

Regulated hazardous substances, if applicable, are listed on the safety data sheet (SDS) associated with this asphalt mixture. The chemical names and composition of the mix from the SDS is provided here for transparency.

Chemical Name	CAS No.	Weight %
[Chemical 1]	[CAS No.]	[XX]
[Chemical 2]	Trade secret (if applicable)	[XX]

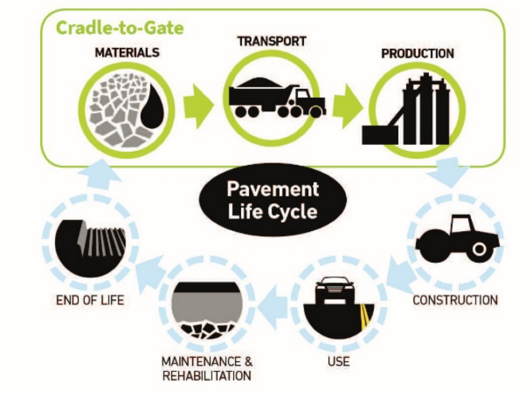
Methodological Framework

Declared Unit

The declared unit is 1 metric tonne (1 short ton) of an asphalt mixture (UNSPSC Code 30111509: Asphalt Based Concrete), which is defined as "a plant-produced composite material of aggregates, asphalt binder, and other materials."[3]

Life Cycle Stages

This is a cradle to gate EPD. It covers the raw material supply, transport, and manufacturing life cycle phases (A1-A3). It does not include construction (placement and compaction), use, maintenance, rehabilitation, or the end-of-life life cycle phases (phases A4, A5, B1-7, and C1-4).[3]



Materials (A1): This stage includes raw material extraction and manufacturing (e.g., quarry operations for aggregates, petroleum extraction and refinery operations for asphalt binder production, etc.) based on the relative proportion of ingredients in the mix design.

Transport (A2): This stage includes transport of raw materials to the asphalt plant based on actual transportation distances and modes for ingredients in the mix design.

Production (A3): This stage comprises plant operations involved in the production of asphalt mixtures, including generation of electricity and heat used during asphalt mix production (e.g., extraction, refining, and transport of fuels). Data for this stage is plant specific.

Life Cycle Inventory

This EPD was created using plant-specific data for asphalt mix production of the production stage (A1-A3). Potential variations due to asphalt mixture design, supplier locations, manufacturing processes, efficiencies, and energy consumption are accounted for in this EPD. All upstream data sources are prescribed in the Product Category Rules (PCR) and are publicly available and freely accessible to enhance transparency and comparability. Use of the prescribed data sources improves comparability among the EPDs developed by limiting variability due to differences in the upstream data within the system boundaries. [3]

Allocation Procedures

Impacts from upstream production and transportation of raw materials are subdivided based on the relative material quantities (percentages) in the mix design. For conventional asphalt plants that produce both hot-mix asphalt (HMA) and warm-mix asphalt (WMA) mixtures, allocation of energy and other resources for asphalt mix production is on a mass basis. Mix-specific production temperatures are not used to separately allocate energy inputs to HMA and WMA mixtures. For conventional asphalt plants that also produce asphalt mixtures at ambient temperatures using cold central plant recycling (CCPR) technologies, HMA and WMA mixtures are subdivided from CCPR mixtures by segregating burner fuel consumption from CCPR mixtures.

For input materials that are manufactured using processes that produce one or more co-products, the prescribed upstream datasets allocate the material production impacts according to principles outlined in the *PCR for Asphalt Mixtures* and ISO 21930. Examples of these processes include petroleum refining (which produces multiple co-products including asphalt binder, petroleum fuels, and other products) and iron and steel manufacturing (which produces iron and steel along with slag aggregates).

Waste materials and other outputs such as byproducts generated during asphalt mixture production exit the asphalt mixture product system burden free. Materials, energy, and environmental impacts are not allocated to waste materials or byproducts.

Cut-off Procedures

Secondary (recycled) materials are evaluated using the cut-off approach. The cut-off boundary is defined as the point beginning after secondary materials are transported to a central storage or processing location. Material flows and potential environmental impacts associated with the previous product system, including deconstruction, demolition, disposal, and transport to the processing location, are not accounted for in this EPD because they enter the asphalt mixture product system burden-free. In some cases, limitations in upstream datasets require these recovery and transportation processes to be included, which is a conservative approach.

Processing of secondary materials for use in asphalt mixtures and transport to the asphalt plant are included in modules A1 and A2, respectively. Processing and transport of secondary fuels to the asphalt plant are included in module A3.

Limitations:

This EPD reports the results of a cradle to gate life cycle assessment (LCA) for asphalt mixtures. This EPD may be used as a data input for full LCAs to compare the environmental impacts of different asphalt roadway, parking lot, or recreational pavement design alternatives.

Comparability

EPDs that comply with the *PCR for Asphalt Mixtures* (and, by extension, ISO 21930) are comparable if the mixtures are expected to meet similar functional and design performance criteria as specified by the customer, such as meeting the same customer specification.

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 is 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 study that includes additional life cycle stages relevant to the functional unit defined in the LCA. For example, when comparing a conventional dense graded asphalt mixture to an asphalt mixture with an additive that is expected to extend the service life of the pavement, a more complete LCA study might also include the pavement construction phase as well as maintenance and rehabilitation activities over a defined time period.

EPDs for asphalt mixtures can also be used as input data for LCA studies to compare different asphalt pavement designs or maintenance strategies to each other only if the LCA study includes additional life cycle stages relevant to the functional unit defined in the LCA study. For example, when comparing a conventional pavement design with a 20-year designed service life to a perpetual pavement design, EPDs are a useful data input for LCA studies that include additional relevant life cycle stages such as the pavement construction phase and maintenance and rehabilitation activities over a defined time period.

Due to the high level of uncertainty and lack of consensus within the scientific literature associated with modeling use phase impacts of different pavement materials, **EPDs for asphalt mixtures should not be compared to EPDs for non-asphaltic pavement materials for road and highway applications even within the context of a cradle to grave LCA.**

Data Gaps:

[This mix uses additives such as fibers, crumb rubbers (if it is added at a plant), liquid antistrips, recycling agents, stabilizers, etc., for which no known public data source exists. The upstream impacts associated with the process of extraction, manufacturing/production, and transportation of the materials listed have not been accounted for in this EPD.]

[This mix uses a [polymer/GTR/polymer + GTR] modified asphalt binder. The upstream impacts associated with the process of extraction, manufacturing/production, and transportation of the materials used in the modification process have not been accounted for in this EPD.]

[The impact of recycling asphalt shingles was estimated using data for processing reclaimed asphalt pavement. The source of the shingles (tear off or factory rejects) is not being accounted.]

[None]

Life Cycle Assessment

The information presented in this EPD can be used to model the environmental impacts of asphalt mixtures purposed to be part of (but not limited to) roadway, parking lot, or recreational pavements. This EPD alone does not provide the environmental impacts of the entire pavement structure itself and does not make any statements that the product covered by the EPD is better or worse than any other product.

Life Cycle Impact Assessment Results

The life cycle impact assessment results are relative expressions and do not predict actual impacts on category endpoints, the exceeding of thresholds, safety margins, or risks. Calculations are based on the TRACI v2.2 impact assessment methodology.

Acronym	**Indicator**	**Unit**	**Quantity per metric tonne asphalt mixture (per short ton asphalt mixture)**			
			Materials (A1)	**Transport (A2)**	**Production (A3)**	**Total (A1-A3)**
GWP-100	Global warming potential, incl. biogenic CO_2	kg CO_2 Equiv.	XX.XX (XX.XX)	XX.XX (XX.XX)	XX.XX (XX.XX)	XX.XX (XX.XX)
ODP	Ozone depletion potential	kg CFC-11 Equiv.	XX.XX (XX.XX)	XX.XX (XX.XX)	XX.XX (XX.XX)	XX.XX (XX.XX)
EP	Eutrophication potential	kg N Equiv.	XX.XX (XX.XX)	XX.XX (XX.XX)	XX.XX (XX.XX)	XX.XX (XX.XX)
AP	Acidification potential	kg SO_2 Equiv.	XX.XX (XX.XX)	XX.XX (XX.XX)	XX.XX (XX.XX)	XX.XX (XX.XX)
POCP	Photochemical ozone creation potential	kg O_3 Equiv.	XX.XX (XX.XX)	XX.XX (XX.XX)	XX.XX (XX.XX)	XX.XX (XX.XX)

Notes:

GWP-100 – Global warming potential. The warming (relative to CO_2) that chemicals contribute to the atmospheric greenhouse effect by trapping the earth's heat. The impact scores for GWP-100 are based on a 100-year time horizon. As prescribed by the *PCR for Asphalt Mixtures*, this EPD does not assign a negative flow of CO_2 to GWP-100 when biogenic CO_2 enters the product system through biofuels or bio-based materials. However, a positive flow of CO_2 is assigned to GWP-100 when biogenic CO_2 is emitted, such as through the combustion of biofuels. This is a conservative approach that may over-estimate GWP-100. 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, so the impacts are low in most cases.

ODP – Ozone depletion potential. The potential damage that chemicals such as chlorofluorocarbons (CFCs) cause to the earth's stratospheric ozone layer, which filters out harmful ultraviolet radiation from the sun. Impact scores for ODP are based on the quantity of ozone-depleting chemicals released to air, normalized to an equivalent mass of CFC-11.

EP – Eutrophication potential. The potential nutrient enrichment to water bodies caused by chemicals that are released to the water or air and subsequently deposited. Impact scores for EP are based on the quantity of nutrients released, normalized to an equivalent mass of N.

AP – Acidification potential. The potential formation of acid rain caused by releases of chemicals to the air. Impact scores for AP are based on the number of hydrogen ions that can be theoretically formed per mass unit of the chemical being releases as compared to SO_2.

POCP – Photochemical ozone creation potential. The release of hydrocarbons and nitrogen oxides that react with sunlight to produce photochemical oxidants, which can cause or aggravate health problems, plant toxicity, and deterioration of certain materials. Impact scores for POCP are based on the quantity of chemicals with POCP equivalency factors released to the air, normalized to an equivalent mass of O_3.

Materials and Resources

Resource Use Indicators

Acronym	Indicator	Unit	Quantity per metric tonne asphalt mixture (per short ton asphalt mixture)			
			Materials (A1)	Transport (A2)	Production (A3)	Total (A1-A3)
RPR_E	Renewable primary resources used as an energy carrier (fuel)	MJ	XX.XX (XX.XX)	XX.XX (XX.XX)	XX.XX (XX.XX)	XX.XX (XX.XX)
RPR_M	Renewable primary resources with energy content used as material	MJ	XX.XX (XX.XX)	XX.XX (XX.XX)	XX.XX (XX.XX)	XX.XX (XX.XX)
$NRPR_E$	Non-renewable primary resources used as an energy carrier (fuel)	MJ	XX.XX (XX.XX)	XX.XX (XX.XX)	XX.XX (XX.XX)	XX.XX (XX.XX)
$NRPR_M$	Non-renewable primary resources with energy content used as material	MJ	XX.XX (XX.XX)	XX.XX (XX.XX)	XX.XX (XX.XX)	XX.XX (XX.XX)
SM	Secondary (recycled) materials	kg	XX.XX (XX.XX)	XX.XX (XX.XX)	XX.XX (XX.XX)	XX.XX (XX.XX)
RSF	Renewable secondary fuels	MJ	XX.XX (XX.XX)	XX.XX (XX.XX)	XX.XX (XX.XX)	XX.XX (XX.XX)
NRSF	Non-renewable secondary fuels	MJ	XX.XX (XX.XX)	XX.XX (XX.XX)	XX.XX (XX.XX)	XX.XX (XX.XX)
RE	Recovered energy	MJ	XX.XX (XX.XX)	XX.XX (XX.XX)	XX.XX (XX.XX)	XX.XX (XX.XX)
FW	Consumption of fresh water	m^3	XX.XX (XX.XX)	XX.XX (XX.XX)	XX.XX (XX.XX)	XX.XX (XX.XX)
ADP_{fossil}	Abiotic depletion potential for fossil resources	MJ	XX.XX (XX.XX)	XX.XX (XX.XX)	XX.XX (XX.XX)	XX.XX (XX.XX)

Notes:

RPR_E - Renewable primary resources used as an energy carrier (fuel). RPR_E are (first use) bio-based materials used as an energy source. Hydropower, solar, and wind power used in the technosphere are also included in this indicator. Calculations for A3 are based on the regional grid energy mix for the balancing authority and does not account for on-site renewable energy generation.

RPR_M - Renewable primary resources with energy content used as material. RPR_M are (first use) bio-based materials used as materials (e.g., bio-based additives, bio-based asphalt extenders, etc.).

$NRPR_E$ - Non-renewable primary resources used as an energy carrier (fuel). $NRPR_E$ are (first use) materials such as peat, oil, gas, coal, and uranium used as an energy source.

$NRPR_M$ - Non-renewable primary resources with energy content used as material. $NRPR_M$ are (first use) primary resources such as oil, gas, and coal used for products (e.g., asphalt binder, plastic-based products, etc.).

SM – Secondary materials. SM are materials recycled from previous use or waste (e.g., reclaimed asphalt pavement (RAP), recycled asphalt shingles (RAS), ground tire rubber (GTR), etc.). These include both renewable and non-renewable material, with or without energy content, depending on the status of the material when it was originally extracted from the environment.

RSF – Renewable secondary fuels. RSF are renewable materials with energy content that have crossed the system boundary between product systems and are used as fuel input (energy source) in another product system (e.g., chipped waste wood, yellow grease).

NRSF – Non-renewable secondary fuels. NRSF are non-renewable materials with energy content that have crossed the system boundary between product systems and are used as fuel input (energy source) in another product system (e.g., recycled fuel oil, tire-derived fuel, etc.).

RE – Recovered energy. RE is energy recovered from disposal of waste in previous systems, such as energy recovery from combustion of landfill gas or energy recovered from other systems using energy sources.

FW – Consumption of fresh water.

ADP_{fossil} – Abiotic depletion potential for fossil resources.

Waste Categories and Other Material Flows

Acronym	Indicator	Unit	Quantity per metric tonne asphalt mixture (per short ton asphalt mixture)			
			Materials (A1)	Transport (A2)	Production (A3)	Total (A1-A3)
Waste Categories						
HWD	Hazardous waste disposed	kg	MND	MND	XX.XX (XX.XX)	XX.XX (XX.XX)
NHWD	Non-hazardous waste disposed	kg	MND	MND	XX.XX (XX.XX)	XX.XX (XX.XX)
RWD-HL	High-level radioactive waste disposed	kg or m^3	MND	MND	0.00 (0.00)	0.00 (0.00)
RWD-LL	Intermedial- and low-level radioactive waste disposed	kg or m^3	MND	MND	0.00 (0.00)	0.00 (0.00)
Other Material Flows						
CRU	Components for reuse	kg	MND	MND	0.00 (0.00)	0.00 (0.00)
MFR	Materials for recycling	kg	MND	MND	XX.XX (XX.XX)	XX.XX (XX.XX)
MET	Materials for energy recovery	kg	MND	MND	0.00 (0.00)	0.00 (0.00)
REE	Recovered energy exported from the product system	MJ	MND	MND	0.00 (0.00)	0.00 (0.00)

Notes:

MND – Module not determined due to inconsistencies in upstream datasets.

HWD – Hazardous waste disposed. Module A3 only includes waste materials generated by asphalt plant operations and does not include upstream production of electricity and fuels.

NHWD – Non-hazardous waste disposed. Module A3 only includes waste materials generated by asphalt plant operations and does not include upstream production of electricity and fuels.

RWD-HL – High-level radioactive waste disposed. Module A3 only includes waste materials generated by asphalt plant operations and does not include upstream production of electricity and fuels. Waste materials from asphalt plant operations are not radioactive.

RWD-LL – Intermediate and low-level radioactive waste disposed. Module A3 only includes waste materials generated by asphalt plant operations and does not include upstream production of electricity and fuels. Waste materials from asphalt plant operations are not radioactive.

CRU – Components for reuse. Module A3 only includes output flows generated by asphalt plant operations and does not include output flows from upstream production of electricity and fuels. Output flows from asphalt plant operations are reused as components for other product systems.

MFR – Materials for recycling. Secondary material for use in the next product system. Module A3 only includes output flows generated by asphalt plant operations and does not include output flows from upstream production of electricity and fuels.

MET – Materials for energy recovery. Secondary fuels for use in the next product system. Module A3 only includes output flows generated by asphalt plant operations and does not include output flows from upstream production of electricity and fuels. Output flows from asphalt plant operations are inert and do not involve energy recovery.

REE – Recovered energy exported from the product system. Module A3 only includes output flows generated by asphalt plant operations and does not include output flows from upstream production of electricity and fuels. Recovered energy is not exported from asphalt plant operations.

Additional Environmental Information:

Greenhouse Gas (GHG) Emission Reductions Associated with Renewable Energy Purchases [OPTIONAL]

This plant uses market-based instruments to purchase renewable energy such as the use of on-site renewable power generation, power purchase agreements (PPAs), or renewable energy certificates (RECs). As required by the *PCR for Asphalt Mixtures*, these market-based instruments are not included in the calculation of GWP-100 reported in the Life Cycle Impact Assessment Results. However, the potential GHG emission reduction from purchasing renewable energy through market-based instruments is provided here as ΔGHG_{RE}. Negative values indicate a net reduction in GHG emissions.

Acronym	**Indicator**	**Unit**	**Quantity per metric tonne asphalt mixture (per short ton asphalt mixture)**			
			Materials (A1)	**Transport (A2)**	**Production (A3)**	**Total (A1-A3)**
ΔGHG_{RE}	GHG emission reduction from renewable energy purchases	kg CO_2 Equiv.	N/A	N/A	-XX.XX (-XX.XX)	-XX.XX (-XX.XX)

End-of-Life Considerations for Pavement LCA Studies

This is a cradle to gate EPD and does 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 this EPD 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 51km (32 miles).

NAPA Awards and Commendations [OPTIONAL]

The National Asphalt Pavement Association's (NAPA) 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.

Diamond Achievement Commendation [OPTIONAL]

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.

This plant earned the Diamond Achievement Commendation in the following years:

[Year1] – Link to commendation
[Year2] – Link to commendation
Etc.

Diamond Achievement Sustainable Commendation [OPTIONAL]

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.

This plant earned the Diamond Achievement Sustainable Commendation in the following years:

[Year1] – Link to commendation
[Year2] – Link to commendation

Etc.

Environmental Leadership Award [OPTIONAL]

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

This plant earned the Diamond Achievement Sustainable Commendation in the following years:

[Year1] – Link to award
[Year2] – Link to award
Etc.

ENERGY STAR [OPTIONAL]

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

Plant Certification [OPTIONAL]

ENERGY STAR certifies manufacturing plants that are the most energy efficient plants in their sector. An ENERGY STAR Certified Plant is in the top quartile of energy efficiency, when compared to similar plants, as evidenced by having an ENERGY STAR score of 75 or higher out of 100 on the Energy Performance Indicator. ENERGY STAR Certified Plants are subject to additional criteria defined in the ENERGY STAR program and verification by EPA.

This plant achieved ENERGY STAR Plant Certification in the following years:

[Year1] – Link to plant certification
[Year2] – Link to plant certification
Etc.

Energy Performance Score [OPTIONAL]

ENERGY STAR Energy Performance Scores measure how efficiently a manufacturing plant produces its products when compared to similar plants on a 1-100 scale. A score of 50 reflects average performance, 1 reflects lowest performance, and 100 reflects highest performance.

This plant's energy performance score in [year] was [XX].

Challenge for Industry [OPTIONAL]

The Challenge for Industry recognizes manufacturers that have achieved a 10% or more reduction in energy intensity within a five-year period.

This plant achieved the Challenge for Industry in [year] and reduced its energy intensity by [XX]%.

Partner of the Year Award [OPTIONAL]

Partner of the Year Award recipients are businesses recognized by EPA for having made outstanding contributions to protecting the environment through superior energy efficiency achievements, documented proven energy savings, and established a corporate energy management program that encompasses key elements identified by ENERGY STAR.

This plant earned the ENERGY STAR Partner of the Year Award in the following years:

[Year1] – Link to award
[Year2] – Link to award

Environmental Management Systems (EMS) [OPTIONAL]

An environmental management system (EMS) is a framework that helps an organization achieve its environmental goals through consistent review, evaluation, and improvement of its environmental performance. The EMS is tailored to a company's own individual objectives and targets.

(if applicable): This plant operates under an EMS. A copy of the company's environmental policy is available here [link to environmental policy].

(if applicable): The EMS was certified to conform to the requirements of ISO 14001 in [year]. A copy of the certification document is available here [link to EMS certification document].

Safety Data Sheet (SDS) [OPTIONAL]

A safety data sheet (SDS) is a document produced in alignment with the UN's Globally Harmonized System of Classification and Labeling of Chemicals (GHS) that the manufacturer, importer, or distributor of a chemical product is required to provide to downstream users. The purpose of an SDS is to ensure that all workers who handle chemicals have the hazard information they need to safely use, handle, and store them.

A copy of the SDS associated with this asphalt mixture is available here [link to SDS].

Release of Dangerous Substances from Construction Products

The National Institute for Occupational Safety and Health (NIOSH) has established a recommended exposure limit (REL) for asphalt fumes of 5 mg/m^3 over a 15-minute time weighted average. Studies of worker exposure to asphalt fumes during asphalt paving operations indicate that exposures are well below the REL during typical asphalt paving operations (NASEM, 2014). In some applications, for example when paving in an enclosed or semi-enclosed area like a tunnel or a subterranean parking garage, personnel involved with asphalt paving operations may potentially be exposed to asphalt fumes in excess of the REL. In these situations, paving contractors should consider either using WMA technologies to reduce paving application temperatures or implementing additional engineering controls or personal protective equipment to reduce occupational exposures below the REL.

References:

1. ISO 14025:2006 *Environmental labels and declarations — Type III environmental declarations — Principles and procedures*. International Organization for Standardization, Geneva, Switzerland. https://www.iso.org/standard/38131.html.
2. ISO 21930:2017 *Sustainability in buildings and civil engineering works — Core rules for environmental product declarations of construction products and services.* International Organization for Standardization, Geneva, Switzerland. https://www.iso.org/standard/61694.html.
3. *Product Category Rules (PCR) for Asphalt Mixtures, version 2.0.* National Asphalt Pavement Association, Greenbelt, Maryland. https://www.asphaltpavement.org/epd.

Declared Product	[Mix_product_code] an asphalt mix for [mix-type]
Declaration Owner Company logo	[Company Name] [Contact Person Name], [Title] [Phone Number] [Company website]
Program Operator NAPA NATIONAL ASPHALT PAVEMENT ASSOCIATION	National Asphalt Pavement Association 6406 Ivy Lane, Suite 350 Greenbelt, MD, 20770 Toll-free: 888-468-6499 www.AsphaltPavement.org/EPD
LCA and EPD Tool Developer triSIGHT	Trisight 906-370-4624 trisightengineering.com
Independent Verifiers LCA and EPD verifier logo	[Verifier name and contact info] The data and declarations produced by the EPD tool was externally, independently verified in accordance with ISO14044, ISO14025, and the referenced PCR. [Name of verifier and signature] [Link to verification statement]
Product Category Rule Emerald ECO LABEL	Product Category Rules (PCR) for Asphalt Mixtures, version 2.0 National Asphalt Pavement Association 6406 Ivy Lane, Suite 350 Greenbelt, MD, 20770 Toll-free: 888-468-6499 www.AsphaltPavement.org/EPD
The PCR review [Logo for review panel chair]	PCR confirmed by PCR Review Panel Lead by [Name and Contact Info] [Link to PCR review statement]

Annex 1: Prescribed Background Datasets

NAPA
NATIONAL ASPHALT PAVEMENT ASSOCIATION

Emerald ECO LABEL

Product Category Rules (PCR) For Asphalt Mixtures: Annex 1

Prescribed Upstream (Secondary) Data Sources

PCR Version 2.0

Annex Version 2.0 Public Review Draft

Effective Date: [Month], 2022

Validity Period: Through [Month] 2027

4606 Ivy Lane, Suite 350 | Greenbelt, MD 20770 | 888-468-6499
AsphaltPavement.org/EPD

Contents

Tables

1. Overview of prescribed background (secondary) data sources

In choosing the datasets, the first priority was transparency. To meet this transparency goal, the prescribed datasets must be publicly available at no cost. This was in response to public agencies who would request and use the Environmental Product Declarations (EPDs) published under this PCR. Cost and a lack of transparency of data sources have been noted as barriers to adoption of other existing EPD programs.

This annex will be updated as new data becomes available to fill existing data gaps.

Further Explanation — Choice of Data Sources

Data sources prescribed are publicly available and freely accessible to ensure transparency. Use of the prescribed data source will improve comparability among EPDs developed using this PCR by limiting variability due to differences in the upstream data within the system boundary.

2. Secondary data sources for upstream production of raw materials (A1)

The prescribed background (upstream) inventories for raw material extraction and manufacturing provided in this section.

2.1. Asphalt binder

2.1.1. Asphalt binder, refined from crude oil

The following inventories are available from Wildnauer et al. (2019):

- Asphalt binder, no additives, consumption mix, at terminal, from crude oil.
- Asphalt binder, 0.5% polyphosphoric acid (PPA) (by weight of asphalt binder), consumption mix, at terminal, from crude oil. This inventory may be used for PPA up to 1.0% (by weight of asphalt binder).
- Asphalt binder, 3.5% styrene-butadiene-styrene (SBS) (by weight of asphalt binder), consumption mix, at terminal, from crude oil. This inventory uses styrene-butadiene-rubber (SBR) as a proxy for SBS and is suitable for asphalt binder that contains SBR or SBS in increments of 0-3.5%, 3.5-5.5%, 5.5-7.5%, and 7.5-10.0% per Mukherjee (2021).
- Asphalt binder, 8% ground tire rubber (GTR) (by weight of asphalt binder), consumption mix, at terminal, from crude oil. This inventory is only valid for terminal blended rubber modified asphalt up to 10% by weight of asphalt binder. It shall not be used for wet process GTR techniques including asphalt-rubber, McDonald process, or continuous process, and shall not be used for dry process GTR techniques.

2.1.2. Bio-based asphalt binder

There are no available background inventories for bio-based asphalt. Bio-based asphalt is considered a data gap.

2.1.3. Emulsified asphalt binder

There are no available background inventories for emulsified asphalt. Emulsified asphalt is considered a data gap.

2.1.4. Natural asphalt binder

There are no available background inventories for natural asphalt binders such as gilsonite and Trinidad Lake asphalt. These materials are considered a data gap.

2.2. Aggregates

2.2.1. Crushed stone, sand, and gravel

The inventory developed by Mukherjee (2021) for coarse aggregate from crushed stone shall be used for crushed stone, sand, and gravel. This inventory was derived from data published by Marceau et al. (2007).

2.2.2. Recycled aggregates

The inventory developed by Mukherjee (2021) for coarse aggregate from crushed stone shall be used as a proxy for recycled aggregates that do not contain asphalt binder, such as recycled concrete aggregate and glass cullet. This inventory was derived from Marceau et al. (2007).

2.2.3. Slag aggregate

There are no available background inventories for slag aggregates, such as blast furnace slag and steel slag. These materials are considered data gaps.

2.3. RAP and RAS

The inventory developed by Mukherjee (2021) for reclaimed asphalt pavement (RAP) and recycled asphalt shingles (RAS) processing shall be used for RAP and RAS. This inventory was derived from data published by Mukherjee (2017).

2.4. Additives

The available inventories for asphalt mixture additives and asphalt binder additives are provided in Table 1.

EPDs shall indicate data gaps for materials that are less than 1% of the total mass inputs for the asphalt mixture (excluding fuel) with no available background (upstream) datasets, as prescribed in Section 7.1.8 of the *PCR for Asphalt Mixtures*. When these materials comprise more than 1% (individually) or 5% (combined) of the total mass inputs for the asphalt mixture (excluding fuel), an EPD cannot be developed, as prescribed in Section 7.1.8 of the *PCR for Asphalt Mixtures*.

Table 1. Background inventories for asphalt mixture additives and asphalt binder additives

Type	Generic Examples	Background (Secondary) Inventory	Reference/Comment
Antioxidants	Lead compounds	Data Gap	
	Carbon	Data Gap	
	Calcium salts	Data Gap	
Antistrip Agents	Amidoamines	Data Gap	
	Hydrated lime	Quicklime, at plant	NREL (2021)
	Imidazolines	Data Gap	
	Organo-metallics	Data Gap	
	Polyamines	Data Gap	
Extenders	Bio-based oils	Data Gap	
	Lignin	Data Gap	
	Re-refined engine oil bottom (REOB), aka vacuum tower asphalt extender (VTAE)	Data Gap	
	Sulfur	Data Gap	
Fibers, natural	Cellulose	Data Gap	
	Mineral	Data Gap	
	Rock wool	Data Gap	
Fibers, synthetic	Fiberglass	Data Gap	
	Polyester	Data Gap	
	Polypropylene	Data Gap	
Modifiers	Biochar	Data Gap	
	Polyphosphoric acid (PPA)	Asphalt binder, 0.5% polyphosphoric acid (PPA) (by weight of asphalt binder), consumption mix, at terminal, from crude oil	Wildnauer et al. (2019) / See Section 2.1.1
Mineral fillers	Baghouse fines	N/A	Cut-off rule
	Crusher fines	Coarse aggregate from crushed stone	Marceau et al. (2007)
	Fly ash	N/A	Cut-off rule
	Lime	Quicklime, at plant	NREL (2021)
	Portland cement	Portland cement, at plant	NREL (2021)
	Slag cement	Slag cement	Slag Cement Association (2015)
Natural asphalts	Gilsonite	Data Gap	
	Trinidad lake asphalt	Data Gap	
Oxidant	Manganese salts	Data Gap	

Type	Generic Examples	Background (Secondary) Inventory	Reference/Comment
Pigments	Iron oxide		
	Titanium dioxide	Data Gap	
Plastic	Ethylene acrylate copolymer	Data Gap	
	Ethylene propylene copolymers (EPM)	Data Gap	
	Ethylene propylene diene (EPDM)	Data Gap	
	Ethylene-vinyl acetate (EVA)	Data Gap	
	Polyethylene	Data Gap	
	Polyolefins	Data Gap	
	Polypropylene	Data Gap	
	Polyvinyl chloride (PVC)	Data Gap	
	Recycled plastics	Data Gap	
Polymers	Biopolymers	Data Gap	
	Blends of plastic and rubber polymers	Data Gap	
	Ground tire rubber	Asphalt binder, 8% ground tire rubber (GTR) (by weight of asphalt binder), consumption mix, at terminal, from crude oil	Wildnauer et al. (2019) / See Section 2.1.1
	Natural rubber	Data Gap	
	Polychloroprene latex	Data Gap	
	Styrene-butadiene-rubber (SBR)	Asphalt binder, 3.5% styrene-butadiene-styrene (SBS) (by weight of asphalt binder), consumption mix, at terminal, from crude oil	Wildnauer et al. (2019) / See Section 2.1.1
	Styrene-butadiene-styrene (SBS)	Asphalt binder, 3.5% styrene-butadiene-styrene (SBS) (by weight of asphalt binder), consumption mix, at terminal, from crude oil	Wildnauer et al. (2019) / See Section 2.1.1
	Styrene-isoprene-styrene (SIS)	Data Gap	
Recycling agents	Aromatic extracts	Data Gap	
	Modified vegetable oils	Data Gap	
	Paraffinic oils	Data Gap	
	Reacted bio-based oils	Data Gap	
	Tall oils	Data Gap	
	Vegetable oils	Data Gap	

3. Secondary data sources for transportation (A2)

The following inventories are available from National Renewable Energy Laboratory (NREL, 2021):

3.1. Boat

- Transportation by barge, diesel powered.
- Transportation by ocean freighter, diesel powered.

3.2. Pipeline

- Transportation by pipeline, natural gas powered.

3.3. Train

- Transportation by train, diesel powered.

3.4. Truck

- Transportation by combination truck, diesel powered.
- Transportation by combination truck, gasoline powered.
- Transportation by refuse truck, diesel powered.
- Transportation by refuse truck, gasoline powered.

4. Secondary data sources for asphalt mixture production (A3)

4.1. Electricity consumption

The inventory data for consumption-based electricity is available from the National Energy Technology Laboratory (NETL, 2019) at the balancing authority level for plants located in the U.S.

The inventory data for consumption-based electricity is available from [Insert Data Source] for plants located in Canada.

4.2. Fuel combustion

4.2.1. Boilers, burners, and other process heating equipment

The available inventories for on-site combustion of fuel for process heating equipment are provided in Table 2. These inventories shall be used for processes including the primary and secondary burner, hot oil heater, and ancillary heating sources such as on-site asphalt-rubber blending plants.

Table 2. Background inventories for fuel consumption by process heating equipment

Fuel type	Inventory	Reference
Biodiesel	Soy biodiesel, production, at plant	NREL (2021)
Brown grease (aka grease trap oil, FOG)	Soy biodiesel, production, at plant (proxy)	NREL (2021)
Coal, anthracite	Anthracite coal, combusted in industrial boiler	NREL (2021)

Fuel type	Inventory	Reference
Coal, bituminous	Bituminous coal, combusted in industrial boiler	NREL (2021)
Coal, lignite	Lignite coal, combusted in industrial boiler	NREL (2021)
Diesel	Diesel, combusted in industrial boiler	NREL (2021)
Landfill gas	Natural gas, combusted in industrial boiler (proxy)	NREL (2021)
Liquid natural gas (LNG)	Natural gas, combusted in industrial boiler	NREL (2021)
Liquified petroleum gas (LPG) (aka propane)	Liquified petroleum gas, combusted in industrial boiler	NREL (2021)
Natural gas	Natural gas, combusted in industrial boiler	NREL (2021)
Recycled fuel oil (aka used oil)	Recycled fuel oil, combusted in industrial boiler	Mukherjee (2021)
Residual fuel oil	Residual fuel oil, combusted in industrial boiler	NREL (2021)
Renewable diesel	Diesel, combusted in industrial boiler (proxy)	NREL (2021)
Renewable natural gas (RNG)	Natural gas, combusted in industrial boiler	NREL (2021)
Yellow grease (aka recycled vegetable oil)	Soy biodiesel, production, at plant (proxy)	NREL (2021)

4.2.2. Internal combustion engines

The available inventories for on-site combustion of fuel for internal combustion engines are provided in Table 3. These inventories shall be used for equipment such as loaders, generators, skid steers, compressors, and other equipment that uses an internal combustion engine.

Table 3. Background inventories for fuel consumption by internal combustion engines

Fuel type	Inventory	Reference
Biodiesel	Soy biodiesel, production, at plant (proxy)	NREL (2021)
Compressed natural gas (CNG)	Compressed natural gas equipment operation, industry average, >56 kW and <560 kW	NREL (2021)
	Compressed natural gas equipment operation, industry average, >19 kw and <56 kW	NREL (2021)
Diesel fuel	Diesel, combusted in industrial equipment	NREL (2021)

Fuel type	Inventory	Reference
Gasoline	Gasoline, combusted in industrial equipment	NREL (2021)
Liquified petroleum gas (LPG) (aka propane)	Propane, combusted in equipment	NREL (2021)

5. References

Marceau, M.L., M.A. Nisbet, and M.G. VanGeem (2007). Life Cycle Inventory of Portland Cement Concrete, SN3011. Portland Cement Association, Skokie, Illinois. http://large.stanford.edu/courses/2016/ph240/pourshafeie2/docs/marceau-2007.pdf.

Mukherjee (2016). Life Cycle Assessment of Asphalt Mixtures in Support of an Environmental Product Declaration. National Asphalt Pavement Association, Lanham, Maryland. https://www.asphaltpavement.org/programs/napa-programs/emerald-eco-label

Mukherjee (2021). Life Cycle Assessment of Asphalt Mixtures in Support of an Environmental Product Declaration. National Asphalt Pavement Association, Greenbelt, Maryland.

NETL (2019). Grid Mix Explorer Version 4.1. National Energy Technology Laboratory. https://www.netl.doe.gov/energy-analysis/details?id=bb9b0ec8-68b1-4406-8655-5bb4b095c7eb.

NREL (2021). USLCI 2021 Q1 v1. National Renewable Energy Laboratory. https://www.lcacommons.gov/lca-collaboration/National_Renewable_Energy_Laboratory/USLCI_2021_Q1_v1/datasets.

Slag Cement Association (2015). Environmental Product Declaration, Slag Cement, Industry Average. Slag Cement Association, Farmington Hills, Michigan. https://www.slagcement.org/Portals/11/xBlog/uploads/2020/8/5/SCASlagCementASTMEPD-011080120.pdf.

Wildnauer, M., E. Mulholland, and J. Liddie (2019). Life Cycle Assessment of Asphalt Binder. Asphalt Institute, Lexington, Kentucky. http://www.asphaltinstitute.org/engineering/lca-study-on-asphalt-binders/.