
Pavement Preservation Products Product Category Rule

Number 2011-01

1 June 2011



A Program of
Institute for Environmental Research and Education
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iere.org/earthsure.aspx

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Pavement Preservation Products

Product Category Rule

1. Identification of Product

- 1.1. UNSPSC Code: These products do not yet have a UNSPSC code, but could be used while performing these services under the noted UNSPSC codes.
 - 1.1.1. 72103301 Parking lot or road maintenance or repairs or services
 - 1.1.2. 72141003 Highway and road maintenance service
 - 1.1.3. 72141104 Highway and road resurfacing service
 - 1.1.4. 72141105 Sidewalk construction and repair service
 - 1.1.5. 30222015 Runway [only maintenance or repair]
 - 1.1.6. 72141101 Airport runway construction service
 - 1.1.7. 95121613 Airfield [only maintenance or repair]
- 1.2. System Function: pavement preservation products restore the function of the existing pavement system and extend its service life, not increasing its capacity or strengthⁱ.
- a) Functional Unit: One square meter year of pavement preserved in average condition per ASTM D6433-09ⁱⁱ or ASTM 5340-10ⁱⁱⁱ. In the United States, Federal Aviation Administration approvals P-626, P-630, P-631, P-632, EB-35, and EB-44, may also apply.
- 1.3. The scope of the PCR is Cradle to Grave.
- 1.4. The purpose of the PCR is to provide a detailed method for developing a business-to-business environmental product declaration to support comparable, informed, and objective sustainable purchasing.
- 1.5. Names and affiliations of the PCR Review Committee
 - Di Lu, independent, LCACP 2010-54
 - Ana Quiros, Eco-Global Advisors, Costa Rica
 - Vivik Khanna, PhD.,P.E., M.ASCE, Oklahoma Aeronautics Commission

The PCR committee recognizes and appreciates the reviewers for their contribution towards making this document stronger and clearer in both technical and editorial senses.

2. Administrative Details

- 2.1. Program operator: Institute for Environmental Research and Education (IERE)
- 2.2. A global search for pavement preservation PCRs identified no such document. This document appears to be the first.
- 2.3. Date of Publication: June 1, 2011
- 2.4. Expiration Date: May 31, 2016

Validity of any EPDs will be until the expiration date of the PCR, but any EPD must be updated in the case of substantial reformulation of the product. Substantial reformulation means any change affecting 10% of the mass of the product formulation or causing a 10% change in any impact category result.

3. Background

- 3.1. This PCR is developed in conformity with ISO 14040^{iv}, 14044^v, 14025^{vi} and IERE's Earthsure Program^{vii}.
- 3.2. The PCR Development was funded by Asphalt Systems, Inc. (ASI)
- 3.3. Outreach was by phone and email, list of individuals contacted seen in Appendix A
Members of the PCR committee included:

Jim Roberts	ASI
Jim Aspin	Independent consultant to ASI
Kerry Nothnagel	Transystems
Kent Newman	Army Corps of Engineers
Alan James	Akzo Nobel
Brad Grose	ASI
Bob Young	ASI
Greg Cline	U.S. FAA, formerly US Navy
N. Mike Jackson	University of North Florida
Larry Galehouse	National Center for Pavement Preservation
Bruce Uhlman	BASF
Arlis A Kadrmas	BASF (Asphalt)

4. Definitions

- 4.1. AP 42: Air Pollution 42: a program of the U.S EPA for estimating air pollution emissions from industrial processes
- 4.2. CAS Number numerical identifier of chemicals provided by the Chemical Abstracts Service.
- 4.3. Competent Authority: an individual with a higher degree or at least five years experience in the relevant industry.
- 4.4. Consumptive Water Use: water removed from available supplies without return to a water resources system, e.g. water used in manufacturing, agriculture, and food preparation.
- 4.5. Ecosphere flows: raw materials taken from nature or returned to nature.
- 4.6. Foreground Data: data in processes under the direct control of the EPD owner.
- 4.7. Primary Data: raw data collected by the individuals in question, e.g., electricity invoices, stack test results, monthly monitoring data, etc.
- 4.8. Secondary Data: aggregated or modified data from a reputable source, e.g. descriptions of the local electric grid derived from the local utility, published peer reviewed articles, etc.
- 4.9. Semivolatiles: organic compounds typically having boiling points above 150 degrees Centigrade, and vapor pressures below 0.01 mm mercury.

- 4.10. Technosphere flows: all modified products and services. Technosphere flows are always accompanied by a financial exchange.
- 4.11. Tertiary data: data aggregated from many sources, e.g. in commercial LCI databases.
- 4.12. Unit Process: the lowest level at which life cycle inventory data is available.
- 4.13. Onsite formulation: changes in the product as applied to optimize for environmental conditions. For example more water or more sand or gravel may be added to the typical formulation.
- 4.14. First Tier Supplier: company selling product to the company seeking the EPD.
- 4.15. Foreground Data: data from processes under operational control of the EPD owner.
- 4.16. EPD Owner: the organization developing the EPD, usually the manufacturer
- 4.17. Background Data: data from processes not under operational control of the EPD Owner.

5. Acronyms

- 5.1. ASTM: American Society for Testing and Materials
- 5.2. BOD: Biological Oxygen Demand
- 5.3. COD: Chemical Oxygen Demand
- 5.4. EPA: Environmental Protection Agency
- 5.5. EPD: Environmental Product Declaration
- 5.6. ISO: international Association for Standardization
- 5.7. LCACP: Life Cycle Assessment Certified Professional.
- 5.8. LCA: Life Cycle Assessment
- 5.9. LCI: Life Cycle Inventory
- 5.10. LCIA: Life Cycle Impact Assessment
- 5.11. PM: Particulate matter (air)
- 5.12. PCR: Product Category Rule
- 5.13. TSS: Total suspended solids (water)
- 5.14. USGS: United States Geological Service
- 5.15. VOCs: Volatile Organic Substances

6. Standards Incorporated by Reference

- 6.1. Recommended Performance Guidelines for Emulsified Asphalt Slurry Seal Surfaces, 2010. International Slurry Surfacing Association A105
- 6.2. Recommended Performance Guidelines for Micro-Surfacing, 2010. International Slurry Surfacing Association A143
- 6.3. ASTM D6433 - 10 Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys
- 6.4. ASTM 5340-10 Standard Test Method for Airport Pavement Condition Index Surveys
- 6.5. ISO 14040: Environmental management — Life cycle assessment — Principles and framework
- 6.6. ISO 14044: Environmental management — Life cycle assessment — Requirements and guidelines

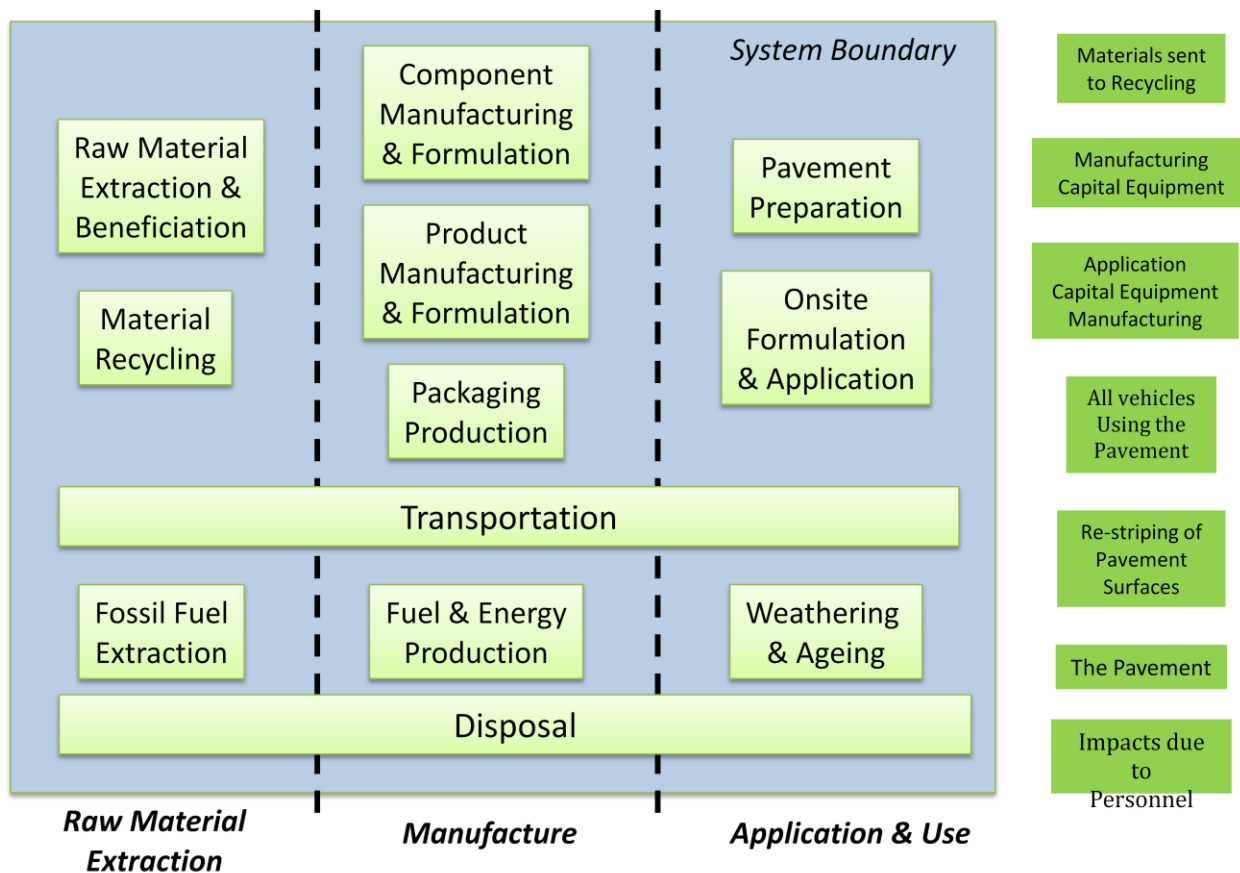
6.7. ISO 14025: Environmental labels and declarations —Type III environmental declarations — Principles and procedures

7. Inventory Analysis

The life cycle inventory is the input and output data collected at the unit process level. Combining the unit process data provides the entire life cycle inventory of the product system. The data is used to calculate the Life Cycle Impact Assessment and ultimately the Environmental Product Declaration.

- 7.1. This life cycle inventory covers all the stages of the life cycle from raw material extraction through the use phase. In the Earthsure system, waste treatment is modeled as an additional unit process rather than a life cycle stage. During use, some pavement products become worn away in use through chemical degradation or physical abridement, and imply no disposal unit process, while others contribute substantially to the pavement surface and their disposal or reuse must be accounted for at the time the road surface is removed.
- 7.2. The system boundary of the LCA study is illustrated in Figure 1. It excludes the production and disposal of capital equipment, but includes the operation of the equipment. The personnel impacts (travel to/from work; lunchroom operations and sanitary water treatment) are excluded. The office operations are excluded. The pavement itself is excluded, as is the operations of vehicles using the pavement. Where it is impossible to exclude office and personnel impacts (due to lack of sub-metering or measurement), these operations may be included, but a sensitivity analysis of this inclusion must be included in the study.

Figure 1 System Boundary for Pavement Preservation Products



- 7.3. The transportation model will ideally be based on actual information on fuel consumption and mode of transport. Where the transport is via common carrier, the following assumptions will be made:
- 7.3.1. All rail is assumed to have no empty haul-back. It is diesel powered.
 - 7.3.2. Road transport is via diesel powered 20-ton tractor-trailers, with empty haul-back 50% of the time.
 - 7.3.3. Ocean transport has no empty haul-back. It is diesel powered using bunker oil.
- 7.4. With the exception of energy producing processes, where unit operations have more than one product, the impact of the operations, including waste disposal is allocated according to the mass of the product. Where the mass of the product is not known, another unit may be used, but it must be converted to mass, and a sensitivity analysis performed on the potential range of the conversion. In the case of energy producing operations, the impacts are allocated according to energy production, on a useful energy equivalent basis.
- 7.5. Any wastes that are recycled (including those used for energy recovery) leave the system boundary, and are analyzed no further. When recycled materials are included in the product, they are considered raw materials, and the impact of their recycling is calculated from the point of discard, either at the discarding facility or at the waste management center.

- 7.6. Where waste disposal methods are known, they must be modeled for waste disposal. Where they are not known, the most recent waste inventory data from the U.S. EPA Office of Solid Waste or equivalent for the host country must be used.
- 7.7. No credit for bio-based greenhouse gases may be employed. However, sequestration of carbon into bio-based materials may be accounted for during raw material unit processes, which must include all the emissions created during growing, harvesting and transporting the biomass.
- 7.8. No carbon offset credits may be included in the calculation.
- 7.9. At least 95% of all mass and energy used in the system must be accounted for. No single flow that represents more than 1% of the total mass or energy flow may be excluded. All known toxic materials must be accounted for. At a minimum, all U.S. EPA Toxics Release Inventory Chemicals, or the equivalent for the host country must be evaluated.
- 7.10. At a minimum, the following ecosphere flows must be evaluated in the inventory, divided into releases to or removals from air, water and soil. If there is no flow, zeros should be noted. All Ecosphere inputs must be in units of in-nature amounts, e.g. nickel (in ground). A complete list can be found in Appendix C.
- 7.10.1. All greenhouse gases identified in the most recent IPCC technical report;
- 7.10.2. All fixed nitrogen; all phosphorus;
- 7.10.3. Categorical groups such as PM, TSS, VOCs, BOD and COD;
- 7.10.4. All substances on the US EPA Toxics Release Inventory or country equivalent;
- 7.10.5. All endocrine disrupters identified in the [EU Annex 9 list](#);
- 7.10.6. All water withdrawal and release;
- 7.10.7. All minerals tracked by the U.S. Geological service in the [Minerals Yearbook](#);
- 7.10.8. All removals of atmospheric components (O₂, N₂. etc.);
- 7.10.9. All fossil fuels extracted;
- 7.10.10. Land occupation (In units of area-years) and land use change (listing both the before and after use, following the satellite landcover naming conventions of the [US Geological Service](#)).
- 7.11. The entire inventory must be made available to the reviewer.
- 7.12. All foreground technosphere data must be primary data, collected over 12 months of operation. The month and year the data was gathered must be disclosed in the EPD.
- 7.13. Companies seeking the EPD must seek primary data from their first tier suppliers representing at least 80% of the mass of their technosphere inflows. Only when data is not available may they use secondary or tertiary data sources.
- 7.14. The electric grid for foreground operations should represent the local electric grid (as supplied by the local electric utility). Where unit operations are background data, or where the local utility will not provide the data, they should represent the most appropriate regional or national electric grid data as published by the U.S. LCI Database, the EU Database (ELCD) or other relevant national database.
- 7.15. Where the unit process is powered by renewable resources, e.g. wind or solar power, and no electricity leaves the facility (i.e. the system is not grid-linked), renewable electricity produced from wind or solar may be accounted for in the system.
- 7.16. All data must be in SI (metric) units.

7.17. The life cycle inventory must include information about the age of the data. All foreground data must be no more than two years old. All technosphere flows must be accompanied by the appropriate UNSPSC code. All Ecosphere flows must be accompanied by a CAS Number.

7.18. Where tertiary data is used, the most relevant data shall be used, in the following order of preference, from most to least desired: same locality > global > other locality. Where properly reviewed U.S. LCI database sets or EU ILCD or other national or regional datasets are available, they should be used for national data.

7.19. No data more than 10 years old may be used, unless it is affirmed by a competent authority that the processes they describe have not substantively changed.

Example Metadata: Extraction of Sand

Includes the removal of sand using heavy equipment and the sorting of the sand by size using a mechanical sieving machine.

Ecosphere inputs

Sand in-ground	CAS # 99439-28-8	Primary data
Land occupation		Primary data

Technosphere inputs

Diesel fuel	UNSPSC 15101505	Primary data
Lubricating oil	UNSPSC 15121520	Primary data
Electricity, single phase	UNSPSC 83101801	Primary data

Ecosphere outputs (all calculated based on AP42)
Secondary data age 9 years

7.20. Wherever possible, primary data should be calculated providing the mean, standard deviation and statistical distribution of the data. This data will support analysis of reproducibility and uncertainty of the data. Where these analyses are not possible, it will be assumed that the data are log-normally distributed with a relative standard deviation of 100%.

7.21. A flow chart showing the system boundaries must be included in the LCA study.

7.22. The unit process based Life cycle inventory must describe each of the unit processes as described above and as called out in ISO 14040 and 14044.

7.23. The inventory must disclose the percent of technosphere flow inventory that that are primary data, based on the number of technosphere flows.

7.24. All emissions factors used must be identified as primary (developed for the local unit process, or based on biological, chemical or physical constants such as stoichiometric equivalents), secondary (derived from studies of equivalent processes) or tertiary (derived from the aggregation of multiple similar processes).

7.25. The length of time of pavement life extension may be calculated using the default values shown below. These default figures represent the **minimum** life extension of the product, not the service life of the product. Most products will have life extension figures longer than found in Figure 2 below.

Figure 2 Default Minimum Pavement Life Extension Times

<i>Asphalt Pavements</i>	<i>Minimum Pavement Life Extension (years)</i>
Rejuvenators	1
Fog Seals	1
Crack Filling	1
Crack Sealing	2
Slurry Seals	4
Micro Surfacing	5
Chip Seals	5
Ultra-Thin Bonded Wearing Course	5
Ultra-Thin HMA Overlays	4
Thin HMA Overlays	5
<i>Concrete Pavements</i>	
	<i>Minimum Pavement Life Extension (years)</i>
Crack Sealing	1
Spall Repair	1
Diamond Grinding	3
Partial Depth Repair	5 ^{viii}
Full Depth Repair	3
Dowel Bar Retrofit	2
Bonded Overlays	15 ^{ix}

If default values are not used, the EPD owner must provide documentation of the expected pavement extension value, either through statistical analysis of existing use, or through engineering calculations. Calculations must be based on the range of anticipated application environments and conditions, and the calculated value for pavement extension must represent an arithmetic mean of the measured or calculated scenarios. Calculated scenarios should consider climate, weather during application and initial pavement condition.

During the use phase, there are losses due to volatilization, UV degradation, and physical debridement. These must be estimated based on the average scenario described above. Where the losses in runoff or in volatilization are not measured, the total bulk amount of the volatiles and semivolatiles in the virgin material must be assumed to be released. Semivolatiles must be characterized using US EPA method 8270 of SW846^x or equivalent. Non-volatile components must be assumed to be landfilled as part of the next life cycle of pavement preservation product, unless it can be shown that the material is recycled into the next use of the product (e.g. through in-place asphalt recycling).

8. Life Cycle Impact Assessment

The impact assessment for methodology is based on expected impacts from the production, application and use of pavement preservation products. Stratospheric ozone depletion is an effect that is driven

largely by the release of refrigerants, which are not used in the pavement preservation product value chain, so this impact will be ignored. Impact assessment will be performed using the following methods

- 8.1. Climate change is the result of the anthropogenic addition of greenhouse gases into the atmosphere. These gases trap heat in the atmosphere, leading to a wide diversity of effects, including sea level rise and acidification, extreme weather events such as hurricane and tornadoes and droughts and floods, Greenhouse gases are released through combustion and through and ultimately effects such as crop failure and increased incidence of disease leading to human mortality and losses of species and ecosystems. The majority of greenhouse gases are derived from combustion, and all products include combustion in their value chains, even if only for the purpose of transportation.

The midpoint indicator of climate change is the CO₂ equivalents is a measure of infrared radiative forcing, using the most common and important (in terms of fraction of the greenhouse effect) gas, CO₂. The lifetime of CO₂ in the atmosphere is very variable, but a weighted average is near 100 years, and thus the 100 year time horizon is selected. The characterization factors are derived from the Intergovernmental Panel on Climate Change's most recent 100-year horizon global warming potentials. In addition to CO₂, N₂O, and CH₄ are major drivers of climate change. Minor drivers of climate change include many refrigerants and some industrial chemicals. All of them must be accounted for in estimating the climate change impact.

- 8.2. Acidification causes the destruction of aquatic and terrestrial ecosystems through the wet and dry deposition of strong acids and ammonia. The acidification of soils mobilizes the aluminum in the soils and this has direct toxic effects on fish and other species, as well as an indirect effect through inhibition of uptake of potassium by plants, leading to loss of forest ecosystems. Acidification also affects the built environment, causing the slow dissolution of buildings. We have chosen the stoichiometric gram equivalents of hydrogen ion for emissions of oxides of sulfur and nitrogen, ammonia, HCL, HF, H₂SO₄, H₃PO₄
- 8.3. Eutrophication is the overgrowth of biomass caused by the anthropogenic release of nutrients, particularly fixed nitrogen and phosphorus. Eutrophied water bodies show early effects in terms of species distribution and toxic algal blooms, and ultimately as algae decompose eutrophication causes oxygen depletion leading to fish kills. Large portions of the world's water bodies are subject to eutrophication seasonally. Most causes of excess nutrient releases are agriculture, human and animal wastes, and combustion processes.

In the 1930's A.C. Redfield discovered that the ratio of carbon to nitrogen to phosphorus uptake into marine ecosystems was constant (C:N:P = 106:16:1, on an atom basis) and subsequently this ratio was confirmed to be the same in freshwater systems. The Redfield ratio

is the basis of all life cycle impact models. Report the phosphorus mass equivalents of carbon, nitrogen and phosphorus compounds released, using the Redfield Ratio.

- 8.4. Human and ecotoxicity represent direct effects of releases of toxic materials on humans and other organisms. It is anticipated that toxic materials will be emitted during the production and application of pavement preservation products, and they may also be emitted during the use phase. These shall be evaluated using the [Use-tox](#), latest version.
- 8.5. Photochemical smog is produced when oxides of nitrogen and volatile organic substances are present in the atmosphere in the presence of sunlight. Ozone is formed, and this form of oxygen causes many direct effects, reducing crop yields, asthma and other respiratory effects in humans and animals. The production of ozone has been shown to be more related to the existence of oxides of nitrogen (NOx) than to the release of volatile organic substances.
- Measurement of smog shall use the most recent U.S. EPA TRACI method, expressed in mass of NOx equivalents.
- 8.6. Fossil fuel use is expected to be used during the production, transportation and application of pavement preservation. The most recent CML Method^{xi} shall be used to evaluate this impact.
- 8.7. Resource Depletion: Listing of all uses of minerals with less than 100 years reserves as calculated by the ratio of extraction/proven reserves, and published by the most recent USGS Minerals Yearbook.
- 8.8. Some pavement preservation products include water, while others use water at various stages of the life cycle. There is currently no consensus on how to measure water resource depletion, so at this time, consumptive freshwater use shall be the indicator. Consumptive water use includes all the use of freshwater resources.

Figure 1 Life Cycle Impact Assessment Models

Impact Category	Category Indicator	Model Source
Climate Change	Mass of CO ₂ Equivalents	Intergovernmental Panel on Climate Change ^{xii} , most recent publication
Acidification	Mass Hydrogen Ion Equivalents	Stoichiometric equivalents
Eutrophication	Mass Phosphorus equivalents	Redfield Ratio ^{xiii,xiv}
Human Toxicity	CTUh	Use-Tox
Ecological toxicity	Cubic Meter Years	Use-tox
Photochemical Smog	Mass NOx equivalents	TRACI
Fossil Fuel Depletion	MJ	CML

Mineral Resource Depletion	Mass of minerals with less than 200 years reserves	USGS (listed in appendix
Water Use	Volume of Water consumed	N/A

9. Sensitivity analyses

Sensitivity analyses must be performed on the following assumptions:

- 9.1. The composition of the product, taking into account the reasonable range of its composition at application;
- 9.2. Any allocation that could not be performed directly using mass or energy data;
- 9.3. Unless default minimum values are used, the range of road lifetime extension of the product.

10. Other measures to be disclosed

- 10.1. All toxic materials in the product as required by the U.S. Occupation and Health Administration (OSHA) requirements for Material Safety Data Sheets shall be disclosed on the EPD. Documentation for this disclosure shall include the MSDSs of components of the product and the formulation of the product.
- 10.2. The business or business unit manager must sign a declaration that affirms that the information disclosed in the EPD is true and correct to the best of his/her knowledge.

11. Format of the EPD

An example of the format is shown in Appendix A, and the EPDs should be substantively similar to the example.

- 11.1. The format of the EPD shall be as follows:
 - 11.1.1. The name of the product, with any numerical identifier
 - 11.1.2. A description of the use of the product (e.g. as fog seal on asphalt, as sealer on cement)
 - 11.1.3. Any specifications or consensus standards the product meets
 - 11.1.4. A photograph of the product either in the container (for packaged shipment) or during application or use (for bulk shipments).
 - 11.1.5. The name of the producer of the product
 - 11.1.6. The name of the PCR and the Program Operator
 - 11.1.7. The date of expiry of the EPD
 - 11.1.8. The table of the impact indicator results, shown by life cycle stage
 - 11.1.9. List of MSDS toxic materials, with percent content
 - 11.1.10. Signature by business unit manager that the EPD is true and correct to the best of his/her knowledge
 - 11.1.11. Validation by third party LCACP that the EPD conforms with this PCR.

11.1.12. Contact information for the validator.

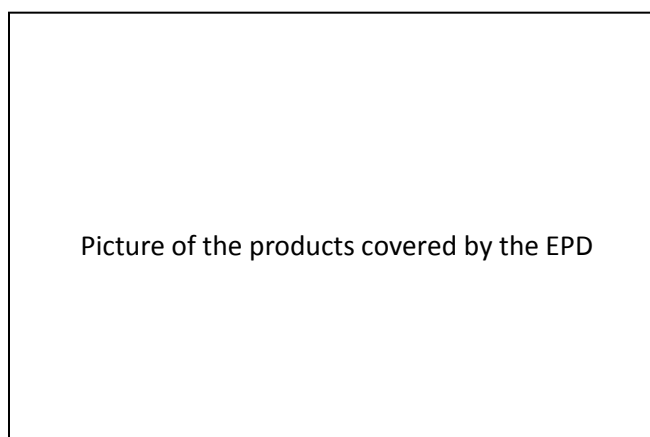
Appendix A: Mockup of EPD

Environmental Product Declaration For XYZ Product, ABC Pavement Preservers

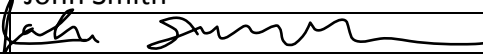
Product Information

XYZ product covers all kinds of asphalt pavements and extends their life four years on average. It is applied by spraying onto surfaces either by hand spray for small areas or by truck spray applicator for larger applications.

The analysis shown here was performed in accordance with the Earthsure Environmental Product Declaration Program, using the product category rule for pavement preservation products. The analysis is based on a life cycle assessment of XYZ Product, using data collected from January to December, 2012. Environmental Product Declarations from other sources using different Product Category Rules may not be comparable to this one.












Measurement Certification

Product Name	XYZ Product
Product ID number(s)	12345, 12345b, 12346
Meets quality specification	California technical specification ABC123, ISSI Standards 143 and ARRA standard 987.
Product Category Rule	Earthsure 2011-01 Pavement Preservation Products
Product Category Rule Operator	Earthsure program, IERE PO Box 2449, Vashon WA 98070 earthsure.org 206-463-7430
This EPD is valid until	May 31, 2016
Validator Name	John Smith
Validator Signature	
LCACP Registration Number	LCACP 2008-22
Date	25 January 2013



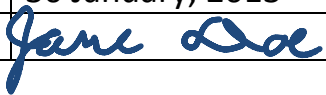
The Life Cycle Environmental Impact of preserving one square meter of pavement for one year using XYZ Product

		Raw Materials	Transport	Manu- facturing	Application and Use	Equivalent Units
	Climate Change	400	50	40	150	Grams CO ₂
	Acidification	1	.01	.05	.6	Grams H ⁺
	Eutrophication	.01	.01	.02	.3	Grams P
	Human Toxicity	.0005	.0008	.00001	.0005	CTUh
	Ecotoxicity	5	1	.5	1	M ³ -yr
	Photochemical Smog	.005	.01	.001	.2	Grams NO ₂
	Fossil Fuel Depletion	150	30	20	75	Grams oil
	Mineral Resource	2	0	0	0	Grams minerals
	Water Resource	5	.01	.5	2	Liters water

More information on XYZ Product

XYZ Product contains these hazardous materials	
CAS Number	Name
1310-73-2	Sodium Hydroxide
8002-05-9	Petroleum distillates
8012-56-4	Sodium dodecyl sulfate
To the best of our knowledge, XYZ Product contains no endocrine disrupters as defined by the European Commission.	
Percentage of primary technosphere data	62%
Dates of data collection	January-December 2012

Product Owner Certification

I have personally examined the conditions and the individuals performing this analysis and to the best of my knowledge, these representations are true and accurate.	
Name	Jane Doe, CEO
Date	30 January, 2013
Signature	

Disclaimers

The analyses presented here were performed with all due care, but the user should realize that they represent the average results measured under standardized conditions and the actual environmental performance will vary depending on the particular application, the climate, the traffic type and intensity and other factors beyond the control of ABC Pavement Preservers.

The results shown here pertain only to the referenced product category rule. They should not be compared directly to results using a different product category rule.

For more information, contact

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[info@ABC PavementPreservers.com](mailto:info@ABCPavementPreservers.com)
 712-222-2222

Appendix B: List of invited interested parties

The following individuals were contacted via email and invited to participate in developing this PCR.

Name	Affiliation
Nancy Albright, P. E.	Director, Division of Maintenance, Kentucky DOT
John Andreae	Idaho Pavement
David Andrews	Pavement Engineer, Indiana DOT
Paul Annarummo	Administrator, Bridge and highway Maintenance, RIDOT
Jim Aspin	Consultant to ASI
Thadd Buzan	Office of Deputy Undersecretary of Defense for Installations and Environment
Francois Chaignon	COLAS, Inc
German Claros	Research and Technology Implementation Office, Texas DOT
Greg Cline	Federal Aviation Administration, formerly U.S. Navy
Caleb Dobbins	Administrator, Bureau of Highway Maintenance, NH DOT
Dale Doughty	Director Bureau of Maintenance and operations Maine DOT
R. Gary Fore	National Asphalt Pavement Association
Larry Galehouse	National Pavement Preservation Center, Michigan State University
John Garrity	Bituminous Engineer, Minnesota DOT
Brad Grose	Asphalt Systems, Inc.
Steve Guy, P.E.	Florida, DOT
Bob Humer	Asphalt Institute
N. Mike Jackson	University of South Florida
Alan James	Akzo Nobel
Arlis Kadrmas	BASF
Richard Lewis	National Center for Asphalt Technology
George Lukes	Utah DOT
Kent Newman	Army Corps of Engineers
Ron Newsome	Alabama DOT
Kent Nicholson	IOWA DOT
Terry Nothnagel	Transystems
Angela Parsons, P.E.	Alaska DOT
Dave Ray, P.E., P.S.	Maintenance Administrator, Ohio DOT
Jim Roberts	ASI
Delmar Salomon	Pavement Preservation Systems
Tom Sands	Operations Division Manager, Nebraska DOT
Shakir Shatnawi	California DOT, Pavement
Peter Stephanos	US DOT
Jon Swartz	Administrator, Montana DOT
Bruce Uhlman	BASF
Joe Wright	Director, Maintenance & Operation, Delaware DOT
Megan White	Washington DOT

In addition, individuals working for the U.S. EPA and environmental non-governmental organizations Greenseal and World Resources Institute were invited to participate. Some of the invitees declined to be listed here.

Appendix C: List of *de minimus* information for life cycle inventory

(ecosphere flows) Compilation of the flows outlined in section 7.10.

Raw materials

Aluminum	Germanium	Platinum-Group Metals
Antimony	Gold	Potash
Arsenic	Graphite	Pumice and Pumicite
Asbestos	Gypsum	Rare Earths
Barite	Helium	Rhenium
Bauxite and Alumina	Indium	Selenium and Tellurium
Beryllium	Industrial Diamond	Silica
Bismuth	Iodine	Silicon
Boron	Iron and Steel	Silver
Bromine	Iron Ore	Soda Ash
Cadmium	Land Occupation	Stone, Crushed
Chromium	Land Use Change	Stone, Dimension
Clays	Lead	Strontium
Coal	Lithium	Sulfur
Cobalt	Magnesium	Talc
Construction Sand and Gravel	Manganese	Thorium
Columbium (Niobium) and Tantalum	Mercury	Tin
Copper	Mica	Titanium
Diatomite	Molybdenum	Tungsten
Feldspar and Nepheline	Natural Gas	Uranium
Syenite	Nickel	Vanadium
Ferroalloys	Nitrogen	Vermiculite
Fluorspar	Oxygen	Fresh Water
Gallium	Peat	Wollastonite
Garnet	Perlite	Zeolites
	Phosphate Rock	Zinc
	Petroleum	Zirconium and Hafnium

Emissions to air water and soil

CAS Number	Name	CAS Number	Name	CAS Number	Name
4080-31-3	1-(3-Chloroallyl)-3,5,7-triazol-2-ylidene imidazolidin-4-one	571-44-7	1,1-Dimethyl hydrazine	95-50-1	1,2-Dichlorobenzene
354-11-0	1,1,1,2-Tetrachloro-2-fluoroethane	96-18-4	1,2,3-Trichloropropane	107-06-2	1,2-Dichloroethane
630-20-6	1,1,1,2-Tetrachloroethane	120-82-1	1,2,4-Trichlorobenzene	540-59-0	1,2-Dichloroethylene
71-55-6	1,1,1-Trichloroethane	95-63-6	1,2,4-Trimethylbenzene	78-87-5	1,2-Dichloropropane
354-14-3	1,1,2,2-Tetrachloro-1-fluoroethane	106-88-7	1,2-Butylene oxide	122-66-7	1,2-Diphenylhydrazine
79-34-5	1,1,2,2-Tetrachloroethane	96-12-8	1,2-Dibromo-3-chloropropane	95-54-5	1,2-Phenylenediamine
79-00-5	1,1,2-Trichloroethane	106-93-4	1,2-Dibromoethane	615-28-1	1,2-Phenylenediamine dihydro-chloride
13474-88-9	1,1-Dichloro-1,2,2,3,3-pentafluoropropane	1649-08-7	1,2-Dichloro-1,1-difluoroethane	106-99-0	1,3-Butadiene
812-04-4	1,1-Dichloro-1,2,2-trifluoroethane	354-23-4	1,2-Dichloro-1,1,2-trifluoroethane	507-55-1	1,3-Dichloro-1,1,2,2,3-pentafluoropropane
111512-56-2	1,1-Dichloro-1,2,3,3,3-pentafluoropropane	422-44-6	1,2-Dichloro-1,1,2,3,3-pentafluoropropane	3601-79-1	1,3-Dichloro-1,1,2,3,3-pentafluoropropane
1717-00-6	1,1-Dichloro-1-fluoroethane	431-86-7	1,2-Dichloro-1,1,3,3,3-pentafluoropropane	570-81-4	1,3-Dichlorobenzene

CAS Number	Name	CAS Number	Name	CAS Number	Name
542-75-6	1,3-Dichloropropylene	149-30-4	2-Mercaptobenzothiazole (MBT)	79-10-7	Acrylic acid
108-45-2	1,3-Phenylenediamine	109-86-4	2-Methoxyethanol	107-13-1	Acrylonitrile
764-41-0	1,4-Dichloro-2-butene	75-86-5	2-Methylacetonitrile	15972-60-8	Alachlor
106-46-7	1,4-Dichlorobenzene	109-06-8	2-Methylpyridine	116-06-3	Aldicarb
123-91-1	1,4-Dioxane	88-75-5	2-Nitrophenol	309-00-2	Aldrin
624-18-0	1,4-Phenylenediamine dihydrochloride	79-16-9	2-Nitropropane	107-18-6	Allyl alcohol
82-28-0	1-Amino-2-methylantraquinone	90-43-7	2-Phenylphenol	107-05-1	Allyl chloride
35691-65-7	1-Bromo-1-(bromomethyl)-1,3-propanedithiocarbonyl	422-86-0	3,3-Dichloro-1,1,1,2,2-pentafluoroethane	107-11-0	Allylamine
354-25-6	1-Chloro-1,1,2,2-tetrafluoroethane	61-94-1	3,3'-Dichlorobenzidine	319-84-6	alpha-Hexachlorocyclohexane
75-68-3	1-Chloro-1,1-difluoroethane	612-83-9	3,3'-Dichlorobenzidine dihydrochloride	134-32-7	alpha-Naphthylamine
306-83-2	2,2-Dichloro-1,1,1-trifluoroethane	64969-34-2	3,3'-Dichlorobenzidine sulfate	7429-90-5	Aluminum (fume or dust)
128903-21-9	2,2-Dichloro-1,1,1,3,3-pentafluoropropane	119-90-4	3,3'-Dimethoxybenzidine	1344-28-1	Aluminum oxide (fibrous forms)
2655-15-4	2,3,5-Trimethylphenyl methylcarbamate	20325-40-0	3,3'-Dimethoxybenzidine dihydrochloride	20859-73-8	Aluminum phosphide
422-48-0	2,3-Dichloro-1,1,1,2,3-trifluoroethane	111984-09-9	3,3'-Dimethoxybenzidine hydrochloride	834-12-8	Ametryn
78-88-6	2,3-Dichloropropene	119-93-7	3,3'-Dimethylbenzidine	33089-61-1	Amitraz
95-95-4	2,4,5-Trichlorophenol	41766-75-0	3,3'-Dimethylbenzidine dihydrofluoride	61-82-5	Amitrole
88-06-2	2,4,6-Trichlorophenol	612-82-8	3,3'-Dimethylbenzidine dihydrochloride	7664-41-7	Ammonia
94-75-7	2,4-D	460-35-5	3-Chloro-1,1,1-trifluoropropane	101-05-3	Anilazine
53404-37-8	2,4-D 2-ethyl-4-methylpentyl ester	563-47-3	3-Chloro-2-methyl-1-propene	62-53-3	Aniline
1928-43-4	2,4-D 2-ethylhexyl ester	542-76-7	3-Chloropropionitrile	120-12-7	Anthracene
1929-73-3	2,4-D butoxyethyl ester	55406-53-6	3-Iodo-2-propynyl	7440-36-0	Antimony
94-80-4	2,4-D butyl ester	101-80-4	4,4'-Diaminodiphenyl ether	7440-38-2	Arsenic
2971-38-2	2,4-D chlorocrotyl ester	80-05-7	4,4'-Isopropylidenediphenol	1332-21-4	Asbestos (friable)
94-11-1	2,4-D isopropyl ester	101-14-4	4,4'-Methylenebis(2-chloroaniline)	1912-24-9	Atrazine
1320-18-9	2,4-D propylene glycol butyl ether ester	101-61-1	4,4'-Methylenebis(N,N-dimethyl)benzenamine	7440-39-3	Barium
2702-72-9	2,4-D sodium salt	101-77-9	4,4'-Methylenedianiline	22781-23-3	Bendiocarb
94-82-6	2,4-DB	139-65-1	4,4'-Thiodianiline	1861-40-1	Benfluralin
615-05-4	2,4-Diaminoanisole	534-52-1	4,6-Dinitro-o-cresol	17804-35-2	Benomyl
39156-41-7	2,4-Diaminoanisole sulfate	60-09-3	4-Aminoazobenzene	98-87-3	Benzal chloride
95-80-7	2,4-Diaminotoluene	92-67-1	4-Aminobiphenyl	55-21-0	Benzamide
120-83-2	2,4-Dichlorophenol	60-11-7	4-Dimethylaminoazobenzene	71-43-2	Benzene
105-67-9	2,4-Dimethylphenol	92-93-3	4-Nitrobiphenyl	92-87-5	Benzidine
51-28-5	2,4-Dinitrophenol	100-02-7	4-Nitrophenol	191-24-2	Benzo(g,h,i)perylene
121-14-2	2,4-Dinitrotoluene	99-59-2	5-Nitro-o-anisidine	98-07-7	Benzoic trichloride
541-53-7	2,4-Dithiobiuret	99-55-8	5-Nitro-o-toluidine	98-88-4	Benzoyl chloride
120-36-5	2,4-DP	71751-41-2	Abamectin	94-36-0	Benzoyl peroxide
606-20-2	2,6-Dinitrotoluene	30560-19-1	Acephate	100-44-7	Benzyl chloride
87-62-7	2,6-Xylidine	75-07-0	Acetaldehyde	7440-41-7	Beryllium
53-96-3	2-Acetylaminofluorene	60-35-5	Acetamide	91-59-8	beta-Naphthylamine
117-79-3	2-Aminoanthraquinone	75-05-8	Acetonitrile	57-57-8	beta-Propiolactone
75-88-7	2-Chloro-1,1,1-trifluoroethane	98-86-2	Acetophenone	82657-04-3	Bifenthrin
2837-89-0	2-Chloro-1,1,1,2-tetrafluoroethane	62476-59-9	Acifluorfen, sodium salt		biological oxygen demand
532-27-4	2-Chloroacetophenone	107-02-8	Acrolein	92-52-4	Biphenyl
110-80-5	2-Ethoxyethanol	79-06-1	Acrylamide	108-60-1	Bis(2-chloro-1-methylethyl)ether

CAS Number	Name	CAS Number	Name	CAS Number	Name
111-91-1	Bis(2-chloroethoxy) methane	5234-68-4	Carboxin	68085-85-8	Cyhalothrin
111-44-4	Bis(2-chloroethyl) ether	120-80-9	Catechol	533-74-4	Dazomet
542-88-1	Bis(chloromethyl) ether	75-69-4	CFC-11	53404-60-7	Dazomet, sodium salt
56-35-9	Bis(tributyltin) oxide	76-13-1	CFC-113	1163-19-5	Decabromodiphenyl oxide
10294-34-5	Boron trichloride	76-14-2	CFC-114	13684-56-5	Desmedipham
7637-07-2	Boron trifluoride	76-15-3	CFC-115	117-81-7	Di(2-ethylhexyl) phthalate
314-40-9	Bromacil	75-71-8	CFC-12	2303-16-4	Diallate
53404-19-6	Bromacil, lithium salt	75-72-9	CFC-13	25376-45-8	Diaminotoluene (mixed isomers)
7726-95-6	Bromine	2439-01-2	Chinomethionat	333-41-5	Diazinon
353-59-3	Bromochlorodifluoromethane	133-90-4	Chloramben	334-88-3	Diazomethane
75-25-2	Bromoform	57-74-9	Chlordane	132-64-9	Dibenzofuran
74-83-9	Bromomethane	115-28-6	Chlorendic acid	124-73-2	Dibromotetrafluoroethane
75-63-8	Bromotrifluoromethane	90982-32-4	Chlorimuron ethyl	84-74-2	Dibutyl phthalate
1689-84-5	Bromoxynil	7782-50-5	Chlorine	1918-00-9	Dicamba
1689-99-2	Bromoxynil octanoate	10049-04-4	Chlorine dioxide	99-30-9	Dichloran
357-57-3	Brucine	79-11-8	Chloroacetic acid	90454-18-5	Dichloro-1,1,2-trifluoroethane
141-32-2	Butyl acrylate	108-90-7	Chlorobenzene	25321-22-6	Dichlorobenzene (mixed isomers)
123-72-8	Butyraldehyde	510-15-6	Chlorobenzilate	75-27-4	Dichlorobromomethane
4680-78-8	C.I. Acid Green 3	75-45-6	Chlorodifluoromethane	75-71-8	Dichlorodifluoromethane
6459-94-5	C.I. Acid Red 114	75-00-3	Chloroethane	75-43-4	Dichlorofluoromethane
569-64-2	C.I. Basic Green 4	67-66-3	Chloroform	75-09-2	Dichloromethane
989-38-8	C.I. Basic Red 1	74-87-3	Chloromethane	127564-92-5	Dichloropentafluoropropane
1937-37-7	C.I. Direct Black 38	107-30-2	Chloromethyl methyl ether	97-23-4	Dichlorophene
28407-37-6	C.I. Direct Blue 218	76-06-2	Chloropicrin	76-14-2	Dichlorotetrafluoroethane
2602-46-2	C.I. Direct Blue 6	126-99-8	Chloroprene	34077-87-7	Dichlorotrifluoroethane
16071-86-6	C.I. Direct Brown 95	63938-10-3	Chlorotetrafluoroethane	62-73-7	Dichlorvos
2832-40-8	C.I. Disperse Yellow 3	1897-45-6	Chlorothalonil	51338-27-3	Diclofop methyl
81-88-9	C.I. Food Red 15	75-72-9	Chlorotrifluoromethane	115-32-2	Dicofol
3761-53-3	C.I. Food Red 5	5598-13-0	Chlorpyrifos methyl	77-73-6	Dicyclopentadiene
3118-97-6	C.I. Solvent Orange 7	64902-72-3	Chlorsulfuron	1464-53-5	Diepoxybutane
842-07-9	C.I. Solvent Yellow 14	7440-47-3	Chromium	111-42-2	Diethanolamine
97-56-3	C.I. Solvent Yellow 3	7440-48-4	Cobalt	38727-55-8	Diethyl ethyl
492-80-8	C.I. Solvent Yellow 34	7440-50-8	Copper	64-67-5	Diethyl sulfate
128-66-5	C.I. Vat Yellow 4	8001-58-9	Creosote	35367-38-5	Diflubenzuron
7440-43-9	Cadmium	1319-77-3	Cresol (mixed isomers)	101-90-6	Diglycidyl resorcinol ether
156-62-7	Calcium cyanamide	4170-30-3	Crotonaldehyde	94-58-6	Dihydrosafrole
133-06-2	Captan	98-82-8	Cumene	55290-64-7	Dimethipin
63-25-2	Carbaryl	80-15-9	Cumene hydroperoxide	60-51-5	Dimethoate
1563-66-2	Carbofuran	135-20-6	Cupferron	2524-03-0	Dimethyl chlorothiophosphate
124-38-9	Carbon dioxide	21725-46-2	Cyanazine	131-11-3	Dimethyl phthalate
75-15-0	Carbon disulfide	1134-23-2	Cycloate	77-78-1	Dimethyl sulfate
56-23-5	Carbon tetrachloride	110-82-7	Cyclohexane	124-40-3	Dimethylamine
124-73-2	Carbon tetrachloride	108-93-0	Cyclohexanol	2300-66-5	Dimethylamine dicamba
463-58-1	Carbonyl sulfide	68359-37-5	Cyfluthrin	79-44-7	Dimethylcarbaryl chloride

CAS Number	Name	CAS Number	Name	CAS Number	Name
115-10-6	Dimethylether	75-63-8	Halon-1301	421-02-03	HCFC-262
88-85-7	Dinitrobutyl phenol (Dinoseb)	124-73-2	Halon-2402	430-55-7	HCFC-271
25321-14-6	Dinitrotoluene (mixed isomers)	354-14-3	HCFC-121	593-70-4	HCFC-31
39300-45-3	Dinocap	354-21-2	HCFC-122		HCFC-235da2
957-51-7	Diphenamid	306-83-2	HCFC-123	76-44-8	Heptachlor
122-39-4	Diphenylamine	306-83-2	HCFC-123	87-68-3	Hexachloro-1,3-butadiene
2164-07-0	Dipotassium endothall	2837-89-0	HCFC-124	118-74-1	Hexachlorobenzene
136-45-8	Dipropyl isocinchomerate	2837-89-0	HCFC-124	77-47-4	Hexachlorocyclopentadiene
138-93-2	Disodium cyanodithioimidocarbonyl	359-28-4	HCFC-131)	67-72-1	Hexachloroethane
330-54-1	Diuron		HCFC-132)	1335-87-1	Hexachloronaphthalene
2439-10-3	Dodine		HCFC-133)	70-30-4	Hexachlorophene
28057-48-9	d-trans-Allethrin		HCFC-141)	680-31-9	Hexamethylphosphoramide
106-89-8	Epichlorohydrin	1717-00-6	HCFC-141b	51235-04-2	Hexazinone
13194-48-4	Ethoprop	1717-00-6	HCFC-141b**	306-83-2	HFC-125
140-88-5	Ethyl acrylate		HCFC-142	811-97-2	HFC-134a
541-41-3	Ethyl chloroformate	75-68-3	HCFC-142b	420-46-2	HFC-143a
759-94-4	Ethyl dipropylthiocarbamate	75-68-3	HCFC-142b**	75-37-6	HFC-152a
100-41-4	Ethylbenzene		HCFC-151	431-89-0	HFC-227ea
74-85-1	Ethylene	75-43-4	HCFC-21**	75-46-7	HFC-23
107-21-1	Ethylene glycol	75-45-6	HCFC-22	690-39-1	HFC-236fa
75-21-8	Ethylene oxide	75-45-6	HCFC-22**	460-73-1	HFC-245fa
96-45-7	Ethylene thiourea	422-26-4	HCFC-221	75-10-5	HFC-32
151-56-4	Ethyleneimine (Aziridine)	422-49-1	HCFC-222	406 58 6	HFC-365mfc
75-34-3	Ethylidene dichloride	422-52-6	HCFC-223	138495-42-8	HFC-43-10mee
52-85-7	Famphur	422-54-8	HCFC-224	3822-68-2	HFE-125
60168-88-9	Fenarimol		HCFC-225	1691-17-4	HFE-134
13356-08-6	Fenbutatin oxide	422-56-0	HCFC-225ca	420-46-2	HFE-143a
66441-23-4	Fenoxaprop ethyl	422-56-0	HCFC-225ca**	78522-47-1	HFE-236ca12 (HG-10)
72490-01-8	Fenoxycarb	507-55-1	HCFC-225cb	22410-44-2	HFE-245c2
39515-41-8	Fenpropathrin	507-55-1	HCFC-225cb**	1885-48-9	HFE-245fa2
55-38-9	Fenthion	431-87-8	HCFC-226	425-88-7	HFE-254cb2
51630-58-1	Fenvalerate	421-94-3	HCFC-231	188690-78-0	HFE-338pcc13 (HG-01)
14484-64-1	Ferbam	460-89-9	HCFC-232	28523-86-6	HFE-347mcc3
69806-50-4	Fluazifop butyl	7125-84-0	HCFC-233	406-78-0	HFE-347pcf2
2164-17-2	Fluometuron	425-94-5	HCFC-234	160620-20-2	HFE-356pcc3
7782-41-4	Fluorine	460-92-4	HCFC-235		HFE-43-10pccc124(H-Galden 1040x)
51-21-8	Fluorouracil (5-Fluorouracil)	666-27-3	HCFC-241	163702-07-6	HFE-449sl (HFE 7100)
69409-94-5	Fluvalinate	460-63-9	HCFC-242	163702-08-7	
133-07-3	Folpet	460-69-5	HCFC-243	163702-05-4	HFE-569sf2 (HFE-7200)
72178-02-0	Fomesafen		HCFC-244	163702-06-5	
50-00-0	Formaldehyde	421-41-0	HCFC-251	163702-08-7	HFE-7100
64-18-6	Formic acid	819-00-1	HCFC-252	67485-29-4	Hydramethylnon
76-13-1	Freon 113	460-35-5	HCFC-253	302-01-2	Hydrazine
353-59-3	Halon-1211	420-97-3	HCFC-261	10034-93-2	Hydrazine sulfate
				7647-01-0	Hydrochloric acid

CAS Number	Name	CAS Number	Name	CAS Number	Name
7647-01-0	hydrochloric acid	108-10-1	Methyl isobutyl ketone	4549-40-0	N-Nitrosomethylvinylamine
7664-39-3	hydrofluoric acid	624-83-9	Methyl isocyanate	59-89-2	N-Nitrosomorpholine
74-90-8	Hydrogen cyanide	556-61-6	Methyl isothiocyanate	759-73-9	N-Nitroso-N-ethylurea
7664-39-3	Hydrogen fluoride	80-62-6	Methyl methacrylate	684-93-5	N-Nitroso-N-methylurea
7783-06-4	Hydrogen sulfide	298-00-0	Methyl parathion	16543-55-8	N-Nitrososornicotine
123-31-9	Hydroquinone	1634-04-4	Methyl tert-butyl ether	100-75-4	N-Nitrosopiperidine
35554-44-0	Imazalil	74-95-3	Methylene bromide	27314-13-2	Norflurazon
13463-40-6	Iron pentacarbonyl	9006-42-2	Metiram	90-04-0	o-Anisidine
78-84-2	Isobutyraldehyde	21087-64-9	Metribuzin	134-29-2	o-Anisidine hydrochloride
465-73-6	Isodrin	7786-34-7	Mevinphos	95-48-7	o-Cresol
25311-71-1	Isofenphos	90-94-8	Michler's ketone	2234-13-1	Octachloronaphthalene
67-63-0	Isopropyl alcohol	2212-67-1	Molinate	29082-74-4	Octachlorostyrene
120-58-1	Isosafrole	1313-27-5	Molybdenum trioxide	528-29-0	o-Dinitrobenzene
77501-63-4	Lactofen	76-15-3	Monochloropentafluoroethane	19044-88-3	Oryzalin
7439-92-1	Lead	150-68-5	Monuron	20816-12-0	Osmium tetroxide
58-89-9	Lindane	505-60-2	Mustard gas	95-53-4	o-Toluidine
330-55-2	Linuron	108-38-3	m-Xylene	636-21-5	o-Toluidine hydrochloride
554-13-2	Lithium carbonate	88671-89-0	Myclobutanil	301-12-2	Oxydemeton methyl
121-75-5	Malathion	121-69-7	N,N-Dimethylaniline	19666-30-9	Oxydiazon
108-31-6	Maleic anhydride	68-12-2	N,N-Dimethylformamide	42874-03-3	Oxyfluorfen
109-77-3	Malononitrile	142-59-6	Nabam	95-47-6	o-Xylene
12427-38-2	Maneb	300-76-5	Naled	10028-15-6	Ozone
7439-96-5	Manganese	91-20-3	Naphthalene	104-94-9	p-Anisidine
108-39-4	m-Cresol	71-36-3	n-Butyl alcohol	123-63-7	Paraldehyde
99-65-0	m-Dinitrobenzene	110-54-3	n-Hexane	1910-42-5	Paraquat dichloride
93-65-2	Mecoprop	7440-02-0	Nickel	56-38-2	Parathion
7439-97-6	Mercury	1929-82-4	Nitrapyrin		particulate matter
150-50-5	Merphos	7697-37-2	Nitric acid	106-47-8	p-Chloroaniline
126-98-7	Methacrylonitrile	10102-43-9	nitric oxide	95-69-2	p-Chloro-o-toluidine
137-42-8	Metham sodium	139-13-9	Nitriilotriacetic acid	104-12-1	p-Chlorophenyl isocyanate
74-82-8	Methane	98-95-3	Nitrobenzene	120-71-8	p-Cresidine
74-82-8	Methane	1836-75-5	Nitrofen	106-44-5	p-Cresol
67-56-1	Methanol	10102-44-0	nitrogen dioxide	100-25-4	p-Dinitrobenzene
20354-26-1	Methazole	51-75-2	Nitrogen mustard	1114-71-2	Pebulate
2032-65-7	Methiocarb	55-63-0	Nitroglycerin	40487-42-1	Pendimethalin
94-74-6	Methoxone	10024-97-2	Nitrous oxide	608-93-5	Pentachlorobenzene
3653-48-3	Methoxone sodium salt	10024-97-2	Nitrous oxide	76-01-7	Pentachloroethane
72-43-5	Methoxychlor	872-50-4	N-Methyl-2-pyrrolidone	87-86-5	Pentachlorophenol (PCP)
96-33-3	Methyl acrylate	924-42-5	N-Methylolacrylamide	57-33-0	Pentobarbital sodium
74-83-9	Methyl bromide	55-18-5	N-Nitrosodiethylamine	79-21-0	Peracetic acid
79-22-1	Methyl chlorocarbonate	62-75-9	N-Nitrosodimethylamine	594-42-3	Perchloromethyl mercaptan
71-55-6	Methyl chloroform	924-16-3	N-Nitrosodi-n-butylamine	52645-53-1	Permethrin
60-34-4	Methyl hydrazine	621-64-7	N-Nitrosodi-n-propylamine	76-19-7	PFC-218
74-88-4	Methyl iodide	86-30-6	N-Nitrosodiphenylamine	355-25-9	PFC-3-1-10

CAS Number	Name	CAS Number	Name	CAS Number	Name
115-25-3	PFC-318	10453-86-8	Resmethrin	62-56-6	Thiourea
678-26-2	PFC-4-1-12	78-48-8	S,S,S-Tributyltrithiophosphate	137-26-8	Thiram
355-42-0	PFC-5-1-14	81-07-2	Saccharin	1314-20-1	Thorium dioxide
306-94-5	PFC-9-1-18	94-59-7	Safrole	7550-45-0	Titanium tetrachloride
	PFPME	78-92-2	sec-Butyl alcohol	108-88-3	Toluene
85-01-8	Phenanthrene	7782-49-2	Selenium	26471-62-5	Toluene diisocyanate (mixed isomers)
108-95-2	Phenol	74051-80-2	Sethoxydim	584-84-9	Toluene-2,4-diisocyanate
26002-80-2	Phenothrin	7440-22-4	Silver	91-08-7	Toluene-2,6-diisocyanate
57-41-0	Phenytoin	122-34-9	Simazine	8001-35-2	Toxaphene
75-44-5	Phosgene	26628-22-8	Sodium azide	10061-02-6	trans-1,3-Dichloropropene
7803-51-2	Phosphine	1982-69-0	Sodium dicamba	110-57-6	trans-1,4-Dichloro-2-butene
7723-14-0	Phosphorus (yellow or white)	128-04-1	Sodium dimethyldithiocarbamate	43121-43-3	Triadimefon
85-44-9	Phthalic anhydride	62-74-8	Sodium fluoroacetate	2303-17-5	Triallate
1918-02-1	Picloram	7632-00-0	Sodium nitrite	68-76-8	Triaziquone
88-89-1	Picric acid	132-27-4	Sodium o-phenylphenoxide	101200-48-0	Tribenuron methyl
51-03-6	Piperonyl butoxide	131-52-2	Sodium pentachlorophenate	1983-10-4	Tributyltin fluoride
29232-93-7	Pirimiphos methyl	100-42-5	Styrene	2155-70-6	Tributyltin methacrylate
100-01-6	p-Nitroaniline	96-09-3	Styrene oxide	52-68-6	Trichlorfon
156-10-5	p-Nitrosodiphenylamine	7446-09-5	Sulfur Dioxide	76-02-8	Trichloroacetyl chloride
1336-36-3	Polychlorinated biphenyls	7446-09-5	sulfur dioxide	79-01-6	Trichloroethylene
7758-01-2	Potassium bromate	2551-62-4	Sulfur hexafluoride	75-69-4	Trichlorofluoromethane
128-03-0	Potassium dimethyldithio-carbamate	18827-32-2	sulfur monoxide	57213-69-1	Triclopyr triethylammonium salt
137-41-7	Potassium N-methyldithio-carbamate	7446-11-9	sulfur trioxide	121-44-8	Triethylamine
106-50-3	p-Phenylenediamine	7664-93-9	Sulfuric acid		trifluoromethyl sulphur pentafluoride
41198-08-7	Profenofos	2699-79-8	Sulfuryl fluoride (Vikane)	1582-09-8	Trifluralin
7287-19-6	Prometryn	35400-43-2	Sulprofos	26644-46-2	Triforine
23950-58-5	Pronamide		suspended solids	639-58-7	Triphenyltin chloride
1918-16-7	Propachlor	34014-18-1	Tebuthiuron	76-87-9	Triphenyltin hydroxide
1120-71-4	Propane sultone	3383-96-8	Temephos	126-72-7	Tris(2,3-dibromopropyl) phosphate
709-98-8	Propanil	5902-51-2	Terbacil	72-57-1	Trypan blue
2312-35-8	Propargite	75-65-0	tert-Butyl alcohol	51-79-6	Urethane (Ethyl carbamate)
107-19-7	Propargyl alcohol	79-94-7	Tetrabromobisphenol A	7440-62-2	Vanadium
31218-83-4	Propetamphos	127-18-4	Tetrachloroethylene	50471-44-8	Vinclozolin
60207-90-1	Propiconazole	961-11-5	Tetrachlorvinphos	108-05-4	Vinyl acetate
123-38-6	Propionaldehyde	64-75-5	Tetracycline hydrochloride	593-60-2	Vinyl bromide
114-26-1	Propoxur	7696-12-0	Tetramethrin	75-01-4	Vinyl chloride
115-07-1	Propylene (Propene)	7440-28-0	Thallium	75-35-4	Vinylidene chloride
75-56-9	Propylene oxide	148-79-8	Thiabendazole		volatile organic compounds
106-42-3	p-Xylene	62-55-5	Thioacetamide	1330-20-7	Xylene (mixed isomers)
110-86-1	Pyridine	28249-77-6	Thiobencarb	7440-66-6	Zinc (fume or dust)
91-22-5	Quinoline	59669-26-0	Thiodicarb	12122-67-7	Zineb
106-51-4	Quinone	23564-06-9	Thiophanate ethyl		
82-68-8	Quintozene	23564-05-8	Thiophanate methyl		
76578-14-8	Quizalofop-ethyl	79-19-6	Thiosemicarbazide		

In facility information																		
Monthly production data	Total Production of facility (mass/month)	units	Total production of GSB88 (mass/month)	units	Total electricity use, kWh	Total Natural Gas Use, Therms	Total Diesel/heating oil use, gallons	Total Water use, gallons	Total Propane use, gallons	Total gasoline use, gallons	Total lubricant use, mass/month	Mass Unit	Total ancillary chemical use, Mass/month	Mass unit	Total Solid Waste Produced, Mass/month	Mass Unit	Total Hazardous Waste Produced/month	Mass unit
Nov-09																		
1-Dec																		
Jan-10																		
Feb-10																		
Mar-10																		
Apr-10																		
May-10																		
Jun-10																		
Jul-10																		
Aug-10																		
Sep-10																		
Oct-10																		
Nov-10																		

Appendix E: Report of the PCR review committee

The Review committee made the following statements.

Overall, I would say that this product category rule was performed to ISO standards in both execution and in the documentation. The documentation is thorough and clear. They've taken care to hit the key points in section 6.7.1 of ISO 14025. The PCR fulfill the general programme instructions.

section 2.2 claims "no other PCR document currently exists..." Is this a statement for USA? For the whole world? Who keeps a "registrar" of current existing PCRs. On another issue: why 5 years for expiration? (is there a logic behind this period?)

some references to data sources are better stated than others.

Better mention of reproducibility and uncertainty

General comment: tables and diagrams should be named and referenced in text (see 7.24). Other comments: 7.3.1 and 7.3.2: only "diesel powered"? For section 7.4 as it relates to "sensitivity analysis": refer to section 9 and enlarge scope and writing of this section 9

Please note section 7.6 has wording ("...or equivalent for the host country") which could be applied in other sections, for example 7.10.10 for land use. For 7.17 indicate in addition to CAS or UNSPSC, the "data level" (primary...) -as per example in 7.21 (include in 7.21 example, the "age").

7.5 for recycling allocation is not clear. Need more explanation. 7.15 specifically "wind or solar"?

General comment: tables should be named and referenced in text (see 8.9). In section 8, why are these impact categories are selected? Why Ozone Depletion is not included? Need to reference each impact category and model sources.

"The characterisation factor for human toxicity (human toxicity potential) is expressed in comparative toxic units (CTUh), providing the estimated increase in morbidity in the total human population per unit mass of a chemical emitted (cases per kilogram), assuming equal weighting between cancer and non-cancer due to a lack of more precise insights into this issue." Need to explain why the characterization factor for human toxicity is DALYs instead of CTUh when using USEtox.

The standards incorporated by reference (page 3 of PCR) include the performance guidelines published by the slurry seal association. I presume that this document will pertain to airport pavements too and therefore should also include FAA approved materials (P-626, P-630, P-631, P-632, EB-35, and EB-44,). The Standards incorporated include ASTM D6433-09 – Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys. Since this is also intended for airport pavement, it should also include ASTM 5340-10 Standard Test Method for Airport Pavement Condition Index Surveys.

While I like the idea of including and requiring the minimum pavement life extensions, I could not understand:

Minimum Extension in life with rejuvenation and Fog seals was expected to be the same. Rejuvenation is a much costlier treatment and in our experience produces an extension of about 2-3yrs in the life of the pavement at least, unless applied incorrectly or to pavements not suited to the treatment due to the nature and extent of distresses.

Again the expectation of minimum life extension is the same for slurry seals and Micro surfacing. This is also counter intuitive since, micro surfacing is expected to last longer.

I feel that the life extensions should be linked to pavement condition prior to the application to give the user a better expectation of the results. I have attached a table in word format with this email for your consideration.

Appendix F: Descriptions of the response to the review

All the recommendations of the reviewers were accepted and addressed, with exception of the final one to put in another table describing pavement extension times under different conditions. The purpose of the minimum time table is to create a level playing field and minimize the potential for misrepresentation of the effectiveness of the product. We have strengthened the language to assure that a broader understanding of the default values and how to provide product-specific information.

References

ⁱ Definition paraphrased from the Federal Highway Administration Pavement Preservations Definitions Memo, September 12, 2005, Signed by David R. Geiger, Director of Asset Management.

ⁱⁱ ASTM D6433-09 – Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys

ⁱⁱⁱ ASTM 5340-10 Standard Test Method for Airport Pavement Condition Index Surveys.

^{iv} ISO 14040: Environmental management — Life cycle assessment — Principles and framework

^v ISO 14044. Environmental management — Life cycle assessment — Requirements and guidelines

^{vi} ISO 14025: Environmental labels and declarations —Type III environmental declarations —Principles and procedures

^{vii} Earth sure® Environmental Product Declarations General Program
<http://iere.org/Data/Sites/1/SharedFiles/earthsure/Earthsure%20General%20Program.pdf>

^{viii} American Concrete Pavement Association. 2006. *Concrete Pavement Field Reference Preservation and Repair*.

^{ix} National Concrete Pavement technology Center. 2008. *Guide to Concrete Overlays Sustainable Solutions to Resurfacing and Rehabilitating Existing pavements*. Second Edition.

^x METHOD 8270D SEMIVOLATILE ORGANIC COMPOUNDS BY GAS CHROMATOGRAPHY/MASS SPECTROMETRY (GC/MS). <http://www.epa.gov/osw/hazard/testmethods/sw846/pdfs/8270d.pdf>

^{xi} Guinée, J.B.; Gorrée, M.; Heijungs, R.; Huppes, G.; Kleijn, R.; Koning, A. de; Oers, L. van; Wegener Sleeswijk, A.; Suh, S.; Udo de Haes, H.A.; Bruijn, H. de; Duin, R. van; Huijbregts, M.A.J. Handbook on life cycle assessment. Operational guide to the ISO standards. I: LCA in perspective. IIa: Guide. IIb: Operational annex. III: Scientific background. Kluwer Academic Publishers, ISBN 1-4020-0228-9, Dordrecht, 2002, 692 pp.

^{xii} Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007 Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.) Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. (Note: updates anticipated in 2012)

^{xiii} Redfield, A.C. 1934. On the proportions of organic derivatives in seawater and their relation to the composition of plankton. In Daniel, R.J [Ed] *James Johnstone Memorial Volume*. University Press of Liverpool pp.177-192.

^{xiv} Redfield, A.C. 1958. The biological control of chemical factors in the environment. *Am. Sci.* 46:205-21.