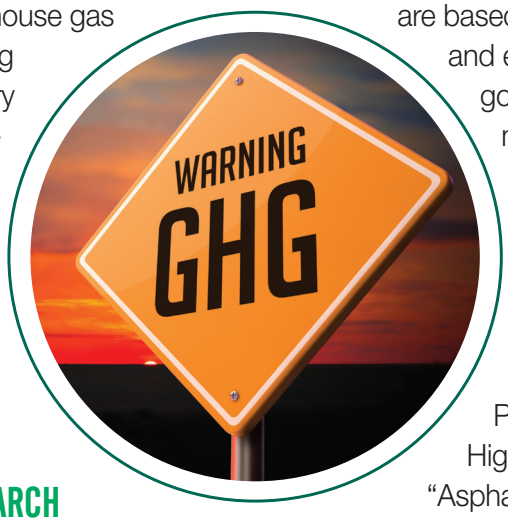
USE OF WARM-MIX ASPHALT AND RECLAIMED ASPHALT PAVEMENT TO REDUCE ENERGY AND GREENHOUSE GAS EMISSIONS

In 2016, nations came together and signed the Paris Agreement. This legally binding international treaty on climate change aims to limit global warming to well below 2° (preferably 1.5°) Celsius, compared to pre-industrial levels. To achieve long-term temperature reductions, countries and the businesses that operate within them must reduce their greenhouse gas (GHG) emissions. Committed to doing its part, the asphalt pavement industry has two existing technologies, warm-mix asphalt (WMA) and reclaimed asphalt pavements (RAP), that further our ongoing efforts to protect the environment, reduce energy consumption, and minimize GHG emissions.



OVERVIEW OF ASPHALT PAVEMENT INDUSTRY TECHNOLOGY AND RESEARCH METHODOLOGY

The asphalt pavement industry has continuously aimed to generate environmental benefits for communities through advanced technologies.

Two key technologies are WMA, which reduces energy use during production, and RAP, which reduces the need for virgin materials. These technologies demonstrate the potential of asphalt pavements to reduce GHG emissions. Using historical industry production data, our reduction calculations are based on publicly available data and emission factors published by government agencies, industry, and non-governmental organizations. A detailed overview of the methodology and assumptions used to calculate energy and GHG emission reduction estimates is available in Appendix C of the National Asphalt Pavement Association-Federal Highway Administration report "Asphalt Pavement Industry Survey on Recycled Materials and Warm-Mix Asphalt Usage 2019." GHG emissions are reported in metric tons (tonne) of CO_2-equivalent (CO_2e) emissions to be consistent with emission inventories published by the U.S. EPA and other government agencies.

Table 1. Estimated GHG emission reduction for two scenarios of WMA produced at reduced temperature

Scenario	Mix Production Energy Reduction (thousand MMBtu)	GHG Emission Reduction (million tonne CO_2e)	Equivalent Number of Passenger Vehicles[1]
Conservative (10˚ F temp Reduction)	790	0.05	11,000
Optimistic (40˚ F temp Reduction)	3,200	0.21	46,000

[1]Assumes that each vehicle emits 4.6 tonne CO_2e/yr (U.S. EPA, 2018).

2019 ENERGY AND GHG EMISSION REDUCTION ESTIMATES FROM PRODUCTION OF WMA AT REDUCED TEMPERATURE

To estimate reductions in energy consumption and GHG emissions associated with the production of WMA at reduced temperature in 2019, the report provides two estimates. The first documents the average temperature reduction achieved by plants that reduce mix production temperature when using WMA technologies. The second estimates the expected energy savings (Btu) from reduced temperature, converted to fuel volume (natural gas). Emission factors are used to estimate the combustion related GHG emission reduction from producing WMA at reduced temperature. Two scenarios for mix production temperature were evaluated. The conservative and optimistic scenarios assume average reductions in mix production temperature of 10°F and 40°F, respectively.

The estimated reductions in energy consumption and GHG emissions for WMA produced at reduced temperature are provided in Table 1. The data in Table 1 are rounded to two significant digits to reflect the underlying uncertainties and approximate level of precision for these estimates. The calculated reduction of GHG emissions from production of WMA at reduced temperature is 0.05 or 0.21 million tonne for the conservative and optimistic scenarios, respectively. Simply stated, in 2019 alone, the use of WMA at reduced temperatures in the U.S. removed the equivalent annual emissions of 11,000 to 46,000 passenger vehicles.

Upstream GHG emission burdens for producing WMA at reduced temperature are not included in Table 1 because either the quantity is insignificant (as is the case for foamed asphalt) or insufficient data are publicly available to confidently estimate these emission burdens (as is the case for chemical and organic additives).

Table 2. Summary of GHG Emission Reductions from use of RAP in New Asphalt Mixtures in 2019 (million tonne CO_2e)

Description	GHG Reduction (Burden)
Avoided Emissions	
Asphalt Binder Replacement	2.6
Aggregate Replacement	0.36
Transportation of Asphalt Binder and Aggregates	0.46
Subtotal Avoided Emissions	**3.4**
Emission Burdens	
RAP Processing	(0.11)
Transportation of RAP	(0.90)
Subtotal Emission Burdens	(1.0)
NET GHG Emissions Reduction	**2.4**
Equivalent Number of Passenger Vehicles[1]	**520,000**

[1]Assumes that each vehicle emits 4.6 tonne CO_2e/yr (U.S. EPA, 2018).

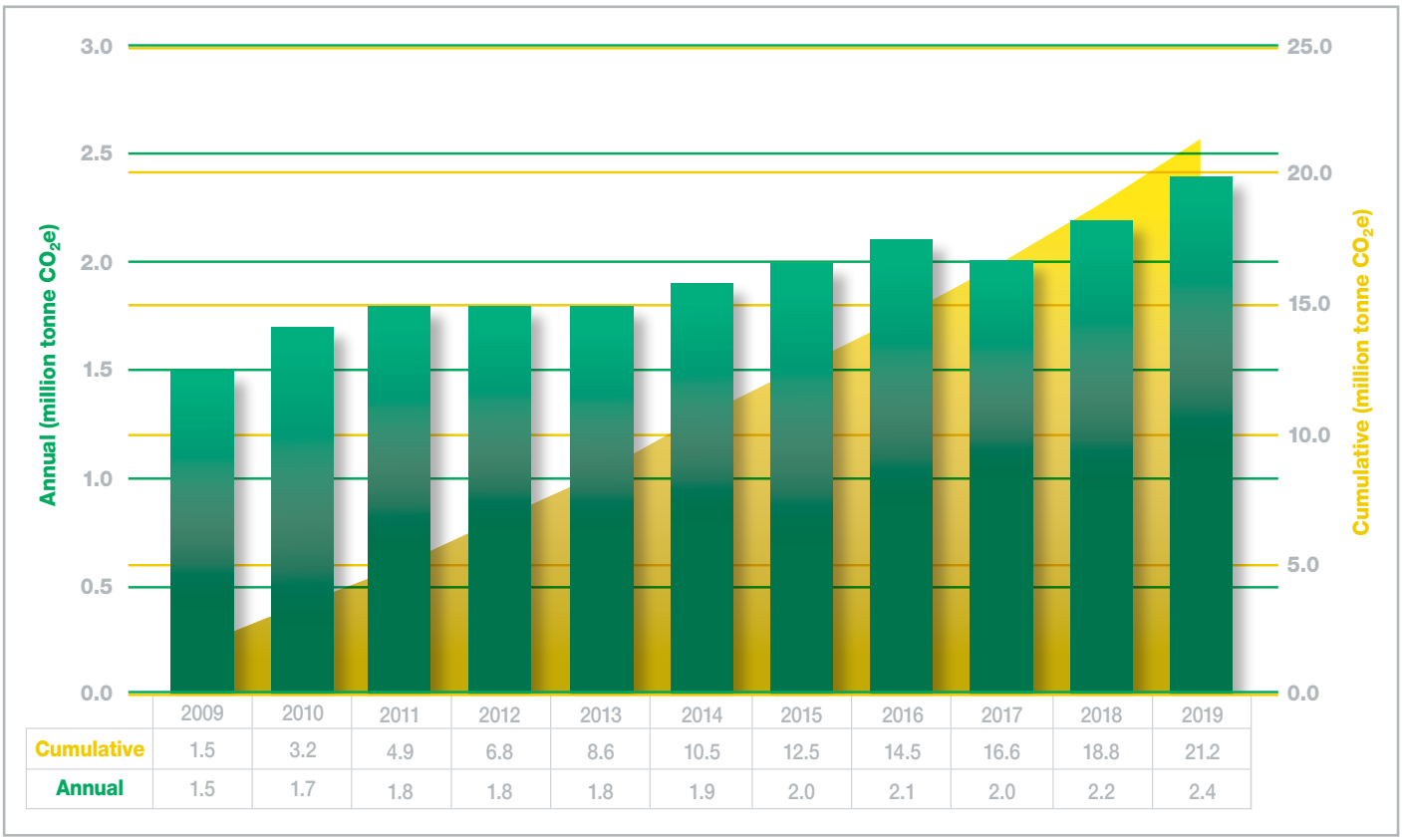
2019 GHG EMISSION REDUCTION ESTIMATES FROM USE OF RAP

A summary of GHG emission reductions from use of RAP is provided in Table 2. Net reduction of GHG emissions from use of RAP in new asphalt mixtures in 2019 is estimated to be 2.4 million tonne CO_2e, equivalent to the annual emissions from approximately 520,000 passenger vehicles. The data in Table 2 are rounded to two significant digits to reflect the underlying uncertainties and approximate level of precision for these estimates.

TEN-YEAR GHG EMISSION REDUCTION ESTIMATES

Reclaimed Asphalt Pavement

Annual and cumulative GHG emission reductions from use of RAP in new asphalt mixtures from previous years of survey data are provided in Figure 1. The cumulative reduction of GHG emissions from use of RAP in new asphalt mixtures for the period 2009-2019 is estimated to be 21.2 million tonne $CO_2$2e, equivalent to the annual emissions from approximately 460,000 passenger vehicles.

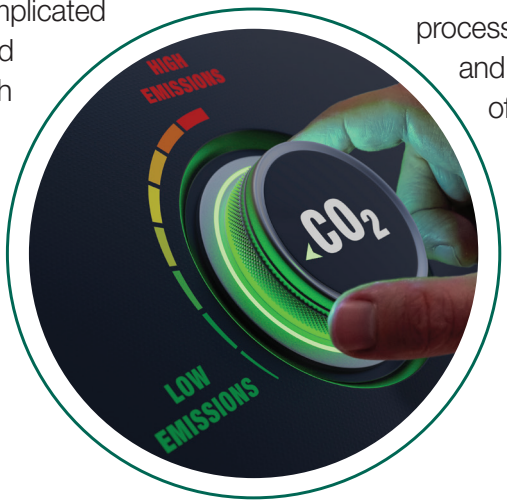


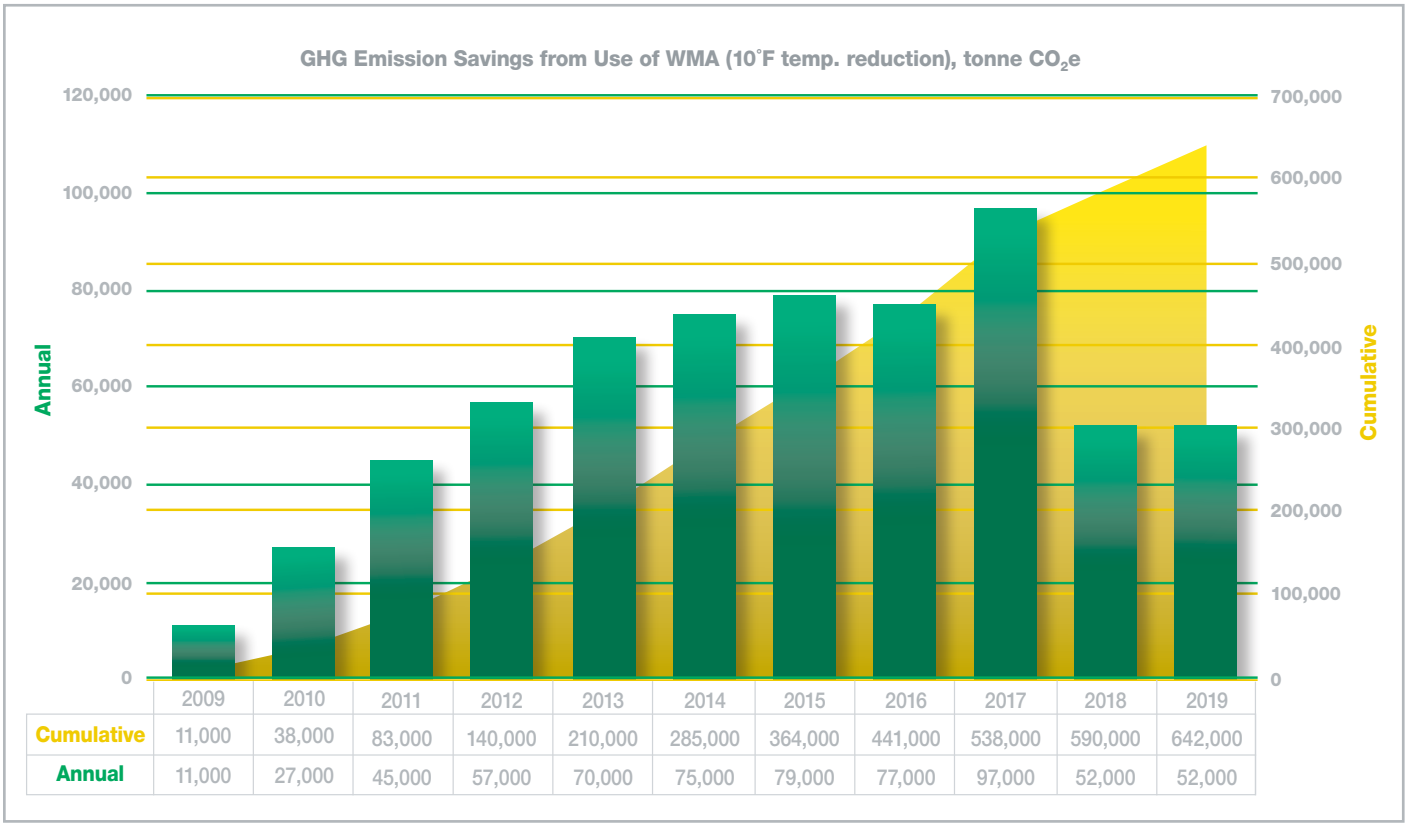
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Cumulative	1.5	3.2	4.9	6.8	8.6	10.5	12.5	14.5	16.6	18.8	21.2
Annual	1.5	1.7	1.8	1.8	1.8	1.9	2.0	2.1	2.0	2.2	2.4

Figure 1. GHG Emissions Reduction from Use of RAP in New Asphalt Mixtures, 2009-2019

Warm Mix Asphalt

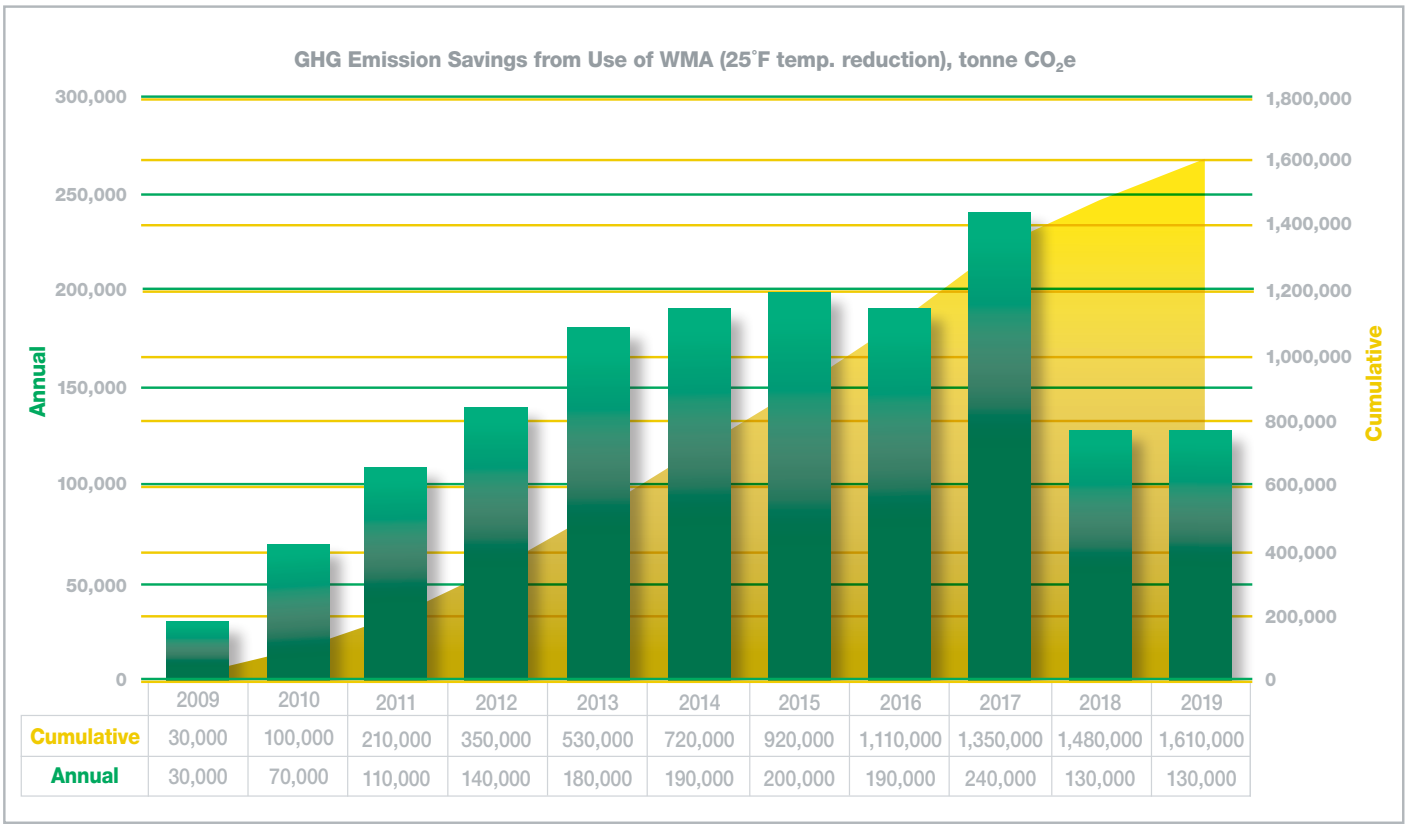
Estimating the 10-year reduction in GHG emissions realized from the use of WMA is complicated by the unknown value of the reduced production temperature and a switch in data collection efforts. In 2018, NAPA and FHWA asked survey respondents to report more specifically WMA at a reduced temp of 10° or more, as well as WMA at standard hot temps. Therefore, three scenarios on the historical GHG reduction are presented in Figures 2, 3, and 4, representing the historical range in GHG emissions. Moving forward, the new collection process will allow for greater transparency and veracity. The cumulative reduction of GHG emissions from use of WMA in new asphalt mixtures for the period 2009-2019 is estimated to be between 0.642 and 2.58 million tonne CO_2e, equivalent to the annual emissions of 14,000 to 56,000 passenger vehicles.





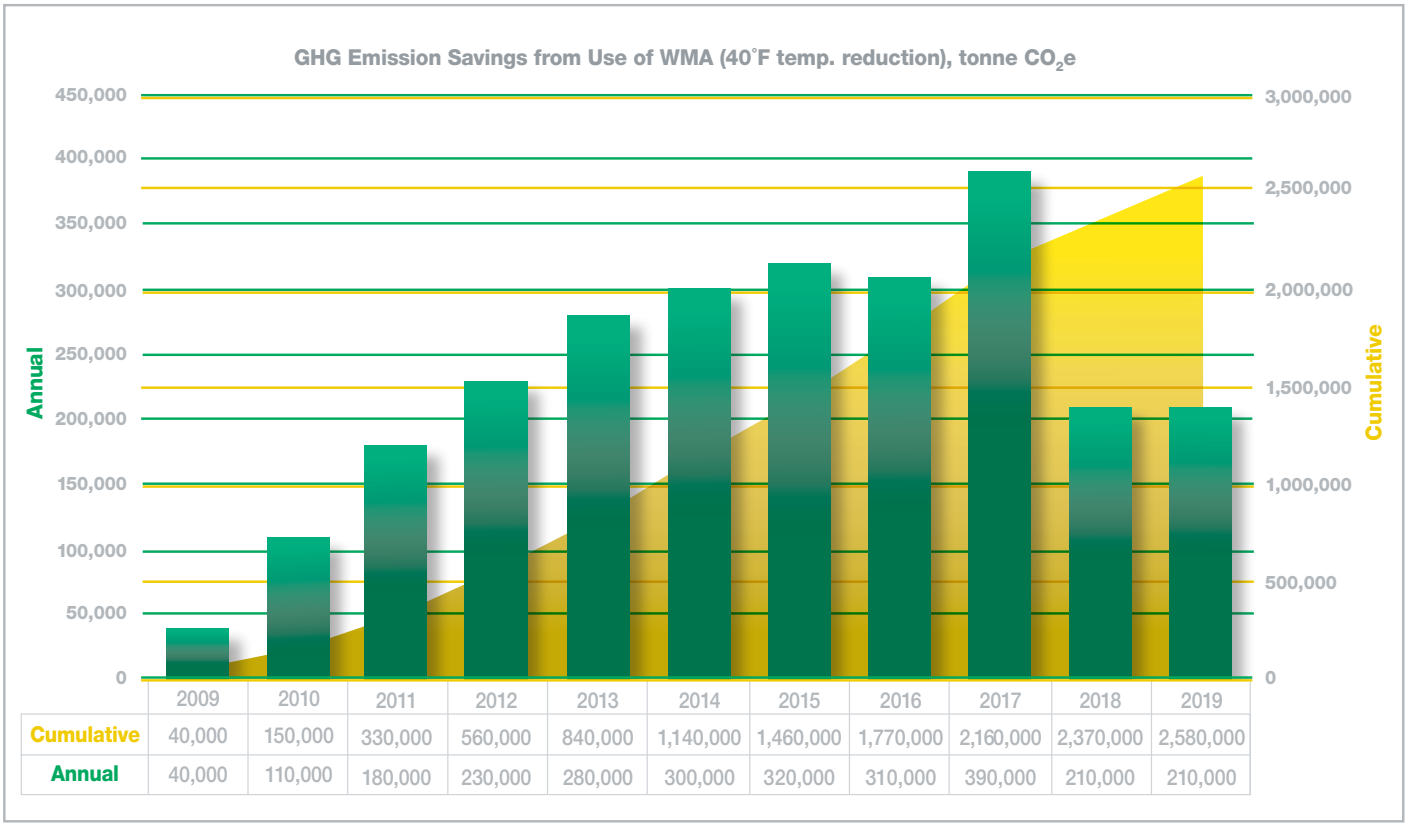
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Cumulative	11,000	38,000	83,000	140,000	210,000	285,000	364,000	441,000	538,000	590,000	642,000
Annual	11,000	27,000	45,000	57,000	70,000	75,000	79,000	77,000	97,000	52,000	52,000

Figure 2. GHG Emissions Reduction from Use of WMA (10°F temp. reduction) in New Asphalt Mixtures, 2009-2019



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Cumulative	30,000	100,000	210,000	350,000	530,000	720,000	920,000	1,110,000	1,350,000	1,480,000	1,610,000
Annual	30,000	70,000	110,000	140,000	180,000	190,000	200,000	190,000	240,000	130,000	130,000

Figure 3. GHG Emissions Reduction from Use of WMA (25°F temp. reduction) in New Asphalt Mixtures, 2009-2019



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Cumulative	40,000	150,000	330,000	560,000	840,000	1,140,000	1,460,000	1,770,000	2,160,000	2,370,000	2,580,000
Annual	40,000	110,000	180,000	230,000	280,000	300,000	320,000	310,000	390,000	210,000	210,000

Figure 4. GHG Emissions Reduction from Use of WMA (40°F temp. reduction) in New Asphalt Mixtures, 2009-2019

IMPLICATIONS FOR THE FUTURE

As the industry continues to look for new ways to reduce its impact on climate, furthering the use of two proven technologies like RAP and WMA should be prioritized. The impacts of both are well documented, and research has proven that the production and construction of high quality, sustainable asphalt pavements provide benefits to the environment, communities, and businesses.

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