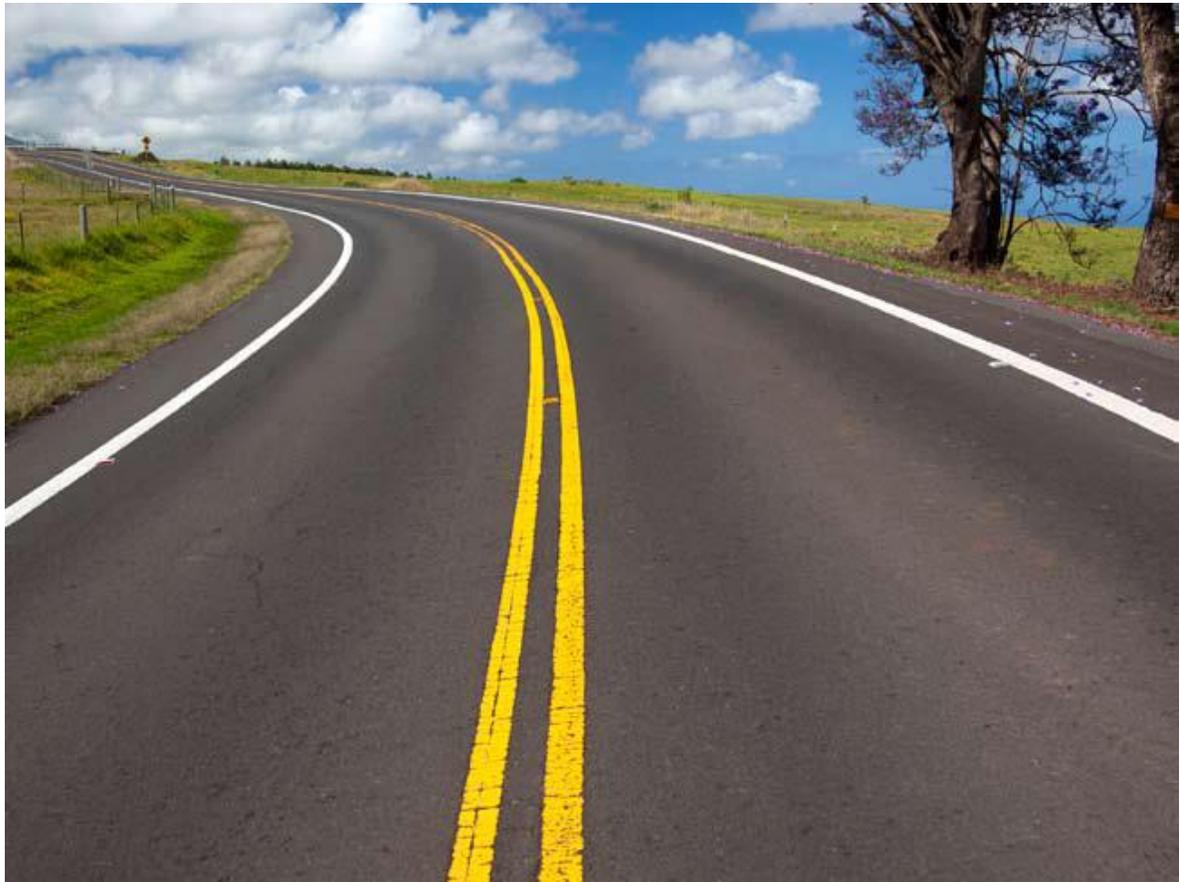


Information Series 138

# Annual Asphalt Pavement Industry Survey on

Recycled Materials  
and Warm-Mix Asphalt Usage:  
2009–2012



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**3<sup>rd</sup> Annual Asphalt Pavement Industry Survey**

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16. Abstract <p>One of the shared goals of the Federal Highway Administration (FHWA) and the National Asphalt Pavement Association (NAPA) is to support and promote sustainable practices such as pavement recycling and warm-mix asphalt (WMA). The use of recycled materials, primarily reclaimed asphalt pavement (RAP) and reclaimed asphalt shingles (RAS), in asphalt pavements reduces the amount of new materials required to produce asphalt mixes and material going to landfills. This is vital to the mission of environmental stewardship and extending the service life of the nation's infrastructure while lowering overall costs.</p> <p>WMA technologies have been introduced to reduce the mixing and compacting temperatures for asphalt mixtures as a means of reducing emissions. Additional benefits include improved compaction of asphalt mixtures leading to improved pavement performance. As part of FHWA's Every Day Counts initiative, WMA was chosen for accelerated deployment in federal-aid highway, state department of transportation (DOT), and local road projects.</p> <p>It is important for the industry to track the deployment of these technologies, which reduce costs, energy, waste, emissions, and the amount of new materials required for road construction. FHWA has established two survey mechanisms for tracking the use of recycled materials and WMA in asphalt pavements. The first survey tracks state DOT usage and the other tracks industry usage. These have established a baseline of RAP, RAS, and WMA usage and tracked the growth of the use of these sustainable practices in the highway industry since 2009.</p> <p>The objective of this survey is to quantify the use of recycled materials, and WMA produced by the asphalt pavement industry. Survey results show significant growth in the use of RAP, RAS, and WMA technologies from 2009 through 2012. The asphalt industry remains the country's number-one recycler by recycling asphalt pavements at a rate of over 99 percent and almost all (98 percent) contractors/branches report using RAP in 2012. The amount of RAP used in asphalt mixtures has increased by 22 percent, from 56 million tons in 2009 to 68.3 million tons in 2012. Assuming 5 percent liquid asphalt in RAP, this represents over 3.4 million tons (19 million barrels) of asphalt binder conserved during 2012. The estimated savings at \$600 per ton for asphalt binder is \$2.04 billion.</p> <p>Use of both manufacturers' scrap and post-consumer asphalt shingles used in asphalt mixes increased 165 percent from 2009 to nearly 1.9 million tons 2012. Assuming a conservative asphalt content of 20 percent for the RAS, this represents about 380,000 tons (2.1 million barrels) of asphalt binder conserved. The estimated savings at \$600 per ton for asphalt binder is \$228 million.</p> <p>For 2012 contractors were asked about their use of other recycled materials in asphalt mixtures. Contractors in 13 states reported using steel and blast furnace slag in asphalt mixtures. Ground tire rubber (GTR) was reported as being used in asphalt mixtures in nine states. Other recycled materials used to a lesser degree include fly ash, bottom ash, foundry slag, cellulose fiber, and glass. Due to the low response rate on other recycled materials no attempt was made to estimate the total quantities of other recycled materials used.</p> <p>In 2012, WMA was over 24 percent of the total asphalt mixture market. WMA use increased by nearly 26 percent from 2011 to 2012, and about 416 percent since 2009. Plant foaming is used most often in producing WMA, with over 88 percent of the market. WMA additives accounted for about 12 percent of the market.</p>			
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# Annual Asphalt Pavement Industry Survey on Recycled Materials and Warm-Mix Asphalt Usage: 2009–2012

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## Executive Summary

The 2012 survey results show that the asphalt pavement industry continues to improve its outstanding record of sustainable practices by further increasing the use of recycled materials and warm-mix asphalt (WMA). The use of recycled materials such as reclaimed asphalt pavement (RAP) and reclaimed asphalt shingles (RAS) conserve raw materials and reduce overall asphalt mixture costs while WMA technologies improve conditions for achieving performance and long life, conserve energy, reduce emissions from production and paving operations, and improve conditions for workers.

The objective of this survey was to quantify the use of recycled materials, including RAP and RAS, and WMA produced by the asphalt pavement industry. The National Asphalt Pavement Association (NAPA) conducted a voluntary survey of asphalt mixture producers in the United States and state asphalt pavement associations (SAPAs). The survey was broken into five sections: general information, RAP, RAS, WMA, and other recycled materials. Asphalt mix producers from 48 states and Puerto Rico completed the 2012 survey. No survey information was available for the District of Columbia, North Dakota, or New Mexico. A total of 213 companies/branches with 1,141 plants are represented in the 2012 survey.

The following are highlights of the 2012 survey:

- The asphalt industry remains the country's number-one recycler by recycling asphalt pavements at a rate of over 99 percent. About 98 percent of the contractors/branches reported using RAP in 2012, the same as in 2011. The amount of RAP used in asphalt mixtures was 68.3 million tons in 2012, a 22.0 percent increase over the tons used in 2009 (56 million tons) and over a 2 percent increase over the tons used in 2011 (66.7 million tons). However total asphalt tonnage was down from 2011 to 2012, so in term of percent of total tonnage there was a 4 percent increase in the use of RAP from 2011 to 2012. Assuming 5 percent liquid asphalt in RAP, this represents over 3.4 million tons (19 million barrels) of asphalt binder conserved. Similar to 2010 and 2011, less than a 0.3 percent of RAP was sent to landfills.
- For the first time in the survey history more RAP was used than was collected. This is primarily due to less RAP being collected than in the prior two years. For 2010 and 2011 an estimated 73.5 and 79.1 million tons of RAP were accepted, respectively. For 2012, 71.3 million tons of RAP were accepted for a 10 percent drop from 2011 to 2012.
- Use of both manufacturers' scrap and post-consumer shingles increased from nearly 1.2 million tons in 2011 to nearly 1.9 million tons in 2012, a 56 percent increase. Assuming a conservative asphalt content of 20 percent for the RAS, this represents 380,000 tons (2.2 million barrels) of asphalt binder conserved. As with RAP, this is the first time the amount of scrap shingles collected was less than the amount used for all purposes. This is due to fewer scrap shingles being collected by asphalt mix producers in 2012 than the prior two years, producers buying from shingle processors, and an increase in the amount of RAS used in asphalt mixtures.
- Information on other recycled materials was obtained for the first time in this year's survey. The most commonly used materials in asphalt mixtures were blast furnace slag, steel slag, and ground tire rubber. Less commonly used recycled materials included; fly ash, bottom ash, foundry sand, cellulose fiber, and glass.
- Total tonnage of WMA is estimated at 86.7 million tons in 2012. This was over a 26 percent increase over 2012 WMA tonnage (68.7 million tons). In 2012, WMA was about 24 percent of the total asphalt mixture market. Plant foaming is used most often in producing WMA, with more than 88 percent of the market; additives accounted for about 12 percent of the market.

## Background

One of the shared goals of the Federal Highway Administration (FHWA) and the National Asphalt Pavement Association (NAPA) is to support and promote sustainable practices such as incorporating recycled materials in pavements and the use of warm-mix asphalt (WMA). Reclaimed asphalt pavement (RAP) ranks as the single-most-recycled material in the United States and is vital to the mission of extending the service life of the nation's infrastructure while lowering overall costs. Another recycled material increasingly used in asphalt mixtures is reclaimed asphalt shingles (RAS) from both manufacturers' waste and post-consumer shingles. The use of RAP and RAS in asphalt pavements reduces the amount of material going to landfills and can reduce the amount of new asphalt binder required in mixes, which helps to stabilize the price of asphalt mixtures. Other recycled materials incorporated into asphalt pavements include: ground tire rubber (GTR), steel slag, and blast furnace slag, among others. These materials reduce the amount of material going to landfills, improving the sustainability of asphalt mixtures.

WMA technologies reduce the mixing and compacting temperatures for asphalt mixtures. Environmental benefits include reductions in both fuel consumption and air emissions. Construction benefits include the ability to extend the paving season into the cooler months, haul the material longer distances, improve compaction, and use higher percentages of RAP (Prowell, et al., 2012). As part of FHWA's Every Day Counts initiative, WMA was chosen for accelerated deployment in federal-aid highway, state department of transportation (DOT), and local road projects. In 2013, WMA was honored with the Construction Innovation Forum's NOVA Award for its engineering, economic, and environmental benefits (CIF, 2013).

FHWA works closely with the pavement industry through associations and other stakeholders to promote pavement recycling technologies and WMA. As part of this effort, FHWA has established two survey mechanisms for tracking the use of recycled materials and WMA in asphalt pavements. The first survey tracks state DOT usage and the other tracks industry usage. Since 2007, FHWA has partnered with the American Association of State Highway and Transportation Officials (AASHTO) to conduct a biennial survey of state DOTs' use of recycled materials (Copeland, 2011; Copeland, et al., 2010; Pappas, 2011). The results of the FHWA/AASHTO survey are typically presented at FHWA Expert Task Group meetings. For the second survey, FHWA partners with NAPA to survey asphalt producers to determine industry use of RAP, RAS, other recycled materials, as well as WMA technologies. These surveys have established a baseline of RAP, RAS, and WMA usage and tracked the growth of the use of these sustainable practices in the highway industry.

The FHWA/NAPA industry survey first began in 2010 and was repeated in 2011. The survey results showed significant growth in the use of RAP, RAS, and WMA technologies from 2009 to 2011 (Hansen & Newcomb, 2011) (Hansen, 2013). In order to continue to track the use of these technologies, FHWA again partnered with NAPA to conduct a similar survey of RAP, RAS, and WMA use for 2012. This report documents the results of the 2012 industry survey, including the survey methodology, results, trends, and changes from 2009 through 2012. For 2012, the survey also asked about the use of other recycled materials used in asphalt mixtures. The survey questions and data by state are included in the appendices.

## Objective and Scope

The objective of this effort is to quantify the use of recycled materials and WMA produced by the asphalt pavement industry. NAPA conducted a voluntary survey of asphalt mixture producers in the United States and of state asphalt pavement associations (SAPAs). While keeping specific producer data confidential, NAPA staff compiled the amount of asphalt mixtures being produced; the amount of RAP, RAS, and other recycled material used; and the amount of WMA being produced in the United States. The data are broken out on a state-by-state basis in Appendix B. The data are analyzed and summarized in this report. In order to accomplish this work, the following tasks were conducted:

1. Develop an online survey similar to the 2009–2011 surveys that enables an analysis of the quantities of RAP and RAS being used in asphalt mixtures, as well as the total amount of WMA produced nationally. For 2012 information on other recycled materials used in asphalt mixtures was gathered, too.

2. Conduct a voluntary survey of asphalt mix producers throughout the United States and follow up with verbal requests for information in locations where responses were low.
3. Estimate the total asphalt mixture market in each state or territory by using data from responding SAPAs and the U.S. Department of Transportation Federal Highway apportionment to determine a weighting factor for each state and reconciling the total U.S. asphalt mix tonnage with national estimates.
4. Analyze and summarize the information nationally and by state and prepare a final report.

## Survey Methodology

The survey was conducted using a web survey service, SurveyMonkey®. Sections 1 through 4 of the survey for 2012 were identical to the surveys used for 2009 through 2011 (Hansen & Newcomb, 2011; Hansen, 2013). Section 5 was added for 2012 to collect information on the use of other recycled material in asphalt mixtures. A copy of the 2012 survey is included as Appendix A.

Producers were notified of the survey through several forums and electronic media. A notice was posted in NAPA’s e-newsletter, *ActionNews*, informing members of the survey and asking for their participation. SAPAs participated by placing notices on their websites and in their newsletters. Announcements were made at NAPA meetings, as well as at several state asphalt conferences. A press release was sent to construction industry trade media and republished in print and to their websites. Notices of the survey and links were shared through social media channels, including Twitter, Facebook, and LinkedIn. Asphalt mixture producers then went to the website and completed the survey form. After the initial data was gathered and analyzed, anomalies in individual producer records were identified and reconciled.

The survey was broken into five sections. These sections were general information, RAP, RAS, WMA, and other recycled materials. Table 1 summarizes the questions asked in each section.

**Table 1: Survey Questions Summary**

Section 1: General Information	Sections 2 and 3: RAP & RAS	Section 4: WMA	Section 5: Other Recycled Materials
Number of Plants	Tons Accepted	Average % Produced for DOT Tons	Other Recycled Materials Used
DOT Tons	Tons Used in HMA/WMA	Average % Produced for Other Agency Tons	Tons of HMA/WMA Produced Using Each Recycled Material
Other Agency Tons	Tons Used in Aggregate	Average % Produced for Commercial & Residential Tons	Tons of Other Recycled Product Used
Commercial & Residential Tons	Tons Used in Cold Mix	Chemical Additive %	
	Tons Used in Other	Additive Foaming %	
	Tons Landfilled	Plant Foaming %	
	Average % for DOT Mixes	Organic Additive %	
	Average % for Other Agency Mixes		
	Average % for Commercial & Residential Mixes		

Most surveys were completed online with one multistate contractor collecting data from its different operations and submitting them in spreadsheet form. Data from the online survey was imported into a spreadsheet and checked for accuracy and missing data. When anomalies in the data were noted, the person submitting the data was contacted to resolve the anomaly.

To determine the total amount of RAP, and RAS used and WMA produced in each state and in the nation, the total amount of asphalt mix produced in each state needed to be determined. Total tonnage of asphalt mix produced represents commercial (i.e., private) and government (i.e., DOTs and local agencies) tonnages. Estimated tonnages were

provided by SAPAs in 36 states/territories which totaled about 299 million tons. This included one SAPA that supplied DOT-estimated tonnages. For this state, the total tonnage was estimated by dividing the DOT tonnage by the percent of DOT tons provided by asphalt mix producers in that state who completed the survey. To estimate the total tons in states where a SAPA estimate of total tonnage was not available, the total asphalt mixture tonnage was estimated through a relationship developed for those states where SAPA estimated tons were available and their federal highway apportionment. This is the same methodology used to estimate tonnage in the 2009–2011 surveys; for more details see Hansen & Newcomb (2011). This resulted in the following power curve relationship:

$$\text{Total Estimated Tons} = 0.6934 \times (\text{State Federal Apportionment})^{0.8009}$$

This formula was then used to estimate the tonnage for states with no SAPA estimate based on the state’s federal apportionment.

## Survey Results

Asphalt mix producers from 48 states and Puerto Rico completed the survey. There is no 2012 survey information available for the District of Columbia, New Mexico or North Dakota. In 2009–2010 and 2011, 48 and 49 jurisdictions completed the survey, respectively. A total of 213 companies/branches with 1,141 plants are represented in the 2012 survey. In the 2009–2010, and 2011 surveys, 1,027, and 1,091 plants were represented, respectively. Table 2 summarizes the number of companies/branches and the number of plants reporting for each state.

**Table 2: No. of Companies/Branches Completing Survey in State**

State	2009–2010		2011		2012		State	2009–2010		2011		2012	
	Cos.	Plants	Cos.	Plants	Cos.	Plants		Cos.	Plants	Cos.	Plants	Cos.	Plants
Alabama	3	17	5	38	4	31	Montana	2	4	4	8	4	8
Alaska	3	20	2	2	2	4	Nebraska	—	—	1	3	1	3
Arizona	2	4	4	6	4	7	Nevada	2	3	2	3	3	14
Arkansas	3	9	2	9	5	17	New Hampshire	1	11	1	11	3	14
California	6	49	4	48	4	36	New Jersey	2	21	3	21	2	19
Colorado	8	26	7	24	5	16	New Mexico	—	—	1	3	—	—
Connecticut	2	18	3	23	1	16	New York	13	68	11	64	11	68
Delaware	1	3	—	—	3	6	North Carolina	6	52	5	29	6	35
District of Columbia	—	—	—	—	—	—	North Dakota	—	—	3	8	—	—
Florida	6	61	4	22	5	34	Ohio	5	50	5	87	6	102
Georgia	2	16	6	66	6	67	Oklahoma	4	20	3	18	3	14
Hawaii	1	4	1	7	1	1	Oregon	6	10	6	16	6	15
Idaho	5	17	3	8	3	8	Pennsylvania	17	63	7	34	15	66
Illinois	16	44	7	24	5	10	Puerto Rico	1	16	1	14	1	13
Indiana	3	19	4	29	5	28	Rhode Island	2	2	2	2	1	1
Iowa	7	16	6	14	10	28	South Carolina	4	16	3	6	4	15
Kansas	6	25	4	21	3	20	South Dakota	1	3	3	9	3	8
Kentucky	3	24	4	19	5	38	Tennessee	2	10	7	72	5	32
Louisiana	2	5	2	5	2	7	Texas	7	38	9	41	10	51
Maine	2	19	2	17	2	18	Utah	5	30	6	17	6	16
Maryland	4	10	4	10	7	23	Vermont	1	9	1	7	1	7
Massachusetts	2	8	2	6	3	14	Virginia	5	38	7	26	8	46
Michigan	4	40	6	39	4	28	Washington	6	39	4	30	4	29
Minnesota	2	4	6	26	4	20	West Virginia	1	14	3	15	3	14
Mississippi	1	12	4	26	3	16	Wisconsin	1	3	3	13	3	16
Missouri	6	35	7	38	5	35	Wyoming	2	2	3	7	3	7

The average tons produced per plant was 121,000, 117,000, 121,000, and 122,000 for 2009, 2010, 2011, and 2012, respectively.

**Table 3: Summary of Estimated and Reported Plant Mix Asphalt Tons by State**

State	Tons (Millions)							
	2009		2010		2011		2012	
	Estimated	Reported	Estimated	Reported	Estimated	Reported	Estimated	Reported
Alabama	7.50	1.75	8.00	1.09	8.00	4.24	8.00	3.37
Alaska	3.67	0.82	4.41	1.15	5.98	0.20	5.46	0.35
Arizona	7.50	0.42	7.14	0.71	8.00	0.91	7.55	1.04
Arkansas	3.05	0.71	4.15	0.78	5.56	0.53	4.20	1.41
California	19.97	8.44	13.79	7.68	23.00	9.38	22.50	4.06
Colorado	7.72	3.00	10.52	2.62	6.50	2.50	6.50	1.48
Connecticut	4.96	2.20	5.01	1.79	4.34	2.95	4.00	1.84
Delaware	0.79	0.35	0.65	0.25	2.08	—	2.20	0.71
District of Columbia	1.62	—	1.81	—	1.71	—	1.85	—
Florida	14.70	6.91	13.00	5.81	13.57	3.01	12.38	3.82
Georgia	13.00	1.39	11.70	1.34	9.50	7.29	8.00	7.78
Hawaii	1.73	0.40	1.91	0.33	1.81	0.54	1.20	0.23
Idaho	3.00	1.13	3.09	1.14	3.45	0.56	3.49	0.79
Illinois	19.25	7.81	17.60	7.17	13.94	2.12	13.50	1.16
Indiana	9.60	3.28	7.90	3.06	9.50	4.07	10.00	4.44
Iowa	4.74	3.54	3.45	1.99	3.30	1.31	4.26	2.80
Kansas	4.17	2.08	7.12	1.85	4.00	1.67	4.50	1.55
Kentucky	7.00	1.72	7.00	1.74	7.00	1.86	9.00	2.90
Louisiana	6.00	1.30	6.00	1.30	6.00	0.58	5.50	0.59
Maine	1.80	1.61	2.03	1.60	1.91	1.56	2.36	1.82
Maryland	7.20	1.07	6.50	1.06	6.50	1.73	6.50	4.01
Massachusetts	6.00	1.54	6.00	1.34	6.00	1.17	6.00	1.64
Michigan	11.50	7.49	10.80	7.03	10.00	6.54	10.00	5.16
Minnesota	12.50	0.42	13.10	0.29	13.00	4.94	13.00	4.73
Mississippi	4.62	1.45	4.79	1.41	6.00	2.67	4.00	1.98
Missouri	7.13	3.02	4.70	3.19	8.00	4.06	6.24	3.23
Montana	3.78	0.19	3.99	0.17	4.89	0.59	4.80	0.51
Nebraska	2.96	—	3.09	—	3.37	0.11	3.43	0.40
Nevada	3.11	0.43	3.57	0.43	4.24	0.43	4.18	1.58
New Hampshire	1.86	1.25	1.94	1.18	1.92	0.90	2.05	1.09
New Jersey	9.33	3.28	9.09	2.87	8.73	3.24	8.09	3.08
New Mexico	3.78	—	3.84	—	4.48	0.52	4.44	—
New York	16.00	5.65	16.00	5.54	16.50	5.88	14.50	6.00
North Carolina	9.37	4.95	12.11	5.66	11.00	2.90	13.00	3.93
North Dakota	2.55	—	2.70	—	3.89	1.05	3.03	—
Ohio	14.50	5.69	15.10	6.23	14.30	10.81	16.30	12.68
Oklahoma	5.74	2.47	5.99	2.16	5.20	1.91	6.50	1.09
Oregon	5.22	1.27	4.81	1.16	4.91	1.95	5.14	1.71
Pennsylvania	17.40	10.97	18.30	11.66	16.83	4.17	15.86	9.03
Puerto Rico	2.49	0.97	1.44	0.75	1.19	0.74	2.06	1.34
Rhode Island	2.07	0.22	2.34	0.19	1.73	0.21	1.87	0.06
South Carolina	6.23	1.77	6.14	1.98	6.00	0.85	5.15	1.62
South Dakota	2.73	0.16	2.96	0.22	2.17	0.93	3.51	0.56
Tennessee	7.95	1.07	7.87	0.73	9.04	7.05	8.00	2.79
Texas	14.77	4.23	16.54	5.73	13.67	6.36	15.85	8.79
Utah	3.14	3.71	3.35	3.23	4.00	2.77	3.99	3.19
Vermont	1.74	0.51	2.12	0.80	1.96	0.71	2.13	0.74
Virginia	9.10	4.64	10.90	4.51	13.10	4.06	12.00	6.78
Washington	5.70	4.65	5.70	4.46	4.20	3.26	4.20	2.99
West Virginia	2.90	1.40	3.00	1.79	3.75	2.10	3.50	1.65
Wisconsin	10.52	0.50	11.96	0.50	13.00	1.53	11.20	4.22
Wyoming	2.77	0.15	2.83	0.20	3.25	0.32	3.32	0.30
Total	358.43	123.98	359.85	119.87	365.97	130.54	360.29	139.03

Note: Shaded cells indicate states and years where the SAPA provided data used to compute total estimated value. Where no data was available on total tons, a relationship between tonnage and federal apportionment was used to estimate the total tons for states.

Table 3 includes the estimated tonnage for each state as given by the SAPA or estimated from the federal apportionment and includes the reported tonnage for each state from the survey results. Figures 1–4 illustrate the Table 3 data and provide another perspective on the survey responses that represent the ratio of the tons reported in each state to the total estimated tons for each year, 2009–2012. The closer a state’s number is to 100 indicates that the reported tonnage from the survey matches the estimated tonnage provided by the SAPA or estimated from the federal apportionment. The data reported in the survey represent about 39 percent of the estimated total U.S. tonnage for 2012.

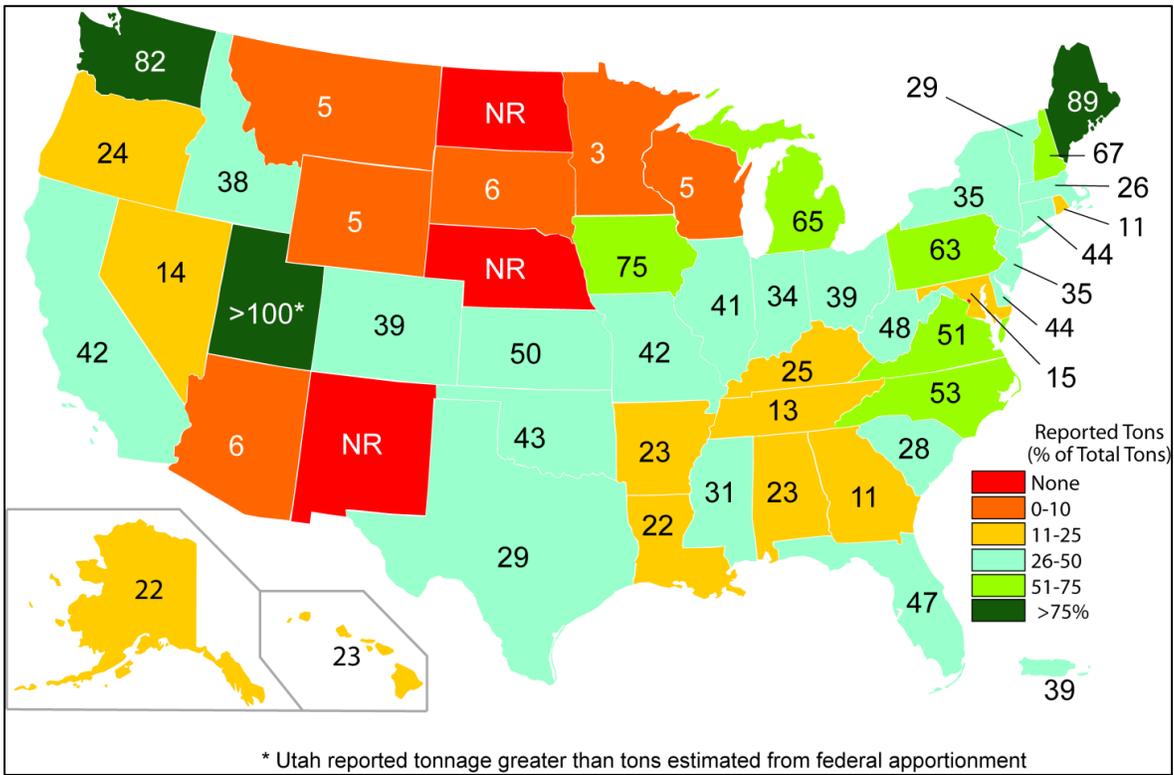


Figure 1: 2009 Reported Tons as a Percent of Estimated Total Tons

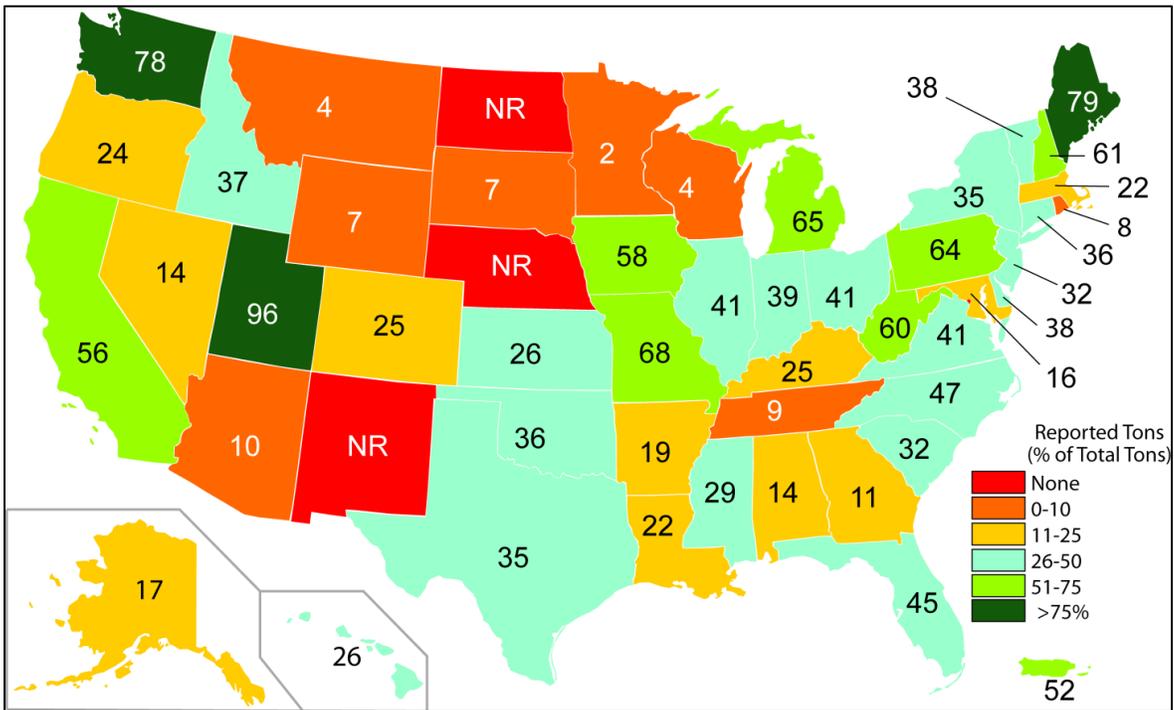


Figure 2: 2010 Reported Tons as a Percent of Estimated Total Tons

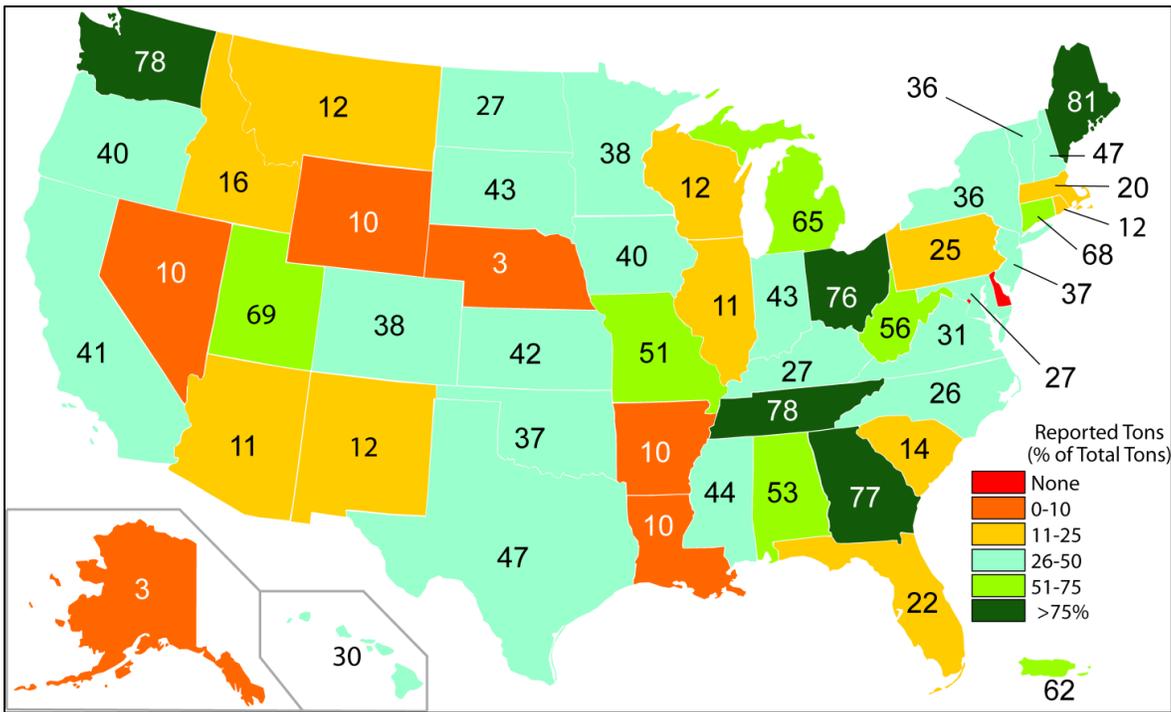


Figure 3: 2011 Reported Tons as a Percent of Estimated Total Tons

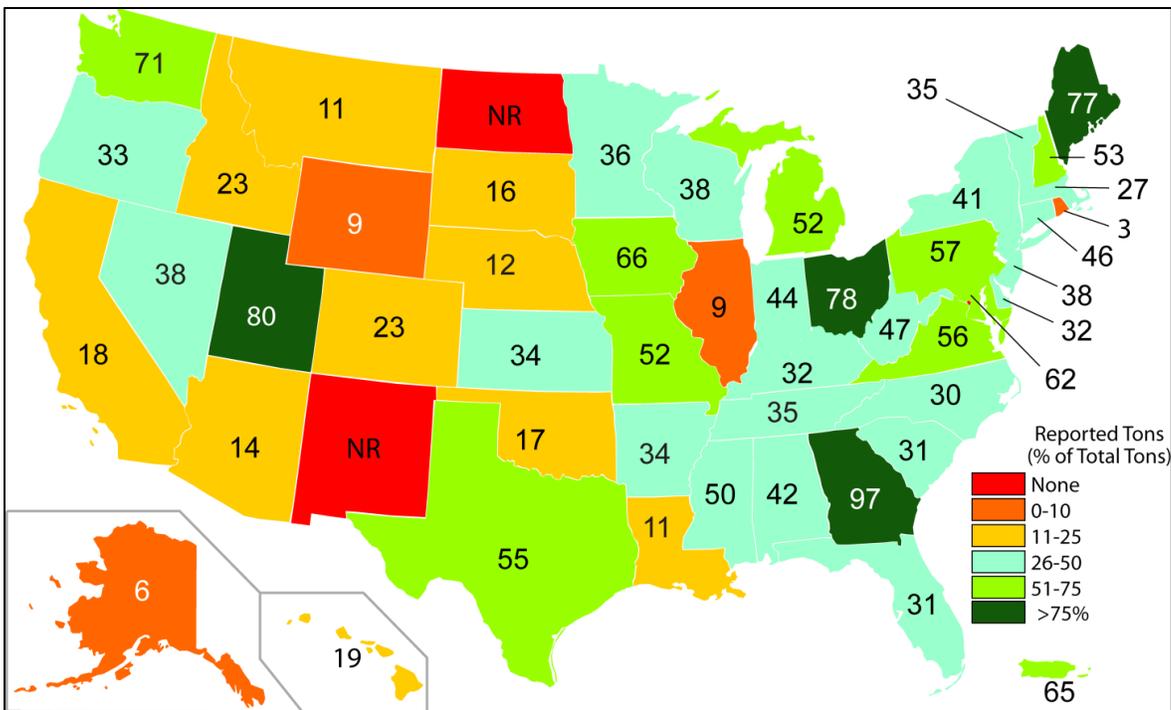


Figure 4: 2012 Reported Tons as a Percent of Estimated Total Tons

Figure 5 shows the number of plants as well as the average tons produced per plant separated by different user/producer group regions. The tons/plant for the Northeast Asphalt User/Producer Group (NEAUPG), North Central Asphalt User/Producer Group (NCAUPG), and Southeast Asphalt User/Producer Group (SEAUPG) increased slightly from 2011 to 2012. The tons/plant for Rocky Mountain Asphalt User/Producer Group (RMAUPG) and Pacific Coast Conference on Asphalt Specification (PCCAS) dropped significantly from 2011 to 2012, but is closer to the values reported in 2010. The number of plants represented in the 2012 survey increased for both NEAUPG and SEAUPG. Both NCAUPG and RMAUPG/PCCAS saw a drop in the number of plants represented in the survey. For RMAUPG/PCCAS, this is the third consecutive drop in the number of plants reporting.

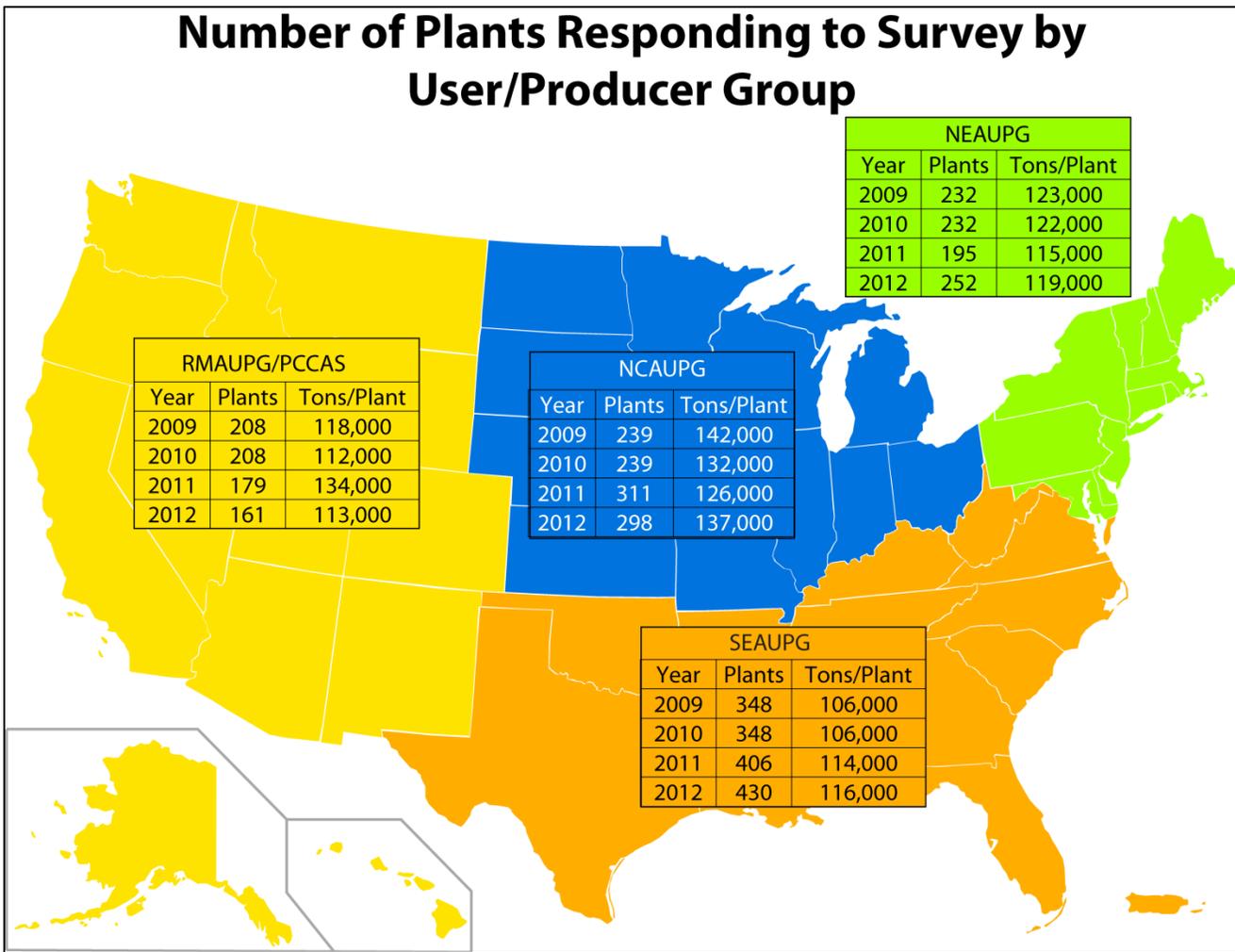


Figure 5: Number of Plants Responding to Survey by User/Producer Group Regions and Estimated Tonnage for Each Year

### Reclaimed Asphalt Pavement

Table 4 summarizes the RAP, RAS, and WMA data from the surveys. The information asked for in the survey is shown in Appendix A and summarized in Table 1. Producers were not asked about allowable RAP or binder replacement requirements. Based on the total estimated tons of RAP received for a given survey year and the amount used for all purposes, including landfilling, there was an estimated 2.3 million, 1.7 million, and 6.3 million tons of RAP stockpiled for future use in 2009, 2010, and 2011, respectively, out of a total of 67.2 million, 73.5 million, and 72.8 million tons received, respectively. In 2012, however, total RAP usage exceeded the amount of RAP accepted by 1.2 million tons.

Figure 5 is a visual representation of the estimated total tons of RAP used in asphalt mixes, aggregate, cold mix, other uses, and landfilled. The overwhelming majority of RAP is used in hot-mix asphalt (HMA) or warm-mix asphalt, which is the most optimal use of RAP. It is estimated that less than 0.1 percent was sent to landfills in 2009 and 2010; less than 0.4 percent in 2011; and less than 0.3 percent in 2012.

Table 4: Summary of RAP, RAS, WMA Data

	Reported Values				Total Estimated Value			
	2009	2010	2011	2012	2009	2010	2011	2012
<b>Tons of HMA/WMA Produced</b>	Tons (Millions)				Tons (Millions)			
Total	124.0	119.8	131.7	139.0	358.4	359.8	366.0	360.3
DOT	56.9	55.6	63.1	69.1	169.2	172.5	175.3	179.1
Other Agency	28.1	27.8	36.4	32.8	83.5	86.2	101.2	84.9
Commercial and Residential	35.6	32.6	32.2	37.1	105.8	101.2	89.5	96.2
Companies/Branches Reporting	196		203	213				
<b>RAP</b>	Tons (Millions)				Tons (Millions)			
Accepted	23.2	24.0	29.8	29.1	67.2	73.5	79.1	71.3
Used in HMA/WMA	20.1	21.6	25.1	27.2	56.0	62.1	66.7	68.3
Used in Aggregate	1.4	1.6	1.2	1.2	6.2	7.3	4.9	3.6
Used in Cold Mix	0.4	0.4	0.1	0.1	1.5	1.6	0.2	0.2
Used in Other	0.1	0.1	0.2	0.1	0.7	0.8	0.7	0.2
Landfilled	0.1	0.0	0.1	0.1	0.1	0.0	0.3	0.2
	Average % Used in Mixes							
Average % for DOT Mixes <sup>1</sup>	12.5%	13.2%	15.8%	18.1%				
Average % for Other Agency Mixes <sup>1</sup>	14.0%	15.2%	16.7%	18.2%				
Average % for Commercial & Residential <sup>1</sup>	17.5%	18.0%	19.7%	20.5%				
National Average All Mixes, Based on % Reported for Different Sectors <sup>1</sup>	15.6%	17.2%	18.2%	18.9%				
National Average All Mixes, Based on RAP Tons Used in HMA/WMA <sup>2</sup>	16.2%	18.0%	19.1%	19.6%				
Companies/Branches Reporting Using RAP	189	189	198	208				
<b>RAS</b>	Tons (Thousands)				Tons (Thousands)			
Accepted	332	559	769	693	957	1,851	2,500	1,724
Used in HMA/WMA	246	393	430	783	702	1,100	1,192	1,863
Used in Aggregate	5	3	14	20	6	3	74	73
Used in Cold Mix	—	—	—	—	—	—	—	—
Used in Other	39	35	—	4	123	125	—	12
Landfilled	—	0.5	0.1	—	—	7	0.2	—
	Average % Used in Mixes							
Average % for DOT Mixes <sup>1</sup>	0.33%	0.78%	0.66%	0.83%				
Average % for Other Agency Mixes <sup>1</sup>	0.37%	0.47%	0.93%	0.90%				
Average % for Commercial & Residential <sup>1</sup>	0.63%	0.81%	1.04%	1.25%				
National Average All Mixes, Based on RAS Tons Used in HMA/WMA <sup>2</sup>	0.20%	0.33%	0.33%	0.56%				
Companies/Branches Reporting Using RAP	44	61	81	87				
<b>WMA</b>	% Total Production				Tons (Millions)			
DOT	6.3%	15.0%	23.5%	30.8%	8.6	20.0	34.6	46.4
Other Agency	4.4%	11.7%	18.2%	24.5%	3.6	9.8	16.3	18.9
Commercial and Residential	4.5%	11.6%	19.9%	22.8%	4.6	11.3	17.8	21.4
Total					16.8	41.1	68.7	86.7
	% of Market							
Chemical Additive %	15.0%	6%	4.1%	9.6%				
Additive Foaming %	2.0%	1%	0.2%	2.1%				
Plant Foaming %	83.0%	92%	95.4%	88.1%				
Organic Additive %	0.3%	1%	0.3%	0.2%				
Companies/Branches Reporting Using WMA	85	121	150	161				

<sup>1</sup> Average percent based on contractor's reported percentage for each sector.

<sup>2</sup> Average percent based on total reported tons of RAP used in HMA/WMA divided by reported total tons HMA/WMA produced.

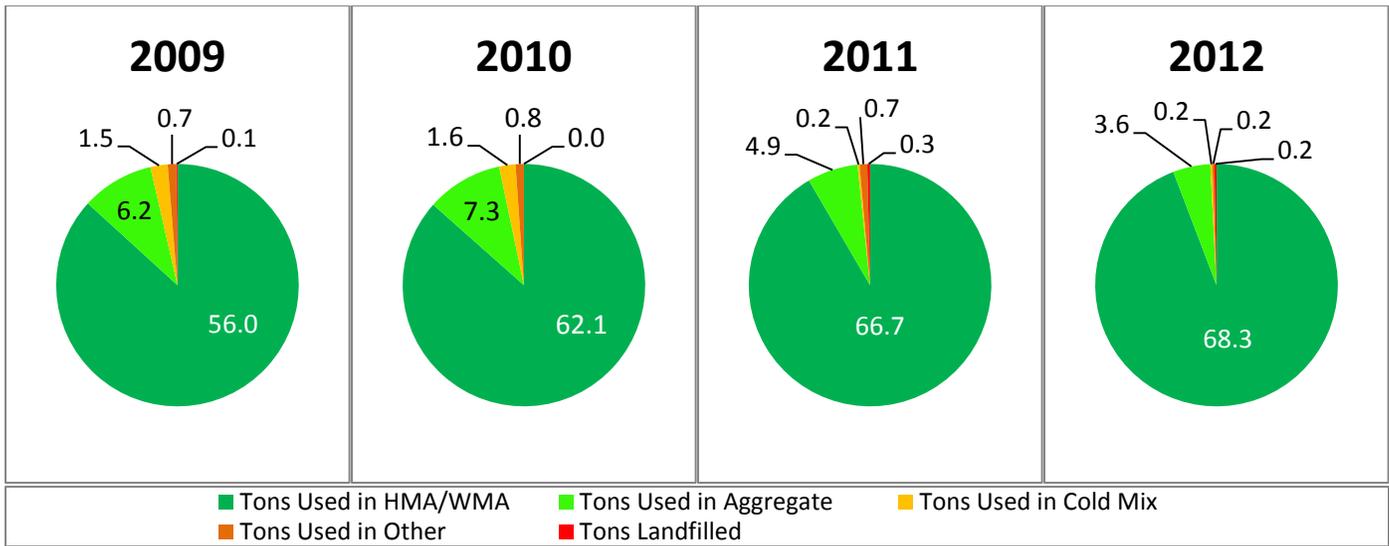


Figure 6: RAP Tons by Final Use (Million Tons)

Figure 6 shows the total estimated amount of RAP used in the different industry sectors. These values were calculated using the average percentages of RAP reported for the different sectors and adjusted to account for the difference between reported RAP tons and tons calculated from the percentage by sector.

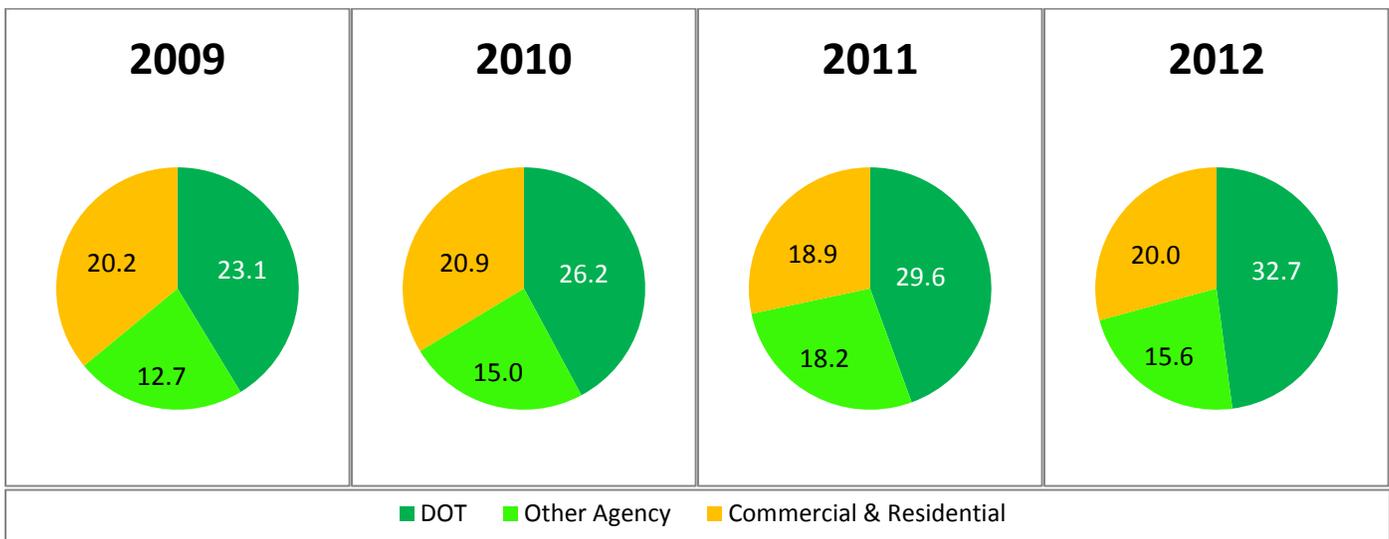


Figure 7: RAP Use by Sector (Million Tons)

Figures 8–11 and Table 5 show the average percent of RAP used in the different states based on reported RAP and total tons. It should be noted that the accuracy of data for individual states will vary depending on the number of responses received from each state and the total number of tons represented by the responses. Comparing Figures 8–11, the number of states averaging more than 20 percent RAP in HMA/WMA (colored lime and dark green in the charts) increased steadily from nine states in 2009 to 20 states in 2012. The use of increased amounts of RAP has quickly spread in the Midwest and West. For example Idaho average percent RAP increased steadily from 6 percent in 2009 to 28 percent in 2012.

For 2011 and 2012, 98 percent of the contractors/branches reported using RAP, and more than 89 percent of these contractors reported excess RAP in 2012. From 2011 to 2012, the amount of RAP used in HMA/WMA increased from 66.7 million to 68.3 million tons, a modest 2 percent increase despite a decrease in total tonnage for the industry. The average percent RAP used in mixes has increased from about 19 percent in 2011 to about 20 percent in 2012.

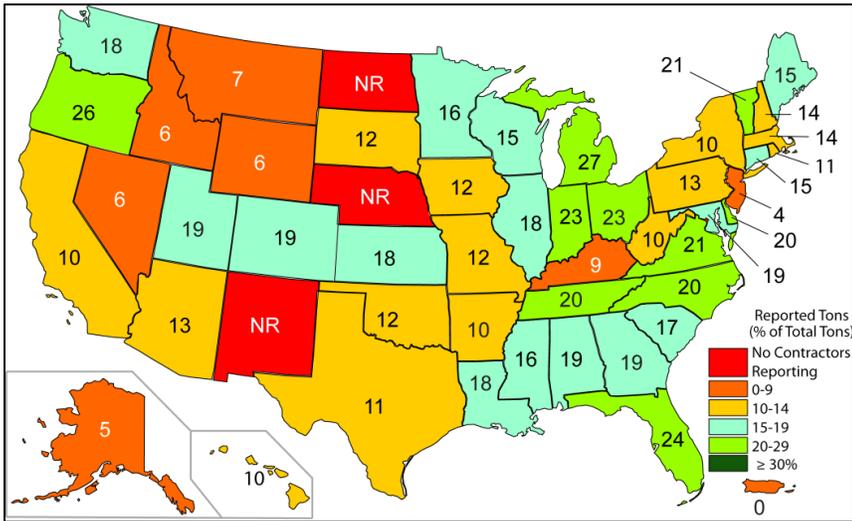


Figure 8: Estimated Average Percent of RAP by State for 2009

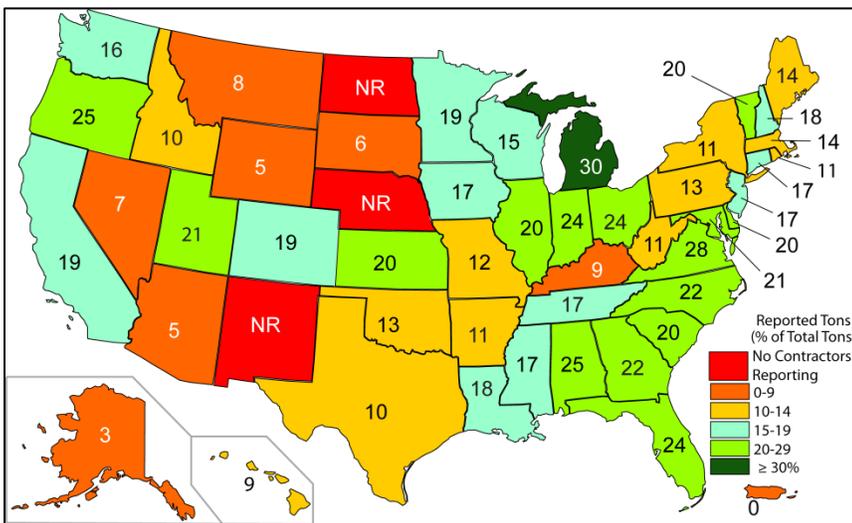


Figure 9: Estimated Average Percent of RAP by State for 2010

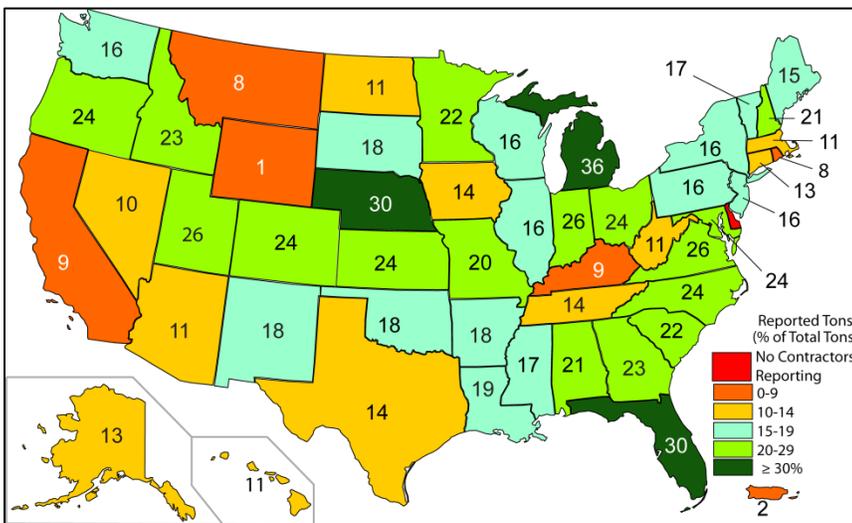


Figure 10: Estimated Average Percent of RAP by State for 2011

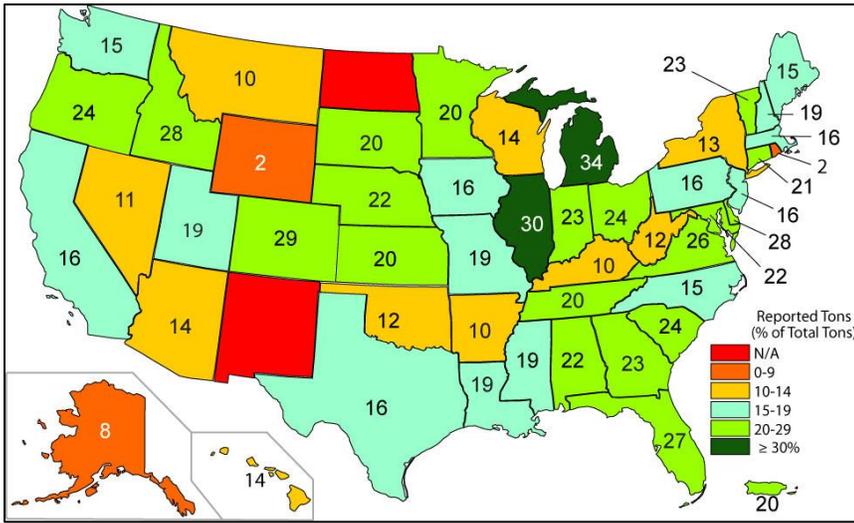


Figure 11: Estimated Average Percent of RAP by State for 2012

Table 5: Estimated Average Percent of RAP by State

State	Average RAP Percent				State	Average RAP Percent			
	2009	2010	2011	2012		2009	2010	2011	2012
Alabama	19%	25%	21%	22%	Montana	7%	8%	8%	10%
Alaska	5%	3%	13%	8%	Nebraska	NR	NR	30%	22%
Arizona	13%	5%	11%	14%	Nevada	6%	7%	10%	11%
Arkansas	10%	11%	10%	10%	New Hampshire	15%	18%	21%	19%
California	10%	19%	9%	16%	New Jersey	4%	17%	16%	16%
Colorado	19%	19%	24%	29%	New Mexico	NR	NR	18%	NR
Connecticut	15%	17%	13%	21%	New York	10%	11%	16%	13%
Delaware	20%	20%	NR	28%	North Carolina	20%	22%	24%	15%
Dist. of Columbia	NR	NR	NR	NR	North Dakota	NR	NR	11%	NR
Florida	24%	24%	30%	27%	Ohio	23%	24%	23%	24%
Georgia	19%	22%	23%	23%	Oklahoma	12%	13%	18%	12%
Hawaii	10%	9%	11%	14%	Oregon	26%	25%	24%	24%
Idaho	6%	10%	23%	28%	Pennsylvania	13%	13%	16%	16%
Illinois	18%	20%	16%	30%	Puerto Rico	0%	0%	2%	20%
Indiana	23%	24%	26%	23%	Rhode Island	11%	11%	8%	2%
Iowa	12%	17%	14%	15%	South Carolina	17%	20%	22%	24%
Kansas	18%	20%	20%	20%	South Dakota	12%	6%	18%	20%
Kentucky	9%	9%	9%	10%	Tennessee	20%	17%	14%	20%
Louisiana	18%	18%	18%	19%	Texas	11%	10%	13%	16%
Maine	13%	14%	15%	15%	Utah	19%	21%	25%	19%
Maryland	19%	21%	24%	22%	Vermont	21%	20%	17%	23%
Massachusetts	14%	14%	11%	16%	Virginia	21%	28%	26%	26%
Michigan	27%	30%	36%	34%	Washington	18%	16%	16%	15%
Minnesota	16%	19%	22%	20%	West Virginia	10%	11%	11%	12%
Mississippi	16%	17%	18%	19%	Wisconsin	15%	15%	16%	14%
Missouri	12%	12%	19%	19%	Wyoming	6%	5%	1%	2%

NR = No Contractors Reporting  
 % = 0–9%  
 % = 10–14%  
 % = 15–19%  
 % = 20–29%  
 % ≥ 30%

## Reclaimed Asphalt Shingles

Table 4 includes the summary of RAS data from the surveys. The information asked for in the survey is shown in Appendix A and summarized in Table 1. Producers were not asked about allowable RAS or binder replacement requirements. In previous surveys, more unprocessed shingles were received than were used for all purposes including landfilling. In 2012 this changed with more than 200,000 tons of RAS used for all purposes than was received. Contractors reporting the use of more RAS than they received indicated that they either had RAS stockpiled or were purchasing it from shingle processors. From 2011 to 2012, the amount of RAS accepted by producers decreased by 31 percent. No RAS was reported as landfilled in 2012; in 2011, the amount landfilled was about 0.008 percent. In 2011, no RAS was reported as being used for other purposes; in 2012 less than 0.7 percent of RAS accepted was used for other purposes.

Figure 12 shows the total estimated amount of RAS used. From 2011 to 2012 there was a large increase, 56 percent, in the amount of RAS used in asphalt mixtures. This is due to a steady increase in a number of states, including Alabama, where the average RAS percentage for all mixes is slightly greater than 3 percent. RAS use in asphalt mixtures saw a similarly large increase, 57 percent, from 2009 to 2010 but a more modest increase, 8 percent, from 2010 to 2011. Similar to RAP, RAS is primarily used in HMA/WMA. Figure 13 summarizes how RAS was used in the different sectors of the paving market. These values were calculated using the average percentages of RAS reported for the different sectors and were adjusted to account for the difference in reported RAS tons and the tons calculated from the percentage by sector. There was a large increase in the use of RAS by DOTs and the commercial/residential sector, and a modest increase in public agencies other than DOTs. The number of companies/branches using RAS increased from 81 to 87 from 2011 to 2012, a 7.4 percent increase.

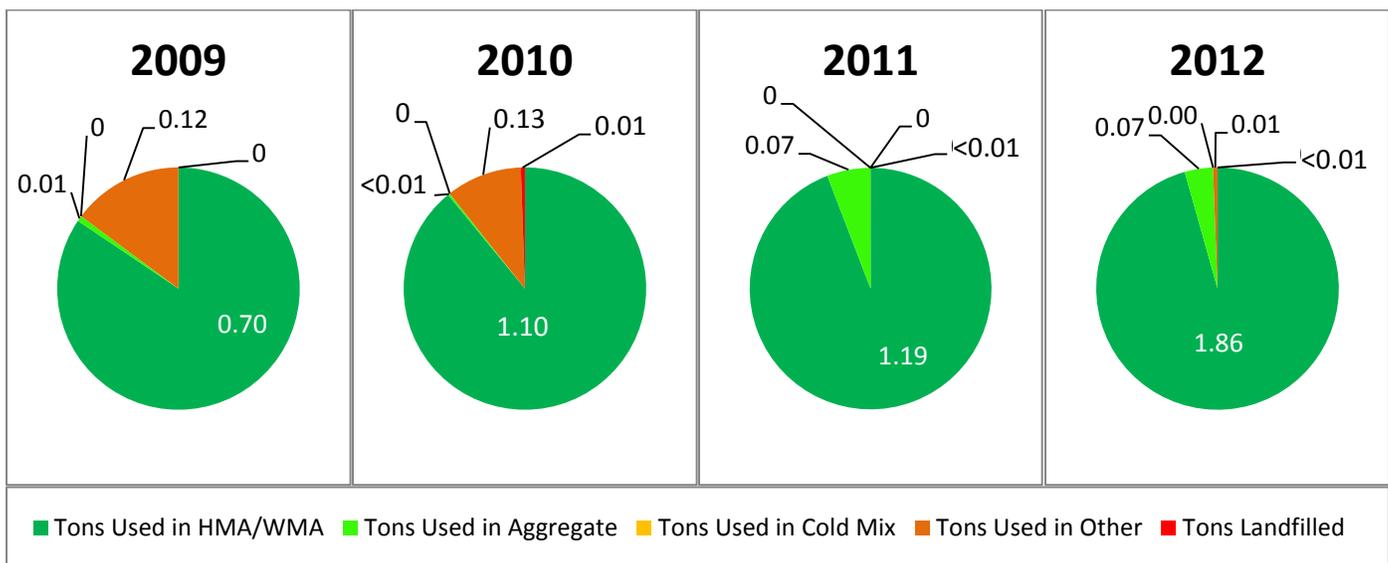


Figure 12: Summary of RAS Use (Million Tons)

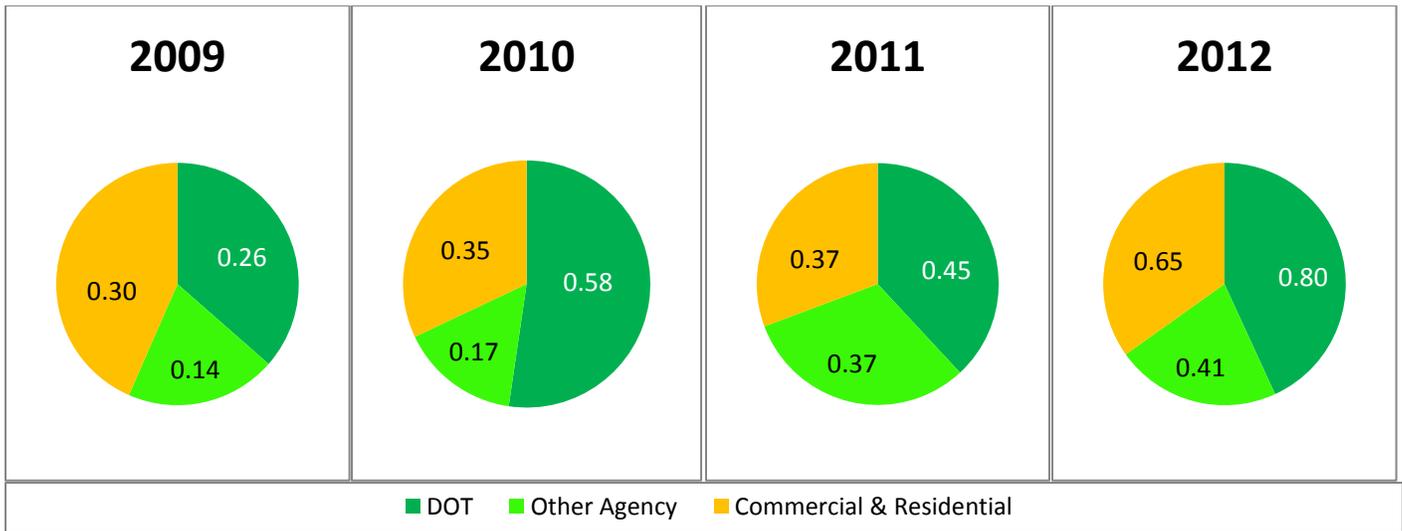


Figure 13: Summary of Estimated RAS Use by Sector (Million Tons)

Figure 14 shows states where plant-mix producers reported using RAS in 2009 through 2012. Red indicates states where RAS use was not reported for these years. The number of states where plant-mix producers reported using RAS increased each year from 22 to 32 from 2010 to 2012. Two states — Vermont and Nebraska — reported their first use of RAS in 2012. Five states — Florida, Massachusetts, Nevada, South Carolina, and West Virginia — reported using RAS in previous years, but did not report its use in 2012. Table 6 shows the states where producers reported using RAS for 2009–2011.

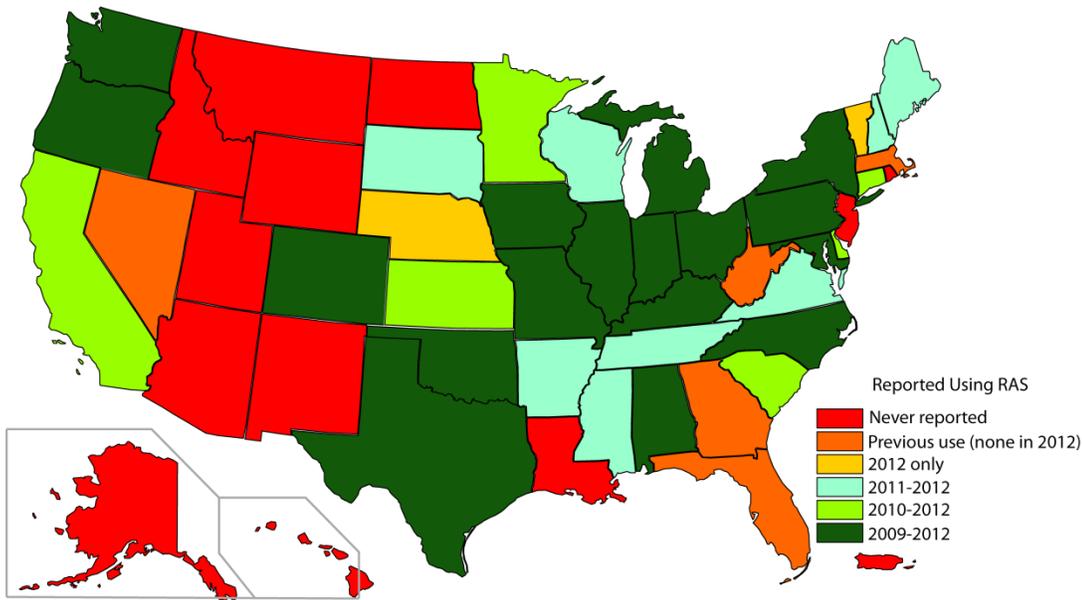


Figure 14: States with Companies/Branches Reporting Using RAS

**Table 6: State Reporting RAS Use**

State	RAS Used?				State	RAS Used?			
	2009	2010	2011	2012		2009	2010	2011	2012
Alabama	Yes	Yes	Yes	Yes	Montana	No	No	No	No
Alaska	No	No	No	No	Nebraska	NR	NR	No	Yes
Arizona	No	No	No	No	Nevada	No	Yes	No	No
Arkansas	No	No	Yes	Yes	New Hampshire	No	No	Yes	Yes
California	No	Yes	Yes	Yes	New Jersey	No	No	No	No
Colorado	Yes	Yes	Yes	Yes	New Mexico	NR	NR	No	NR
Connecticut	No	No	No	No	New York	Yes	Yes	Yes	Yes
Delaware	Yes	Yes	NR	Yes	North Carolina	Yes	Yes	Yes	Yes
Dist. of Columbia	NR	NR	NR	NR	North Dakota	NR	NR	No	NR
Florida	Yes	Yes	No	No	Ohio	Yes	Yes	Yes	Yes
Georgia	No	No	Yes	Yes	Oklahoma	Yes	Yes	Yes	Yes
Hawaii	No	No	No	No	Oregon	Yes	Yes	Yes	Yes
Idaho	No	No	No	No	Pennsylvania	Yes	Yes	Yes	Yes
Illinois	Yes	Yes	Yes	Yes	Puerto Rico	No	No	No	No
Indiana	Yes	Yes	Yes	Yes	Rhode Island	No	No	No	No
Iowa	Yes	Yes	Yes	Yes	South Carolina	No	No	Yes	No
Kansas	No	Yes	Yes	Yes	South Dakota	No	No	Yes	Yes
Kentucky	Yes	Yes	Yes	Yes	Tennessee	No	No	Yes	Yes
Louisiana	No	No	No	No	Texas	Yes	Yes	Yes	Yes
Maine	No	No	Yes	Yes	Utah	No	No	No	No
Maryland	Yes	Yes	Yes	Yes	Vermont	No	No	No	Yes
Massachusetts	Yes	Yes	Yes	No	Virginia	Yes	No	Yes	Yes
Michigan	Yes	Yes	Yes	Yes	Washington	Yes	Yes	Yes	Yes
Minnesota	No	Yes	Yes	Yes	West Virginia	Yes	Yes	No	No
Mississippi	No	No	Yes	Yes	Wisconsin	No	No	Yes	Yes
Missouri	Yes	Yes	Yes	Yes	Wyoming	No	No	No	No

NR	= No Contractors Reporting
Yes	= RAS Use Reported
No	= No RAS Use Reported

## Warm-Mix Asphalt

Table 4 includes the summary WMA data from the survey. The survey asked producers their estimated percentages of tons produced for the different sectors and the percent of which technologies were used.

WMA saw modest increase from 2011 to 2012. Figure 15 shows a slowing increase in the percent of companies/branches using WMA from 2009 to 2012. Figure 16 shows a steady increase in the number of tons of WMA. This is probably attributable to increased acceptance of WMA by all industry sectors.

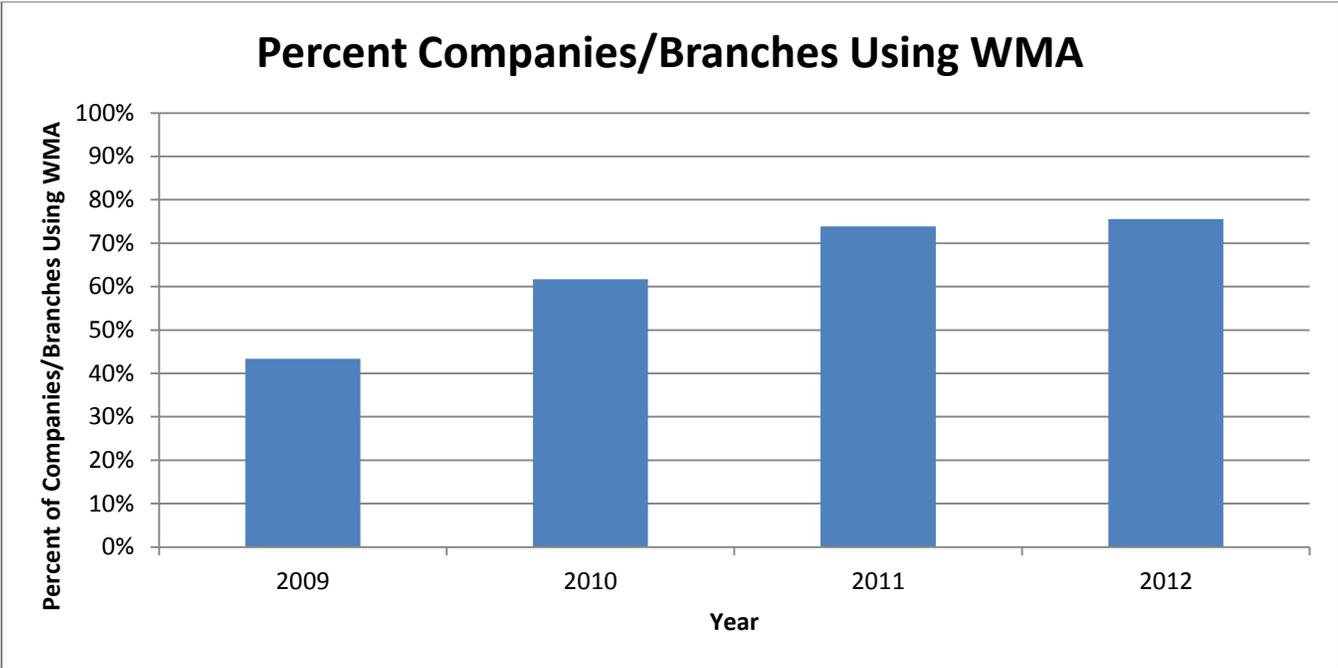


Figure 15: Number of Companies/Branches Using WMA

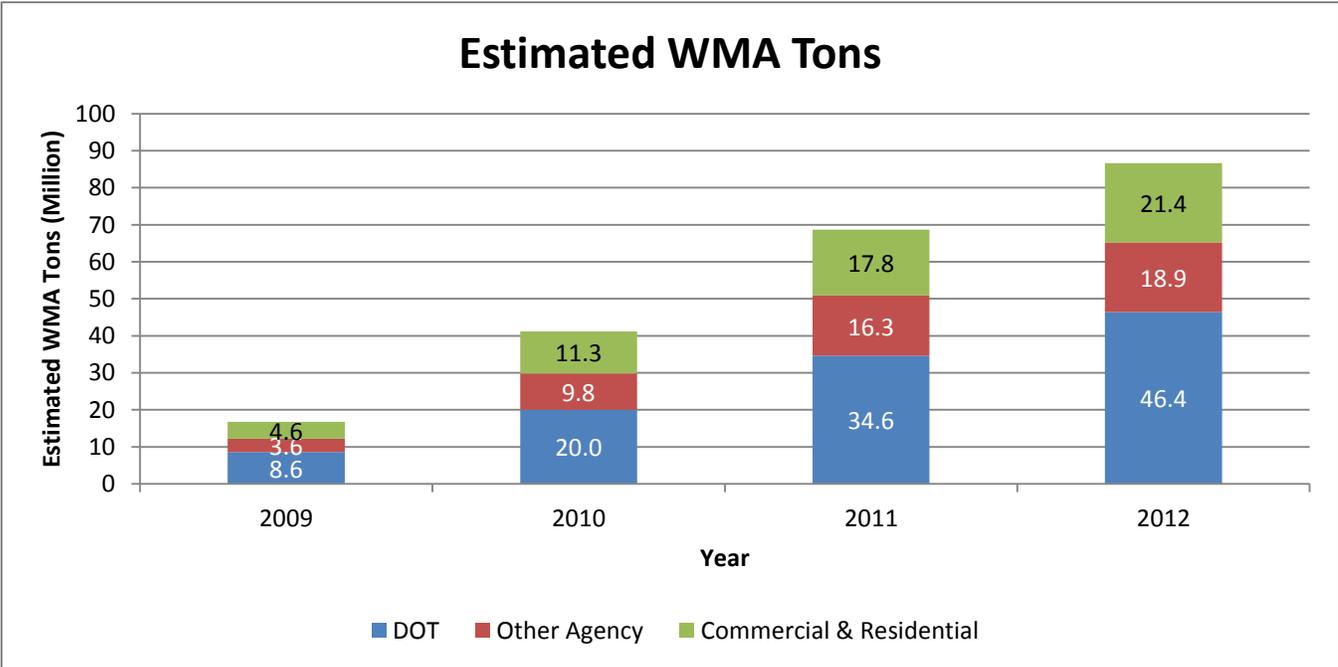


Figure 16: Estimated Tons (in millions) WMA by Industry Sector

Figures 17–20 show the estimated total tons of WMA produced in each state grouped by region. Figure 21 shows WMA production as a percentage of the total asphalt mix production for 2011. It should be noted that the accuracy of data for individual states will vary depending on the number of responses received from each state and the total number of tons represented by the responses.

From 2011 to 2012, 21 states had an increase of 5 percent or greater in WMA production, while eight states had a decrease of 5 percent or greater in WMA production. Six states — Alabama, Tennessee, Alaska, Maryland, Kansas, and Illinois — had an increase of 20 percent or greater in WMA production. Three states — Oklahoma, Louisiana, and Washington — had a decrease of 20 percent or greater in WMA production. The reasons for these fluctuations are uncertain.

Nationally, the total tons of WMA increased from 68.7million tons in 2011 to 86.7 million tons in 2012, a 26 percent increase. Plant foaming is used most often to produce WMA. Use of WMA additives increased from about 5 percent in 2011 to about 12 percent in 2012. This is still below the 17 percent market share noted in 2009, but given that WMA production has increased by more than 416% since 2009 the volume of additives uses, along with plant foaming, has increased significantly.

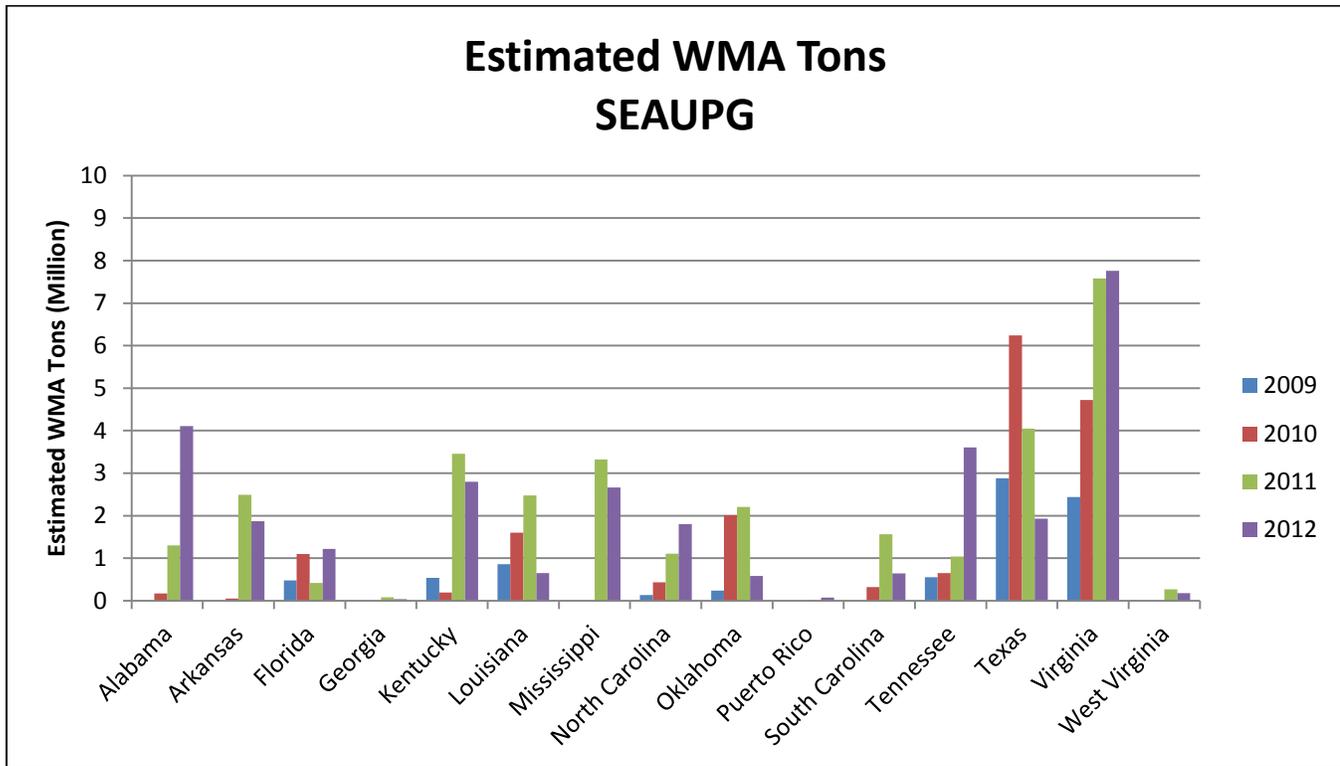


Figure 17: Estimated Total WMA Tons for Southeastern Asphalt User/Producer Group States

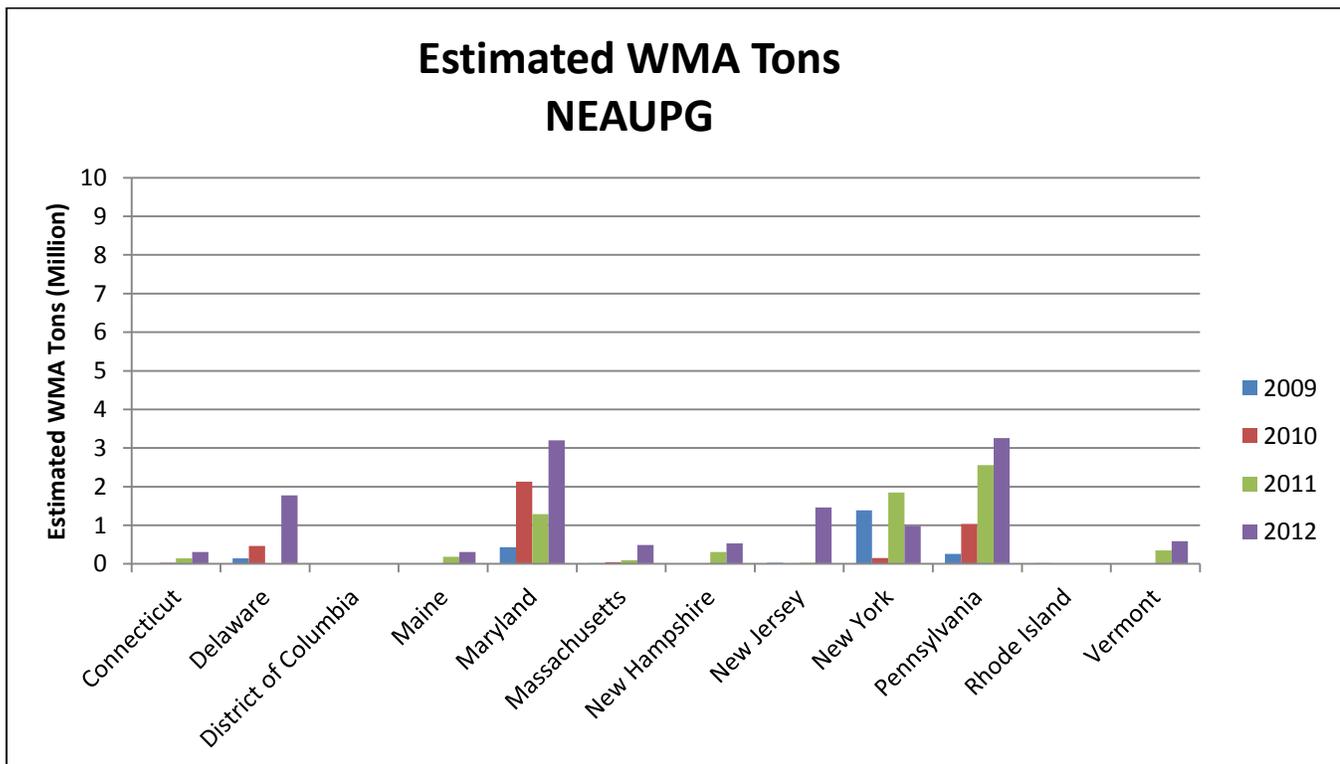


Figure 18: Estimated Total WMA Tons for North East Asphalt User/Producer Group States

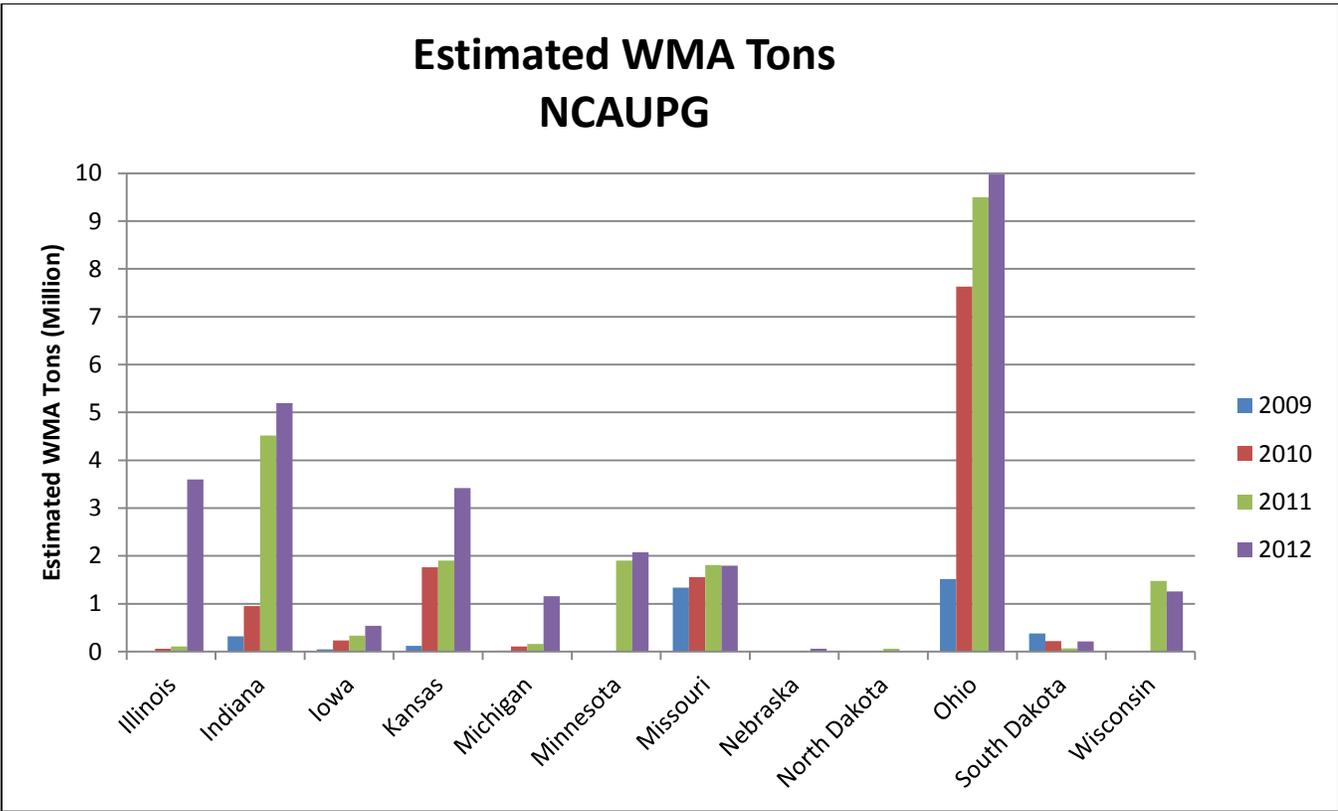


Figure 19: Estimated Total WMA Tons for North Central Asphalt User/Producer Group States

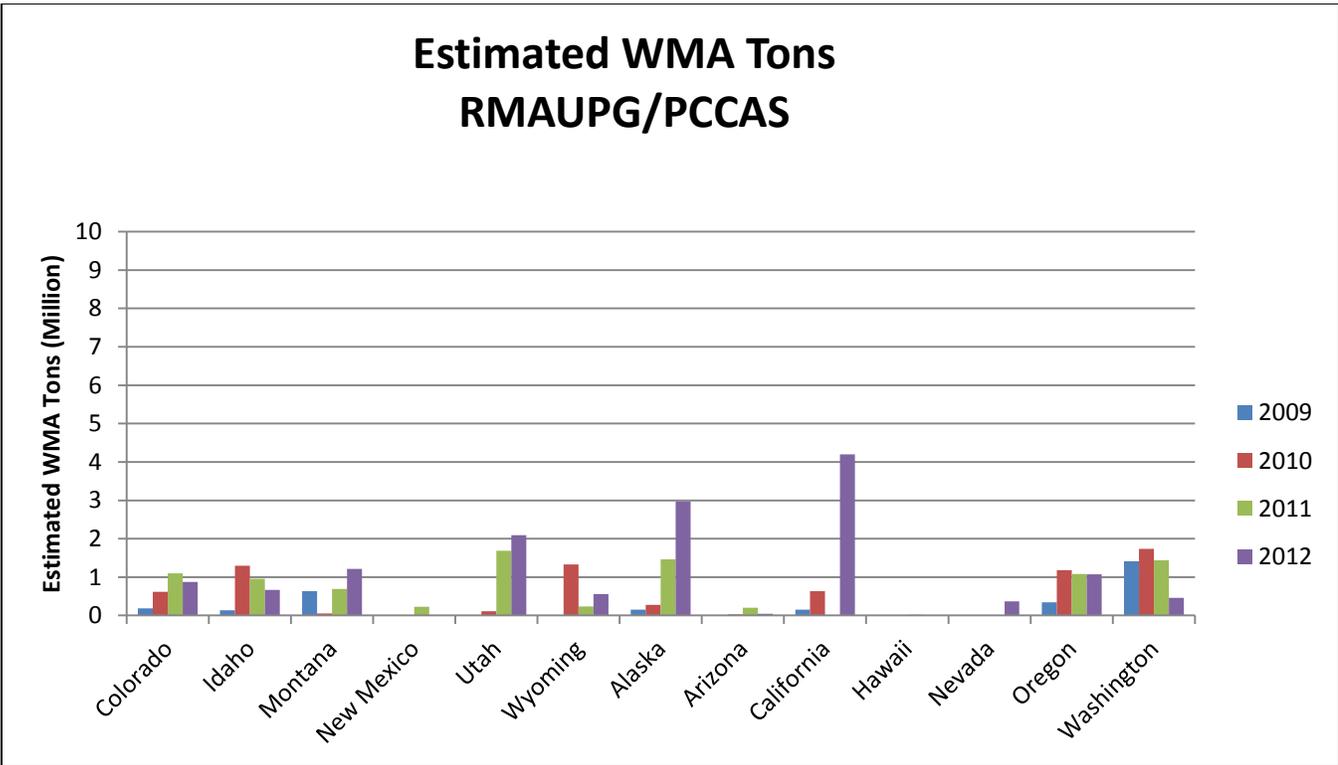


Figure 20: Estimated Total WMA Tons for Rocky Mountain Asphalt User/Producer Group and Pacific Coast Conference on Asphalt Specification States

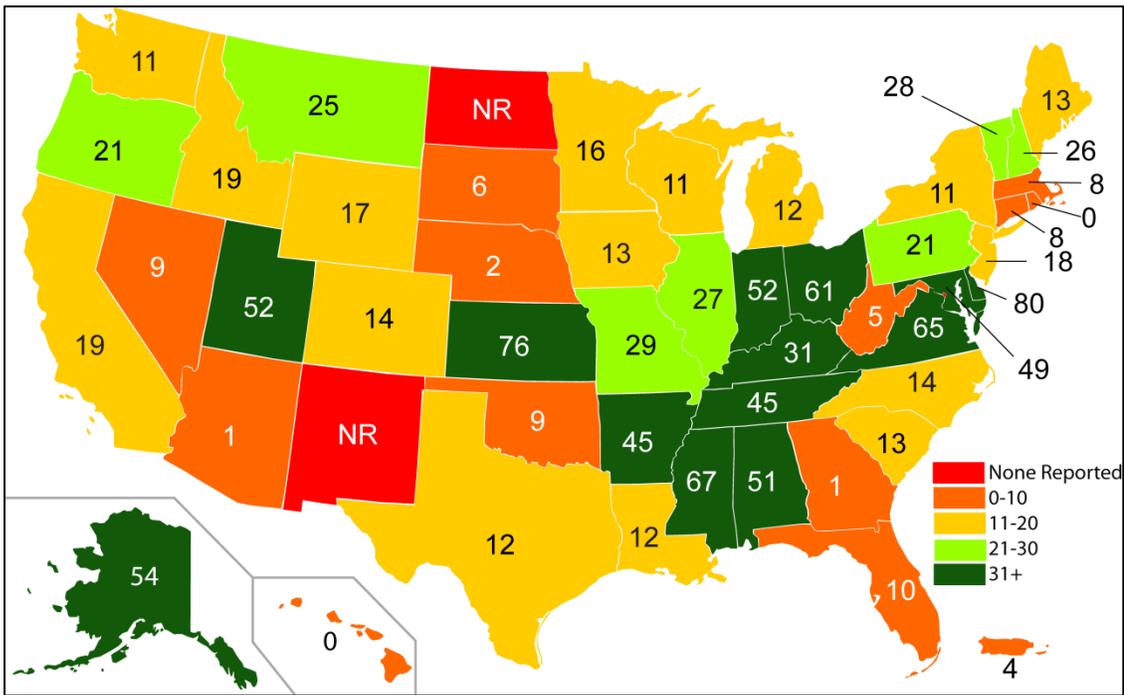


Figure 21: 2012 WMA Production as a Percentage of Total Asphalt Mix Production.

## Other Recycled Materials

For the 2012 survey a series of questions was asked about the use of other recycled materials used in asphalt mixtures. Table 1 summarizes the questions in this section. The full questionnaire is included as Appendix A.

Producers were asked how many tons of mix were produced that incorporated recycled materials, as well as how many tons of the product were used in mix production during 2012. Three recycled materials — ground tire rubber (GTR), steel slag, and blast furnace slag — were specifically mentioned in the survey. The respondents were able to specify up to two additional recycled materials used in mixes. Because it was expected that responses to these other recycled materials would be low and that producers may not be tracking these materials, it was agreed to not attempt estimating the total quantities for these materials. **Therefore, all values in this section are reported values and do not represent estimates of the total quantity of these materials by state or nationally. A total of 40 contractors from 23 states reported using other recycled materials in asphalt mixtures.**

Table 7 summarizes information on the use of ground tire rubber. Producers from nine states reported the use of GTR in some mixes. It must be noted that states such as Arizona and California, which are known to use large quantities of GTR in mixes, had a relatively low participation rate in the survey, while Georgia had a very high participation rate. This likely explains why Georgia’s reported quantity of GTR is higher than Arizona and California. Also, one California contractor that is known to produce mixes with GTR did not include rubber in its response. Follow ups with this contractor were unsuccessful.

**Table 7: Reported Tons Ground Tire Rubber**

State	Reported Tons of Mix Using GTR	Reported Tons of GTR Used
Arizona	33,590	532
California	101,000	7,983
Florida	86,441	195
Georgia	281,958	13,628
Louisiana	25,000	—
Michigan	2,400	20
Missouri	100,000	300
Ohio	36,200	1,170
Texas	25,000	2,500
<b>Total</b>	<b>691,589</b>	<b>26,328</b>

Table 8 summarizes the reported use of steel slag and blast furnace slag in asphalt mixes. 13 states reported using these recycled materials.

**Table 8: Reported Tons for Steel and Blast Furnace Slag**

State	Reported Tons of Mix Using Steel Slag	Reported Tons of Steel Slag Used	Reported Tons of Mix Using Blast Furnace Slag	Reported Tons of Blast Furnace Slag Use
Alabama	625,000	133,441	100,000	10,100
Arkansas	120,000	12,000	—	—
Illinois	23,000	8,000	—	—
Indiana	70,000	44,000	1,487,000	304,000
Iowa	20,000	—	—	—
Kentucky	5,714	800	—	—
Michigan	—	—	500,000	50,000
Minnesota	145,500	21,800	—	—
Ohio	150,000	42,030	208,028	72,400
Tennessee	30,000	6,000	—	—
Virginia	—	—	54,520	16,356
Washington	450,000	80,000	—	—
West Virginia	—	—	588,120	180,308
<b>Total</b>	<b>1,639,214</b>	<b>348,071</b>	<b>2,937,668</b>	<b>633,164</b>

Table 9 summarizes other recycled materials used in asphalt mixtures. These other recycled materials include fly ash, cellulose fiber, casting sand, bottom ash, and recycled glass. Two states — Mississippi and Texas — reported using fly ash. Cellulose fiber use was reported only by Mississippi, but it is expected that use of this material is much more widespread as it is commonly used in stone-matrix asphalt (SMA) and open-graded friction courses (OGFC), which are used in many states.

Table 9: Other Recycled Materials

State & Description Other Recycled Material	Reported Tons of Mix Produced Using Other Recycled Material	Reported Tons Other Recycled Material Used
<b>Mississippi</b>		
Fly Ash	50,000	2,400
Cellulose Fiber	76,000	250
<b>Missouri</b>		
Casting Sand From a Local Fabrication Facility	5,000	500
<b>South Dakota</b>		
Bottom Ash	52,000	4,280
<b>Texas</b>		
Fly Ash	18,000	1,200
<b>Virginia</b>		
Recycled Glass	173	34

## Summary and Conclusions

The objective of this survey was to quantify the use of recycled materials and WMA produced by the asphalt pavement industry. Asphalt mix producers from 48 states and Puerto Rico completed the 2012 survey. A total of 213 companies/branches with 1,141 plants were represented in the 2012 survey.

The estimated total asphalt mix production saw a slight decrease from 366 million to 360 million tons from 2011 to 2012.

The use of recycled material continues to increase. The survey shows:

- The percent of producers reporting using RAP increased from 96 percent in 2009 and 2010 to 98 percent in 2012.
- The estimated amount of RAP used in asphalt mixtures has increased steadily from 2009 to 2011. The estimated tons of RAP used in asphalt mixes for 2009, 2010, 2011, and 2012 are 56.1 million, 62.1 million, 66.7, and 68.3 million tons, respectively. This represents about a 22 percent increase in the amount of tons used from 2009 to 2012 and a greater than 2 percent increase in the amount of tons used between 2011 and 2012.
- The estimated average percent of RAP used has increased from 16.2 percent to 18.0 percent to 19.1 to 19.6 percent for 2009, 2010, 2011, and 2012, respectively.
- 89 percent of the contractors/branches reported having excess RAP in 2011. For the first time in this survey's history, the estimated amount of RAP used for all purposes in 2012, including landfilling, exceeded the amount accepted by 1.2 million tons.
- Use of both manufacturers' scrap and post-consumer recycled asphalt shingles increased from 1.2 million tons used in 2011 to 1.9 million tons used in 2012, an 58 percent increase.
- The amount of RAS accepted by asphalt mix producers decreased by more than 31 percent from 2011 to 2012, and 73 percent of the contractors/branches reported having excess RAS for 2012. In 2012, more than 224,000 tons of RAS was used for all purposes than was received.
- Of the RAS used in 2012, over 95 percent was used in asphalt mixes. The remainder was primarily combined with aggregates. No RAS was landfilled.
- The number of states with reported RAS use increased slightly from 31 to 32 in 2012.
- Nine states reported using ground tire rubber (GTR) in asphalt mixtures.
- 13 states reported using steel or blast furnace slags.
- Two states reported using fly ash in asphalt mixtures.
- Less commonly reported recycled materials included glass, foundry sand, bottom ash, and cellulose fiber.

The use of WMA continues to increase steadily. The survey shows:

- The estimated total production of WMA for 2011 was 86.7 million tons. This was a greater than a 26 percent increase over 2010 WMA (68.7 million tons) and more than 416 percent increase over 2009.
- WMA was about 24 percent of the total asphalt mixture market in 2012.
- Plant foaming, representing more than 88 percent of the market, is the most commonly used technology; additives accounted for less than 12 percent of the market.

The 2012 survey results show that the asphalt pavement industry continues to improve its outstanding record of sustainable practices by further increasing the use of recycled materials and WMA. RAP use continues to increase, albeit at a slower rate. For the first time in the survey, more RAP was used than accepted. This is primarily due to a decrease in the amount of RAP collected. The reason for this decrease is uncertain, but it may be partially be due to reduced construction as indicated by the reduction in total production volume. With more than 89 percent of producers indicating they have excess RAP, there are still opportunities to increase the amount of RAP used in asphalt mixes through permissive specifications and through improved RAP processing, production equipment and procedures, and education.

RAS use saw a large increase in 2012 to nearly 1.9 million tons used in asphalt mixes. This represents nearly 17 percent of the estimated 11 million ton waste shingle market (manufacturer and post-consumer waste). This indicates that there are still opportunities for increasing the use of RAS in asphalt mixtures, especially in the 17 states and territories where no RAS use was reported for 2012. As with RAP, permissive specifications, improved processing, production equipment and procedures, and education will help.

The asphalt pavement industry recycles many products from other industries. The survey shows that steel and blast furnace slag is used in 13 states, GTR is used in 9 states, and fly ash in two states. Other less common materials include glass, foundry sand, bottom ash, and cellulose fiber. Cellulose fiber is probably underrepresented in the survey results as it is a common material used in SMA and OGFC.

WMA again saw an increase of about 26 percent from 2011 to 2012. All reporting states, with the exception of Hawaii, reported using WMA in 2011. WMA production now represents about 24 percent of total estimated asphalt mix production in the United States, and it is expected to grow as contractors and agencies gain experience and more states implement permissive specifications.

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