APPENDIX A

Survey and Results

Questionnaire

NCHRP PROJECT 20-5 SYNTHESIS TOPIC 41-04 FY2010
SUSTAINABLE PAVEMENT MAINTENANCE

Increasing societal awareness of the environmental effects of the road and pavement infrastructure has lead to new demands on transportation agencies to provide environmentally responsive infrastructure. Pavement preservation and maintenance practices are applied to restore the pavement condition and extend service life. The United States Federal Highway Administration (FHWA) considers pavement preservation as one of the three types of activities that restores the pavement serviceability: pavement maintenance, pavement rehabilitation, and pavement reconstruction. Pavement maintenance treatments usually provide the least expensive pavement preservation strategy available.

This survey is directed at benchmarking current state-of-the-practice in usage and quantification of preservation and maintenance practices in terms of environmental performance utilized by the respondent’s agency. Sustainability in the survey refers to promoting environmentally friendly practices that also provide technical and economic benefits. Survey participants will be asked to identify and quantify six Sustainability Impact Factor Areas (SIFA) including: (1) Virgin Material Usage; (2) Alternative Material Usage; (3) Pavement In-Service Monitoring and Management; (4) Noise; (5) Air Quality/Emissions; and (6) Water Quality and their relationship to typical preservation and maintenance practices in their agency. The survey is seeking information on all pavement types including: asphalt, concrete, composite, surface treated and gravel roads and pavements. Second, the survey seeks to quantify whether the selected treatments are being assessed in terms of the six SIFA factors.

The survey is directed to pavement maintenance practitioners in state, provincial, federal, and selected transportation agencies. This survey will take approximately 20 minutes to complete. Those respondents that believe that they have an example project or protocol that would make a good case study to illustrate a particularly successful incorporation of environmental performance invited to indicate their willingness to contribute detailed information about the project, and they will be contacted individually by the researcher to obtain the case study information. The results of this survey will be summarized and incorporated into a synthesis that will be shared and distributed through AASHTO, the FHWA, Transportation Research Board, and others, with the goal of assisting in the development and implementation of preservation and maintenance that improve environmental performance. Should you have any questions or comments in completing the survey, please contact either:

Susan L. Tighe, Ph.D., P.Eng  
University of Waterloo  
E-mail: sltighe@uwaterloo.ca  
Phone: 1-519-888-4567 Ext. 33152  
Fax: 1-519-888-4300

Douglas D. Gransberg, PhD, PE  
University of Oklahoma  
E-mail: dgransberg@ou.edu  
Voice: 1-405-325-6092  
FAX: 1-405-325-7558
Question 1

**Respondent Information**

<table>
<thead>
<tr>
<th>Point of Contact Name:</th>
<th>Agency/Organization:</th>
<th>State/Province:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E-mail Address:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Question 2**

**Type of Agency/Organization:**

- [ ] Federal Agency
- [ ] State/Provincial Agency
- [ ] County Agency
- [ ] Municipal Agency
- [ ] Private Organization
- Other, please specify: ____________________________

1—**General Program Information:** (Non-agency respondents, please skip to Section 2, question 14)

**Question 3**

What is the magnitude of your agency's highway maintenance program?

<table>
<thead>
<tr>
<th>Rural—Local (Total miles or km)</th>
<th>Rural—Interstate (Total miles or km)</th>
<th>Urban—Local (Total miles or km)</th>
<th>Urban—Interstate (Total miles or km)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**Question 4**

What is your approximate annual budget for:

- [ ] Pavement Maintenance: $_____
- [ ] Pavement Preservation: $_____
- [ ] Funds are not separated: Pavement Maintenance/Preservation combined: $_____

**Question 5**

For each of the below pavement types, check those practices that you use for pavement maintenance:

<table>
<thead>
<tr>
<th>Gravel</th>
<th>Regrading</th>
<th>Regravel</th>
<th>Dust palliative</th>
<th>Otta seal</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Treated</td>
<td>Chip seal</td>
<td>Hot patches</td>
<td>Slurry seal</td>
<td>Cold patches</td>
<td>Microsurfacing</td>
</tr>
<tr>
<td>Asphalt</td>
<td>Chip seal</td>
<td>Hot patches</td>
<td>Slurry seal</td>
<td>Cold patches</td>
<td>Microsurfacing</td>
</tr>
<tr>
<td>Concrete</td>
<td>Diamond grind</td>
<td>Shotblasting</td>
<td>Mill</td>
<td>Mud jacking</td>
<td>Thin PCC overlay</td>
</tr>
<tr>
<td>Composite</td>
<td>Chip seal</td>
<td>Hot patches</td>
<td>Slurry seal</td>
<td>Cold patches</td>
<td>Microsurfacing</td>
</tr>
</tbody>
</table>

**Question 6**

For each of the below pavement types, check those practices that you use for pavement preservation:

<table>
<thead>
<tr>
<th>Gravel</th>
<th>Regrading</th>
<th>Regravel</th>
<th>Dust palliative</th>
<th>Otta seal</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Treated</td>
<td>Chip seal</td>
<td>Hot patches</td>
<td>Slurry seal</td>
<td>Cold patches</td>
<td>Microsurfacing</td>
</tr>
<tr>
<td>Asphalt</td>
<td>Chip seal</td>
<td>Hot patches</td>
<td>Slurry seal</td>
<td>Cold patches</td>
<td>Microsurfacing</td>
</tr>
<tr>
<td>Concrete</td>
<td>Diamond grind</td>
<td>Shotblasting</td>
<td>Mill</td>
<td>Mud jacking</td>
<td>Thin PCC overlay</td>
</tr>
<tr>
<td>Composite</td>
<td>Chip seal</td>
<td>Slurry seal</td>
<td>Microsurfacing</td>
<td>Fog seal</td>
<td>Crack</td>
</tr>
</tbody>
</table>
Question 7
Which of the following differentiates your pavement maintenance program from your pavement preservation program?
- Source of funding
- In-house crews vs. contractor-performed
- Scheduled versus reactive
- No difference
- We don't have a formal pavement preservation program

Question 8
Does your agency utilize a formal pavement management system in the daily work?
- Yes
- No
- Additional Comment (if you'd like to further explain):

Question 9
Does your agency use performance models/design tools to select and quantify the maintenance or preservation practice?
- Yes
- No
- If yes, how are the practices selected?

Question 10
Does your agency use life cycle costing to select the maintenance or preservation practice?
- Yes
- No
- If yes, what economic tools are used?

Question 11
Does your agency use environmental performance to select the maintenance or preservation practice?
- Yes
- No
- If yes, how is this done?

Question 12
Does your agency use formal specifications in pavement maintenance or preservation activities?
- Yes, both
- Yes, maintenance only
- Yes, preservations only
- No

Question 13
Does your agency have its own specifications in pavement materials?
- Yes
- No
- Additional comment (if you'd like to further explain):

Question 14
Does your agency have a formal sustainable design and/or construction program?
- Yes
- No
- Additional comment (if you'd like to further explain):
  - Virgin Material Usage

For purposes of this survey: “Recycled Materials” are defined as those materials that originated in a previously constructed pavement that provide technical, economic, and environmental benefits.

Question 15
Are recycled materials allowed in your current pavement maintenance/preservation specifications?
- Yes
- No
- Additional comment (if you'd like to further explain):
### Question 16
Which of the following recycled materials does your agency use in its pavement maintenance specifications? If yes, what percentage is allowable?

<table>
<thead>
<tr>
<th>Material</th>
<th>Allowable percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recycled Asphalt Pavement (RAP) in Base or Subbase Layers</td>
<td></td>
</tr>
<tr>
<td>Recycled Asphalt Pavement (RAP) in Flexible Layer</td>
<td></td>
</tr>
<tr>
<td>Recycled Concrete Aggregate in Base or Subbase Pavement Layers</td>
<td></td>
</tr>
<tr>
<td>Recycled Concrete Aggregate in Concrete Pavement Layers</td>
<td></td>
</tr>
</tbody>
</table>

### Question 17
Does your agency have incentives to encourage virgin material usage reduction or to encourage recycling?
- [ ] Yes
- [ ] No
  If yes, what are these?

### Question 18
How would you describe the current virgin material usage in your current pavement maintenance activities?
- [ ] Use virgin materials only
- [ ] Prefer to use recycling;
- [ ] Always try to minimize the use of virgin materials
- [ ] Don’t know/no opinion

### Question 19
Do you agree with this statement “The utilization of recycled material can reduce the cost of pavement maintenance activities and preserve the virgin aggregate resource”?
- [ ] Agree
- [ ] Somewhat agree
- [ ] Neutral
- [ ] Somewhat disagree
- [ ] Disagree
- [ ] No opinion

### Question 20
Do you have any other comments regarding virgin material usage in your agency?
- [ ] Yes
- [ ] No
  If yes, what are they?

- **Alternative Material Usage**

For purposes of this survey: “Alternative Materials” are defined as those materials that would be added to a pavement structure that provide technical, economic, and environmental benefits. Examples would include: coal tar materials, recycled asphalt shingles, recycled glass, reclaimed carbon from copier toner, etc.

### Question 21
Are alternative materials allowed in your current pavement maintenance/preservation specifications?
- [ ] Yes
- [ ] No
  Additional Comment (if you’d like to further explain): 

### Question 22
Which of the following recycled materials does your agency use in its pavement maintenance specifications? If yes, what percentage is allowable, if applicable?

<table>
<thead>
<tr>
<th>Material</th>
<th>Allowable percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt shingles in asphalt maintenance mixes</td>
<td></td>
</tr>
<tr>
<td>Coal tar in asphalt maintenance mixes</td>
<td></td>
</tr>
<tr>
<td>Warm mix asphalt in asphalt maintenance mixes</td>
<td></td>
</tr>
<tr>
<td>Emulsion binders in lieu of hot AC binders</td>
<td></td>
</tr>
<tr>
<td>Glass cullet in asphalt maintenance mixes</td>
<td></td>
</tr>
<tr>
<td>Recycled tire rubber in asphalt maintenance mixes</td>
<td></td>
</tr>
<tr>
<td>Recycled tire rubber in chip seal binder</td>
<td></td>
</tr>
<tr>
<td>Reclaimed carbon in asphalt maintenance mixes</td>
<td></td>
</tr>
<tr>
<td>Foundry sand in asphalt maintenance mixes</td>
<td></td>
</tr>
</tbody>
</table>
Table:

<table>
<thead>
<tr>
<th>Material</th>
<th>Allowable Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fly ash in asphalt maintenance mixes</td>
<td></td>
</tr>
<tr>
<td>Foundry sand in concrete maintenance mixes</td>
<td></td>
</tr>
<tr>
<td>Fly ash in concrete maintenance mixes</td>
<td></td>
</tr>
<tr>
<td>Glass cullet in concrete maintenance mixes</td>
<td></td>
</tr>
<tr>
<td>Fly ash grouts for sealing voids beneath pavement slab sections</td>
<td></td>
</tr>
</tbody>
</table>

Question 23:
Do your agency have incentives to encourage the use of alternative materials that provide environmental benefits?
- [ ] Yes
- [ ] No
  - If yes, what are these?

Question 24:
How would you describe the current alternative material usage in your current pavement maintenance activities?
- [ ] Use conventional materials only
- [ ] Prefer to use alternative materials where appropriate
- [ ] Use a combination of conventional and alternative materials
- [ ] Always try to maximize the use of alternative materials where appropriate
- [ ] Don’t know/no opinion

Question 25:
Do you agree with this statement “The utilization of alternate material can reduce the cost of pavement maintenance activities and preserve the virgin aggregate resource”?
- [ ] Agree
- [ ] Somewhat agree
- [ ] Neutral
- [ ] Somewhat disagree
- [ ] Disagree
- [ ] No opinion

Question 26:
Please check which of the following are applicable to your agency when an alternative material is proposed?
- [ ] Carry out agency-specific testing to ensure alternative material meets standard
- [ ] Use contractor data only to ensure alternative material meets standard
- [ ] Don’t know

Question 27:
Do you have any other comments regarding alternative material usage in your agency?
- [ ] Yes
- [ ] No
  - If yes, what are they?

3—Pavement Monitoring and Management Information:

Question 28:
Does your agency utilize Pavement Management System (PMS) software for pavement maintenance purposes?
- [ ] Yes
- [ ] No
  - If yes, what is its name?

Question 29:
Does your agency utilize Pavement Management System (PMS) software to monitor environmental performance?
- [ ] Yes
- [ ] No
  - If yes, in what way?

Question 30:
Do you think PMS is a valuable tool in planning for pavement maintenance?
- [ ] Yes
- [ ] No
- [ ] No opinion/don’t know

Question 31:
Do you think PMS could be used to monitor environmental performance of maintenance?
- [ ] Yes
- [ ] No
- [ ] No opinion/don’t know
  - If yes, what should be monitored?
Question 32
Does your agency perform pavement condition surveys on your road network?
☐ Yes, annually ☐ Yes, biannually ☐ Yes, no specific frequency ☐ No

Question 33
In order to achieve effective pavement maintenance and/or preservation, what do you think is the most important (Check one only)?
☐ Proactive planning ☐ Proper investigation ☐ Maintenance timing ☐ Workmanship
☐ Material quality and selection ☐ Quality control/quality assurance

Question 34
Please furnish your opinion as to how the following practices promote sustainable pavement maintenance and/or preservation in your agency?

<table>
<thead>
<tr>
<th>Practice</th>
<th>Promotes</th>
<th>Neutral</th>
<th>Does not promote</th>
<th>No opinion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proactive Planning</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proper Investigation</td>
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<tr>
<td>Maintenance Timing</td>
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<tr>
<td>Workmanship</td>
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<tr>
<td>Material Quality and Selection</td>
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<tr>
<td>Quality Control</td>
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<td></td>
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<tr>
<td>Quality Assurance</td>
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</tbody>
</table>

Question 35
Do you have any other comments regarding the relationship between pavement monitoring and management and sustainability in your agency?
☐ Yes ☐ No     If yes, what are they?

4—Noise Information:

Question 36
How important do you consider noise disturbance during pavement maintenance in your agency?
☐ Very important ☐ Important ☐ Neutral ☐ Not important ☐ Not even considered ☐ No opinion

Question 37
For which of the following does your agency develop pavements noise standard?
☐ Daytime Construction Noise ☐ Nighttime Construction Noise ☐ Daytime Maintenance Noise
☐ Nighttime Maintenance Noise ☐ Daytime Traffic Noise ☐ Nighttime Traffic Noise
☐ No noise standards in effect ☐ Other, please specify:

Question 38
Does your agency promote noise planning program to mitigate noise during maintenance activities?
☐ Yes ☐ No ☐ Don’t know

Question 39
Does your agency use surface treatments/materials that reduce noise?
☐ Yes ☐ No ☐ Don’t know

Question 40
Does your agency use any of the following surface materials to reduce noise?
☐ Open Friction Courses ☐ Smaller Aggregate Materials ☐ Variable tine spacing
☐ Microsurfacing ☐ Rubberized asphalt ☐ Inverted chip seals
5—Air Quality/Emissions Information:

Question 42
Is there an air quality monitoring program/system regulated by an environmental agency in the geographic location of the highway network in your jurisdiction?
- Yes
- No
- Don’t know

Question 43
Does your agency have regulations on construction emission that contractors must comply for construction?
- Yes
- No
- Don’t know

Question 44
Does your agency attempt to mitigate harmful pollutant released into the atmosphere during pavement construction or maintenance activities?
- Yes
- No
- Don’t know

Question 45
If the answer to the previous question is Yes, for which of the following do you have a mitigation program?
- CO₂
- CO
- NOₓ
- SO
- Ozone
- Don’t know
- Other, please specify:

Question 46
Do you have any other comments regarding air quality/emissions?
- Yes
- No
- If yes, what are they?

6—Water Quality Information:

Question 47
Does your agency consider water quality in routine decision making?
- Yes
- No
- Don’t know

Question 48
Are you aware if governmental regulations that exist for transportation maintenance?
- Yes
- No
- Don’t know

Question 49
How important do you think to have control plan construction water discharge?
- Very Important
- Somewhat Important
- Neutral
- Not Important

Question 50
Does your agency provide guidelines in controlling pavement maintenance practices that could impact water quality?
- Yes
- No
- Don’t know
Question 51
Do you have any other comments regarding Water Quality and Maintenance?

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>If yes, what are they?</th>
</tr>
</thead>
</table>

7—Other Factors of Sustainability:

Question 52
Does your agency consider energy consumption when selecting maintenance or preservation treatments (i.e. emulsions versus hot mix, warm mix, etc)?

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Don’t know</th>
</tr>
</thead>
</table>

Question 53
Does your agency consider other factors that promote environmental benefits?

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Don’t know</th>
<th>If yes, what are they?</th>
</tr>
</thead>
</table>

8 – General Maintenance/Preservation Program Information:

Question 54
How often does your agency revise or update its maintenance/preservation/material specifications?

<table>
<thead>
<tr>
<th></th>
<th>Specifications have been reviewed and updated within the past 5 years</th>
<th>Specifications have been reviewed and updated within past 6 to 10 years</th>
<th>Specifications have not been reviewed and updated for the past 10 years or more</th>
<th>Don’t know</th>
</tr>
</thead>
</table>

Question 55
Does your agency perform routine maintenance activities with in-house staff?

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>If no, skip to question 60</th>
</tr>
</thead>
</table>

Question 56
Does your agency stockpile of pavement maintenance materials?

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

Question 57
Does your pavement maintenance specification provide instructions on material storage and stockpiling?

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>No pavement maintenance specifications</th>
</tr>
</thead>
</table>

Question 58
Does your agency monitor the quality of material and storage environment of the material being used in pavement maintenance activities?

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

Question 59
Do you think that monitoring stockpile of material quality would allow better utilization of the material (such as providing easier construction, better performance in field)?

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>No opinion</th>
</tr>
</thead>
</table>

Question 60
How important to environmental protection is cleaning maintenance equipments at the end of pavement maintenance activity?

<table>
<thead>
<tr>
<th></th>
<th>Very important</th>
<th>Important</th>
<th>Neutral</th>
<th>Not important</th>
<th>Not even considered</th>
<th>No opinion</th>
</tr>
</thead>
</table>
Question 61
Does your agency provide written guidelines in maintaining or cleaning construction/maintenance equipment?

☐ Yes  ☐ No  ☐ Don’t know

Question 62
Which of the below lists of pavement performance indicators, does your agency use to govern its maintenance/preservation program? (Check all that apply.)

☐ International Roughness Index (IRI)  ☐ Pavement Condition Index (PCI)
☐ Distress Manifestation Index (DMI)  ☐ Riding Comfort Index (RCI)
☐ Pavement Quality Index (PQI)  ☐ Structural Adequacy Index (SAI)
☐ Surface Distress Index (SDI)  ☐ Friction/skid number

Other, please specify:

Question 63
Please rate the following treatments with regard to your perception of its sustainability.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Very Sustainable</th>
<th>Sustainable</th>
<th>Neutral</th>
<th>Not Sustainable</th>
<th>Not Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt Treatments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crack seal</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Hot patch pothole repairs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cold patch pothole repairs</td>
<td></td>
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<tr>
<td>Fog seal</td>
<td></td>
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<tr>
<td>Slurry seal</td>
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<tr>
<td>Microsurfacing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chip seal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thin hot mix overlay</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Asphalt level-up</td>
<td></td>
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</tbody>
</table>

Concrete Treatments

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Very Sustainable</th>
<th>Sustainable</th>
<th>Neutral</th>
<th>Not Sustainable</th>
<th>Not Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultra-thin white topping</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concrete crack sealing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concrete joint sealing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diamond grinding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milling/grooving</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shotblasting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Partial depth concrete repair</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slab mud jacking</td>
<td></td>
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<td></td>
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<tr>
<td>Dowel bar retrofit</td>
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</tbody>
</table>

Question 64
Would you be filling to share a case study on one or more sustainable maintenance/preservation treatments with which your agency has had either a success or failure?

☐ Yes  ☐ No  ☐ Don’t know

Do you have any other comments on sustainable pavement maintenance/preservation that you would like to share with the research team?

Additional comments: