

Filtering protocol for innovative paving materials, including waste derived materials

Helena Lacalle Jiménez¹, Jessica Tuck¹, Iswandaru Widyatmoko¹, Robin Hudson-Griffiths², Arash Khojinian², Malcolm Simms³, David Giles⁴

¹AECOM, ²Highways England, ³Mineral Products Association, ⁴Eurobitume UK

Abstract

Drivers towards enhanced sustainability, efficiency and performance in pavement construction have resulted in innovative developments including the use of non-bituminous, non-mineral and waste-derived products under a broad heading of “innovative paving materials”. The focus is often on specific benefits associated with composition (such as recycled content) and/or use (for example durability). There is an increasing trend to focus on innovation without fully assessing the impact of the application on the pavement industry, and without holistic consideration of the impact of these technologies. Consequently, there is a need to develop an inclusive protocol, to assess and manage impacts including standardisation of process, requirements and considerations, to support all stakeholders at the various stages of technology development. This paper presents findings from a collaborative research project between Highways England, The Mineral Products Association (MPA), Eurobitume UK and AECOM, where a Filtering Protocol is under development. The Filtering Protocol will provide an inclusive regulatory and technological assessment of the suitability of innovative paving materials intended for use on Highways England’s Strategic Road Network (SRN), which will be independent of source (primary, by-product, manufactured, recycled and waste stream). The Filtering Protocol is being developed for use by any individual or organisation proposing an innovative paving material, use of an innovative paving material in their processes, or, use of an innovative paving material in a pavement asset. The Protocol includes input from UK industry and wider stakeholders responsible for safety, environmental, waste and technical requirements. The next steps will be to validate the Protocol with a wider industry stakeholder engagement before seeking to incorporate the Filtering Protocol within Highways England published documents for implementation.

1. INTRODUCTION

Increasingly, non-bituminous, non-mineral and waste-derived products are being proposed as novel additives or components for inclusion in paving materials; hereinafter they are referred to as “innovative paving materials”. While this proposal may address individual sustainability challenges faced by the respective industries producing these products, the potential impacts on the whole-life performance of the materials into which they are proposed to be adopted in road pavements are often not fully addressed or appropriately benchmarked from a holistic standpoint. For example, some waste-derived additive streams may not comply with the UK End of Waste (EoW) criteria themselves and/or have the potential to limit future recycling and reuse of the paving products.

The filtering protocol is under development to assess innovative paving materials and/or their components to ascertain if they are appropriate for use in pavements. This protocol should be inclusive, considering established Standards and UK requirements such as (but not exclusively): Health & Safety, EoW, recyclability, environmental regulatory requirements, user technology and mechanical properties.

2. SCOPE

This paper presents a Filtering Protocol which is being developed to facilitate the assessment of the suitability of innovative paving materials proposed for use as a paving material in the Strategic Road Network (SRN) in England. A paving material could be anything from additives, modifiers, fillers, binders, natural or manufactured aggregates, hydraulically bound mixtures, asphalt mixtures and concrete, to all types of admixtures or any other constituent used in a mixture proposed to be incorporated in the structure of a pavement.

This Filtering Protocol will apply to all innovative paving materials, independent of source (primary, by-product, manufactured, recycled and waste stream). However, some of the requirements will be specific for by-products or materials originated from a waste stream and will not apply to materials coming from a primary source.

2.1. Who should be using the Filtering Protocol?

The Filtering Protocol will be designed to be used by any individual or organisation gathering the information necessary for the assessment of an innovative paving material, herein referred to as the “User”, or by an individual or organisation assessing or checking the information provided, herein referred to as the “Reviewer”.

Based on the development stage of the innovative paving material the User and the Reviewer may be one or more of the parties defined below:

- An individual or organisation proposing the innovative paving material, herein referred to as the “Innovator”.
- An individual or organisation that may incorporate the innovative paving material in their products or processes, herein referred to as the “Supply Chain”.
- An individual or organisation that may authorise the use of the innovative paving material in a pavement asset, herein referred to as the “Asset Manager”.

2.2. Purpose of the Filtering Protocol

The Filtering Protocol will be developed to support sustainable innovation and efficient use of paving materials and their constituents. It will be applicable in Highways England’s SRN. The Protocol is intended to be read in conjunction with the “Assessment procedure of ‘innovative’ techniques and materials” [1] and the “Pilots and trials guidance” [2].

In addition to the Filtering Protocol, it is advised to refer to the PAS 440:2020 “Responsible Innovation - Guide” [3] to understand responsible development of innovative solutions.

3. DEVELOPMENT OF THE FILTERING PROTOCOL

For the development of the Filtering Protocol the following documents have been considered:

- The Waste and by-product definitions in the EU Waste Framework Directive (WFD 2008/98/EC) [4];
- The Environmental Agency EoW and by-product assessment (IsItWaste tools) [5];
- REACH chemical regulations [6];
- The Environmental Agency risk assessment guidance [7].

3.1. How to use the Filtering Protocol

The requirements included in the Filtering Protocol, will not affect permitting; or any other legal requirements, including the obligations of producers, to hold an environmental permit (including an exception) and to comply with its conditions when transporting, storing and processing waste and by-products. The Filtering Protocol will include guidance on good practice to support the development of sustainable innovations for the pavement industry.

The Filtering Protocol comprises 4 stages as illustrated in Figure 1. The User will be required to follow these stages and provide the relevant information and documentation to the Reviewer. Notes for guidance in the Protocol will help the User compile the information and will help the Reviewer check the completeness of the submission and evaluate the innovative paving material. Checklists will also be developed to assist the User and Reviewer assessing the suitability of the innovation. The proposed Checklists will be:

- Checklist A Technology Readiness Level
- Checklist B Material characterization and comparator selection
- Checklist C Scenario selection and requirements identification
- Checklist D End of waste / by-product
- Checklist E Health and Safety
- Checklist F Environmental assessment
- Checklist G Materials production, installation and use
- Checklist H Technical requirements
- Checklist I Market assessment

Checklists A to C are included in this paper while Checklists D to I are currently being developed.

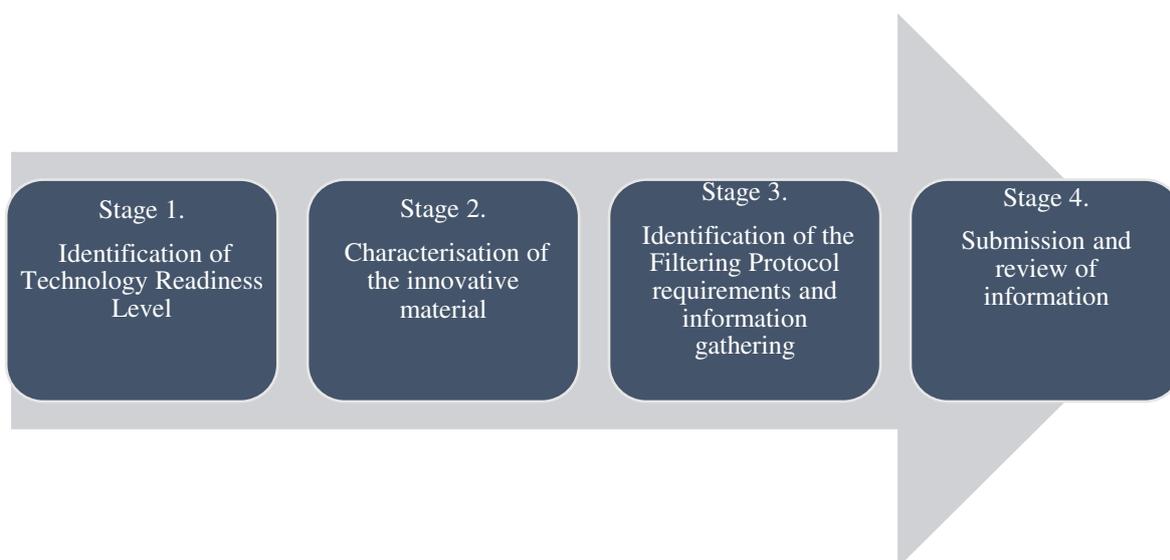


Figure 1 Filtering Protocol stages

3.2. Stage 1. Identification of the Technology Readiness Level.

In Stage 1, the minimum parties to be involved in the discussion regarding the innovative paving material will be dependent on the development stage of the innovation, which in turn will depend on the Technology Readiness Level of the innovative paving material. The user will be requested to complete a Checklist (Checklist A as per Table 1) to report the Technology Readiness Level of the innovation.

Table 1 Checklist A. Technology readiness level

Technology Readiness Level	Description	Select as appropriate
1	Basic principles observed and reported.	
2	Technology concept and/or application formulated.	

3	Analytical and experimental critical function and/or characteristic proof-of-concept.	
4	Technology validation in a laboratory environment.	
5	Technology basic validation in a relevant environment.	
6	Technology model or prototype demonstration in a relevant environment.	
7	Technology prototype demonstration in an operational environment.	
8	Actual technology completed and qualified through test and demonstration.	
9	Actual technology qualified through successful mission operations.	

Early engagement with all parties involved in the process is recommended; however, depending on the Technology Readiness Level, the minimum parties to be involved at the outset are:

- In the early stage of development (Technology Readiness Level between 1 and 5), it is envisaged that the Innovator will be looking for support from the Supply Chain to develop the innovative paving material. In this scenario the Innovator is the Filtering Protocol's User and the Supply Chain is the Reviewer. If the Innovator is the Supply Chain, this Filtering Protocol may be used to evaluate the suitability of the innovative paving material internally.
- In the later stages of development (Technology Readiness Level between 6 and 9), trials should be carried out on the SRN; therefore, the involvement of the Asset Manager is essential. In this scenario, the Asset Manager is the Reviewer and the User is a combination of the Innovator and the Supply Chain.

3.3. Stage 2. Characterisation of the innovative paving material.

Stage 2 will identify a suitable comparator for the assessment. This will help when completing Stage 3.

The comparator is the agreed benchmark material or technology for assessing the innovative paving material; ideally at the mixture rather than the constituent level. This must be an existing material commonly used in the pavement industry.

To select the comparator, the innovative paving material will be classified either as a mixture or as a constituent. The user will be requested to complete a Checklist (Checklist B as per Table 2) to report the type of material and the selected comparator.

Table 2 Checklist B. Material characterisation

Category	Material	In accordance with the relevant part of:	Select as appropriate
Mixture	Bituminous mixture	BS EN 13108	
	Concrete	BS EN 206, BS 8500 or BS EN 13877	
	Hydraulically bound mixture	BS EN 14227	
	Unbound mixture	BS EN 13285	
Constituent	Additive	BS EN 13108 or BS EN 197	
	Admixture	BS EN 197	
	Aggregate	BS EN 13043 or BS EN 12620 or BS EN 13242	
	Bituminous binder	BS EN 12591 or BS EN 13924 or BS EN 14023 or BS EN 13808	
	Cement	BS EN 197	
	Filler	BS EN 13043 or BS EN 12620	
	Hydraulic binder or their constituents	BS EN 197-1 or BS EN 15167-1 or BS EN 14227-4 or BS EN 459-1 or BS EN 13282	
-	Modifier	BS EN 12597	
-	Other (to be specified)		
State comparator			

3.4. Stage 3. Identification of the Filtering Protocol requirements and information gathering.

The aim of Stage 3 will be to identify the information that should be submitted and reviewed in Stage 4 to ascertain if the innovative paving material is suitable for use in pavements.

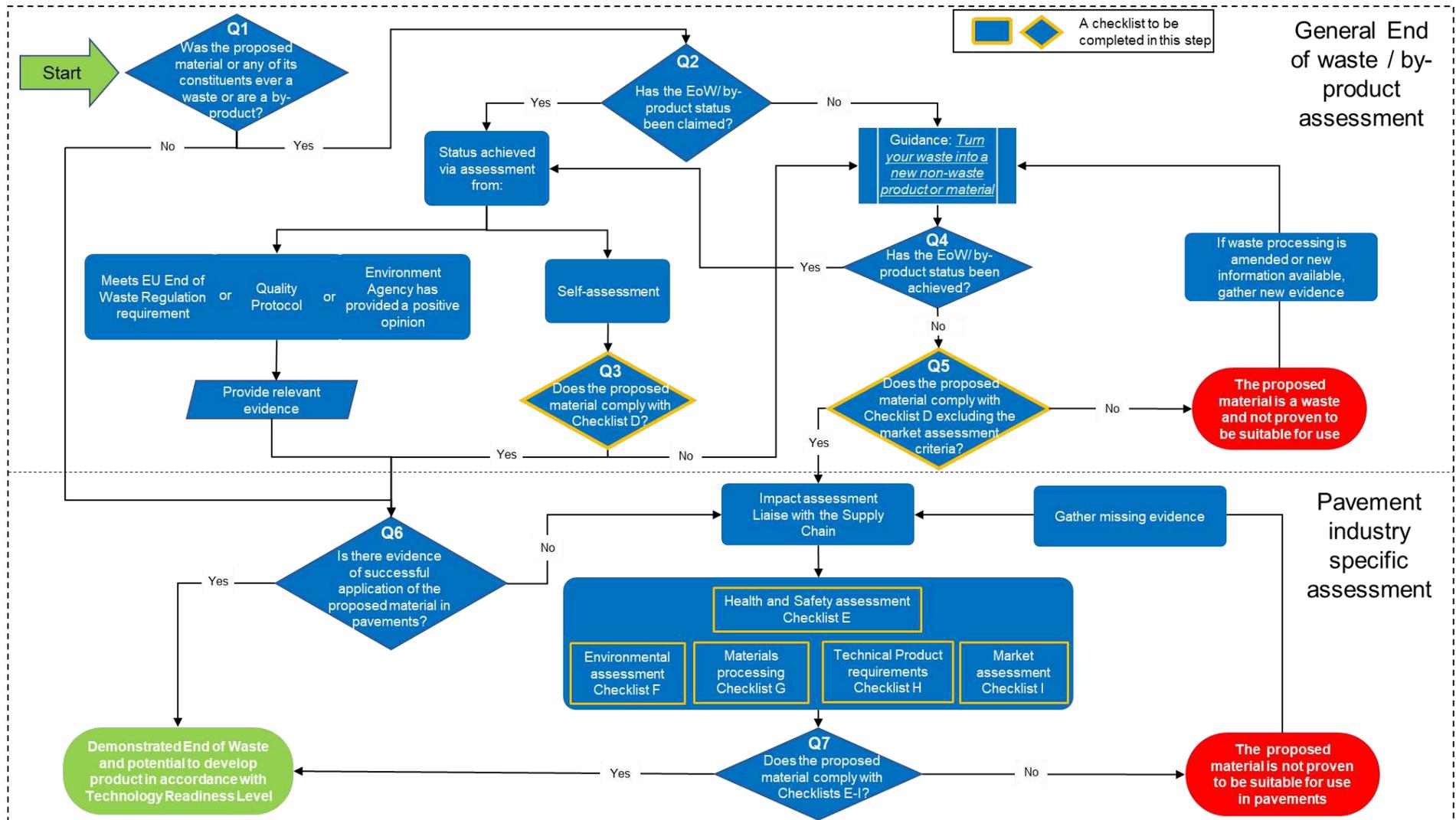
Several Checklists will be developed to guide the User and the Reviewer through the evaluation of the innovative paving material. The aim of these Checklists will be to make sure all aspects in terms of achievement of EoW or by-product status (if necessary), Health & Safety, Environment, Performance of the material and Market assessment are considered when evaluating the innovative paving material.

The Flowchart in Figure 2 will help the User and the Reviewer ask the appropriate questions, gather and review the relevant information.

The User must navigate the Flowchart and gather the information required in each step. The process will lead the User to either a red or green shape on the Flowchart (outcome).

If by answering the questions the outcome terminates in a red shape, then the innovation is not currently considered suitable for use. This will direct the User to gather further information, re-consider their upstream processes, or if necessary, withdrawn the proposal.

If by answering the questions the result is that the green shape is reached, then submission of the evidence/information gathered is recommended. If the Reviewer does not agree with the level of information provided or the answers given to the questions, the User should be requested to provide further information.



Navigation through the Flowchart from Figure 1 may result in 11 possible scenarios as summarised in Table 3. Each scenario can be linked to the submission requirements.

The User will be required to complete a Checklist (Checklist C as per Table 4) and the Reviewer may use this to ascertain that all the information has been submitted.

Table 3 Summary of scenarios

Scenario	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Outcome
1	Yes	Yes ¹	Yes	-	-	Yes	-	✓
2	Yes	Yes ¹	Yes	-	-	No	Yes	✓
3	Yes	Yes ¹	Yes	-	-	No	No	X
4	Yes	Yes	No	Yes	Loop, see scenarios 1 to 3			
5	Yes	Yes	No	No	Yes	-	Yes	✓
6	Yes	Yes	No	No	Yes	-	No	X
7	Yes	Yes	No	No	No	-	-	X
8	Yes	No	-	Loop, see scenarios 4 to 7				
9	No	-	-	-	-	Yes	-	✓
10	No	-	-	-	-	No	Yes	✓
11	No	-	-	-	-	No	No	x

Notes:
 1 If EoW/by-product status was not achieved via a self-assessment, skip Q3 and go straight to Q6.
 ✓ Demonstrated EoW/by-product status (if applicable) and potential to develop product
 X The innovative paving material is a waste or is not proven to be suitable for use in pavements. New evidence may be gathered to re-asses the material.

Table 4 Checklist C. Scenario selection and requirements identification

Scenario ¹	Checklist D	Checklist E	Checklist F	Checklist G	Checklist H	Checklist I
1 ²	✓	x	x	x	x	x
2 ²	✓	✓	✓	✓	✓	✓
3	Submission of the information/evidence is not recommended in this case.					
4	Follow the requirements of the selected Scenario (Scenario 1, 2 or 3)					
5	✓	✓	✓	✓	✓	✓
6	Submission of the information/evidence is not recommended in this case.					
7	Processing of the material should be amended, or further information provided.					
8	Follow the requirements of the selected Scenario (Scenario 4, 5, 6 or 7)					
9 ³	x	x	x	x	x	x
10	x	✓	✓	✓	✓	✓
11	Submission of the information/evidence is not recommended in this case.					

Notes:
 1. Checklists A, B and C need to be compiled in all scenarios.
 2. Checklist D only needs to be completed if EoW/by-product status was achieved via a self-assessment or if the market assessment criteria has not been met. If EoW/by-product status was achieved by any other route specified in the Flowchart, then evidence must be submitted as part of the EoW assessment submission (notes for guidance will be provided).
 3. None of the checklists of this Filtering Protocol is required for submission if the scenario selected is Scenario 9. However, evidence of successful application of the innovative paving material in pavements must be demonstrated as detailed in the notes for guidance for Q6 of the Flowchart.

Checklists D to I will be developed to help the User and the Reviewer consider all the aspects related to:

- EoW and by-product status achievement;
- Health, safety, environment, technical performance of the innovative paving materials; and
- Analyse the possible market.

It is here that the comparator selected in Stage 3 will be used to ascertain if the innovative paving material will pose any advantages or disadvantages in terms of a broad range of health, safety, environment or technical performance when compared to materials currently used in pavements. This process may result in the need for new or bespoke methods of assessment being identified to evaluate performance when using particular innovative materials, which may not be applicable from the comparator methods.

The final aim of this protocol is to aid conversations between the Innovator, the Supply Chain and the Asset Manager and to have a transparent process to review the suitability of these materials for their use in pavements.

3.5. Stage 4. Submission and review of information

All the relevant information identified in Stages 1 to 3 will be required to be submitted and reviewed. Depending on this process there are three different possible outcomes, identified on the Flowchart from Figure 1 as green or red shapes:

- Demonstrated EoW/by-product status or the innovative paving material was never a waste and there is potential to develop the material to be used in pavements. In this case, there is enough evidence to consider the development of the innovative paving material following the Technology Readiness Level process.
- The innovative paving material is a waste not proven to be suitable for use. In this case the information provided is not enough to demonstrate EoW/by-product status. Processing of the innovative paving material should be amended, or further information provided.
- The innovative paving material is not proven to be suitable for use in pavements. In this case, further evidence is needed to demonstrate the innovative paving material is appropriate for the selected application.

The checklists aim to help identify areas of concern or missing information. If the outcome of the Filtering Protocol ends up being one of the red shapes, one of the following actions can be considered: (1) new evidence could be collected; (2) any aspect of the waste/by-product processing may need to be amended; (3) the use of the innovative paving material may be reconsidered; or, (4) the proposal may be dropped.

4. CONCLUDING REMARKS

The use of the Filtering Protocol will help Innovators, the Supply Chain and Asset Managers evaluate the suitability of innovative paving materials. It provides structured and clear guidance to demonstrate the performance characteristics of potential innovative paving materials, as well as any health, safety and environmental impacts arising from the production, installation and use of the materials. The protocol accounts for market evaluation of the new materials and helps identify potential advantages from the use of the innovative paving materials when compared to the current paving materials.

The Filtering Protocol is being finalised with feedback from the industry project members (Highways England, MPA and Eurobitume UK). The next step will be to validate the Protocol with a wider industry stakeholder engagement before seeking to incorporate the Filtering Protocol within Highways England published documents for implementation.

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