JRC TECHNICAL REPORTS

Revision of EU Green Public Procurement Criteria for Road Construction

Proposal of product scope and definition

Elena Garbarino, Oliver Wolf (JRC IPTS Seville)

Linda Høibye, Frans Christensen (COWI)

March 2013

Joint
Research
Centre

European Commission
Joint Research Centre
Institute for Prospective Technological Studies (IPTS)

Contact information
Elena Garbarino, Rocío Rodríguez Quintero
Address: Joint Research Centre, Edificio EXPO, Calle Inca Garcilaso 3, E-41092 Sevilla, Spain
E-mail: JRC-IPTS-ROADS@ec.europa.eu
Tel.: +34 954 487 179

http://susproc.jrc.ec.europa.eu/
http://ipts.jrc.ec.europa.eu/

This publication is a Technical Report by the Joint Research Centre of the European Commission.

Table of Contents

1. DEFINITION AND SCOPE

This draft proposal outlines recommendations for the definition of the Road Construction product group to be used in the revision of the criteria for this product group.

This draft also addresses the scope of the study - in particular the previous criteria for road construction and traffic signs which will be evaluated and the proposals presented for their revision.

1.1 Scope and definition of the previous EU GPP criteria on road construction and traffic signs

The following recaps the scope of the previous EU GPP criteria for Road Construction and Traffic Signs[1].

1.1.1 Scope and definition for road construction

The construction of some roads falls within the remit of Council Directive 97/11/EC of 3 March 1997 amending Directive 85/337/EEC on the assessment of effects of certain public and private projects on the environment. These roads include:

- Construction of motorways and express roads (Annex 1, 7(b))
- Construction of new road of four or more lanes or realignment and/or widening of an existing road of two lanes or less so as to provide four or more lanes where such new road or realigned and/or widened section of road would be 10 km or more in a continuous length (Annex 1, 7 (c)).
- Construction of roads, harbours and port installations, including fishing harbours (projects not included in Annex I) (Annex 2, 10(e)).

In the current criteria road construction is defined to be the preparation and building of a road using materials including aggregate[2], bituminous binders and additives that are used for the sub-base, road-base and surfacing layers of the road. The subject matter of the criteria for road construction is defined as: *Construction of new road or renovation of existing roads using environmentally sound construction methods and materials*.

1.1.2 Technical description of a road construction

When a vehicle moves along a road it concentrates its considerable weight through the relatively small surface area of the tyres onto the road. The construction of modern paved roads is designed to spread

[1] http://ec.europa.eu/environment/gpp/pdf/road_construction_and_traffic_signs_GPP_product_sheet.pdf

[2] http://www.uepg.eu/what-are-aggregates, http://ftp.jrc.es/EURdoc/JRC53238.pdf and http://www.cen.eu/cen/Sectors/TechnicalCommitteesWorkshops/CENTechnicalCommittees/Pages/default.aspx?param=6136&title=Aggregates

the weight of the vehicles vertically and horizontally, so that the ground underneath the road carries the weight without distorting[3]. Materials used in the construction of roads can be described in two main ways[4]:

1. By the pavement layer
2. By the type of material

These are described in more detail in the subsequent sections.

Pavement layers

The construction of modern paved roads proceeds along a number of stages. Initially the top soil and the vegetation are removed from the area to be paved. The depth of excavation will depend on the condition of the ground, the sub-grade; more excavation with backfilling may be required, or the ground may require compacting. The strength of the soil is dependent on its composition of solid matter, water and air. If necessary, where the soil is weak[5], lime or cement can be used to stabilise the upper part of the sub-grade and reduce the maintenance requirements of the road during its lifetime. Advanced materials can be brought in to provide extra strength if water tables are high, or subsoil is weak. Alternatively, if the road already exists but being resurfaced or reconstructed then layers of the existing road will be removed. It is at this stage the drainage systems must be dug and installed.

Once construction begins, roads are built in layers. There are two main types of road construction:

- Flexible pavement roads (which can incorporate composite pavements)
- Rigid (concrete) pavements

Flexible pavements

Flexible pavements reduce the level of stress being transmitted vertically through the road as a vehicle passes along it into the soil below the road. Flexible pavements are built using a number of layers built on top of each other. The actual number varies depending on local conditions and methods of description. The layers comprise compacted granular material such as crushed rock, gravel or sand that is bound together by bitumen based binders in some layers. The thickness of the layers is dependent of the expected traffic volumes - more traffic means a greater thickness of layers is required.

In Figure 1 an example diagram of a road illustrates the roles of the various layers as described below:

1. The sub-base: this can be the first layer to be built and is placed directly onto the sub-grade (the underlying soil). It is built from aggregates compacted together. The sub-base can be unbound or

[3] http://onlinemanuals.txdot.gov/txdotmanuals/pdm/pavement_types.htm#i1009122 and http://www.fhwa.dot.gov/index.cfm

[4] "Alternative materials in road construction", 2nd edition, Sherwood, P., 2001; http://onlinemanuals.txdot.gov/txdotmanuals/pdm/pavement_types.htm#i1009010 and http://www.trafikverket.se/Foretag/Bygga-och-underhalla/Vag/Tekniska-dokument/Vagteknik/Aldre-versioner-av-ATB-Vag/ATB-Vag-2005/ (in Swedish)

[5] http://www.fhwa.dot.gov/engineering/geotech/pubs/05037/05037.pdf (chapter 7.5 and .6) and http://vejregler.lovportaler.dk/ShowDoc.aspx?q=kalkstabilisering&docId=vd-20101209091911899-full (in Danish)

stabilized with one of various additives such as cement, lime, or other chemical additives to achieve an acceptable level of stiffness and bearing capacity. The purpose of the layer is to assist the spread of weight from a vehicle over the sub-grade, and to allow drainage into the sub-grade. A sub-base course is not always needed or used.

2. The road-base: This is the load bearing layer. The materials may therefore vary depending on the expected volume of traffic. Materials are based on granular aggregates and can either be bound or unbound.

3. The base course: The main function of this layer is to provide support for the top layer of the road and to provide protection for the underlying layers of the road.

4. The surface course and binder course: The surface course constitutes the top layer of the pavement and should be able to withstand high traffic- and environment-induced stresses without exhibiting unsatisfactory cracking and rutting in order to provide an even profile for the comfort of the user and at the same time possessing a texture to ensure adequate skid resistance. Depending on local conditions, functional characteristics such as skid resistance, noise reduction and durability are often required for surface courses. In some cases, for example where spray from vehicle wheels in wet conditions could be hazardous[6], rapid drainage of surface water is desired through a porous surface while in other cases the surface course should be impermeable in order to keep water out of the pavement structure.

   The binder course is the layer between the surface course and the base course.

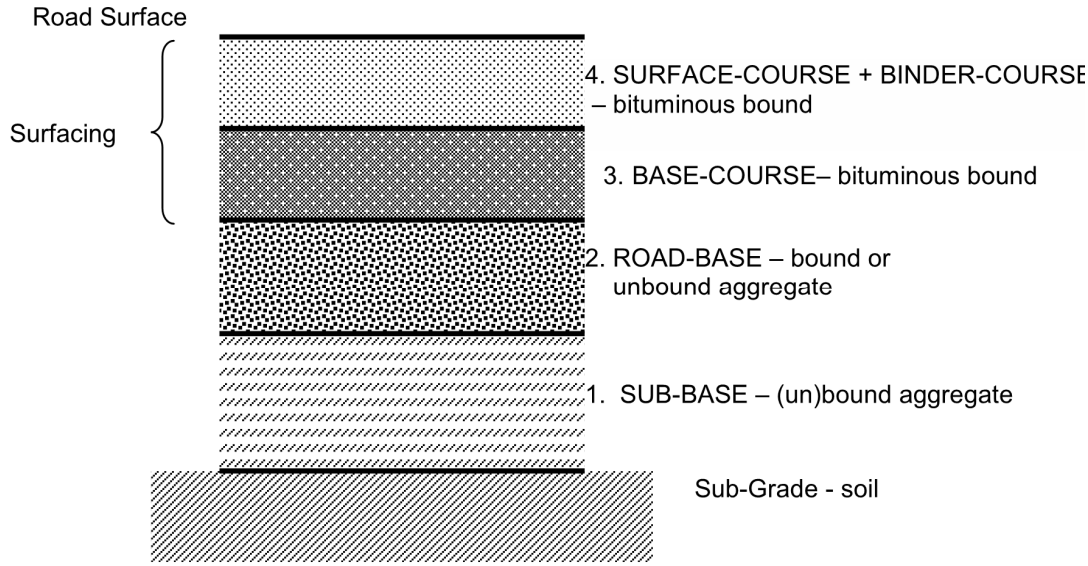

Figure 1: Diagram illustration the flexible pavement layer system[7]

[6] http://www.dft.gov.uk/ha/standards/dmrb/vol4/section2.htm and
http://www.fhwa.dot.gov/engineering/hydraulics/library_arc.cfm?pub_number=22&id=140
[7] from Croney, D & Croney, P (1997) Design and Performance of Road Pavements. 3rd edition. (McGraw Hill), pg.17

Depending on the local conditions, the bearing capacity of the sub-grade, the amount of traffic the road has to carry and the available road building materials, the road base can consist of two layers (a lower and an upper layer) and the same applies for the sub-base. A composite pavement can also be formed by using hydraulically bound materials with asphalt layers.

Rigid pavements

Rigid pavements are so named due to the still behaviour of the pavement. They tend to be used where high traffic loading is expected and are highly durable. It is possible to overcoat the rigid pavement with a bituminous layer that can be replaced when worn out which enhances the riding quality of the road and contributes to noise reduction.

Rigid pavements are usually made of concrete, and can consist of two layers above the sub-grade: the concrete slab and the sub-base, as shown in Figure 2. In addition, reinforcing materials, such as mesh, can be used in the concrete slab to prevent thermal and load cracking. Likewise slip membranes may be used between the slab and sub-base to prevent moisture entering into the lower layer, facilitate movement of the concrete layer and thus accommodate thermal expansion and contraction.

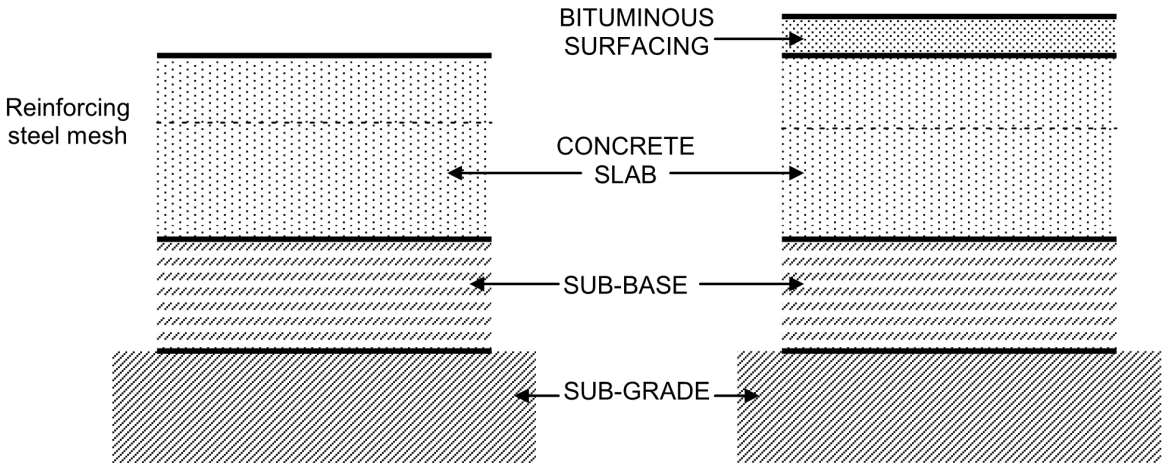

Figure 2: Rigid pavement layer system[8]

In both types of road construction recycled materials can be used, providing they are fit for purpose[9][10] and complying with the local standards and regulations. Such materials include reclaimed asphalt material, fly ash from coal power stations, crushed concrete, or bottom ash from waste incineration, steel slag or construction and demolition waste.

[8] from Croney, D & Croney, P (1997) Design and Performance of Road Pavements. 3rd edition. (McGraw Hill), pg.17
[9] Recycled aggregates, Digest 433, BRE, November 1998.
[10] http://aggregain.wrap.org.uk/procurement/how_to_procure/recycled_roads/index.html

1.1.3 Scope and definition for traffic signs

The key components of traffic signs[11] are:

- Sign facing containing the sign's message
- Substrate (backing) (the backing onto which the facing is attached)
- Fixing (the frame onto which the sign is mounted)

These components will be described in the following.

Sign facings

The sign face displays the intended visual message to the road user. Permanent traffic signs are generally created from vinyl. On top of this will be applied a highly reflective material such as High Intensity Prismatic sheeting or Diamond Grade Reflective Sheeting which are made from glass beads suspended within the material coatings. A sign that is not required to be reflective is likely to be faced with a further layer of clear vinyl. On to both types of sign is likely to be applied a further protective layer, which permits the easier removal of graffiti.

Substrates (backing)

The substrate is the backing material that the sign face will be attached to. Cost, strength, weight and durability determine the material to be used for this component. Typically aluminium or steel is used for permanent traffic signs, however plastics such as Glass-resin Reinforced Polymer are being used increasingly due to sign theft.

Fixings

The sign fixing is the component used to erect the sign. The materials used for this are determined by the application and location of the sign. Temporary signs are more often frame-mounted using plywood covered with plastic to reduce weathering, aluminium, or steel[12].

1.1.4 Outside the scope

The previous criteria for road construction and traffic signs did not include road markings (such as paints), road furniture (pedestrian walkways, bollards, overhead gantries and central reservations), street lighting, traffic signals, foundations or lighting of traffic signs, etc.

[11] According to the previous EU GPP criteria for Road Construction and Traffic Signs and IRF Working Group Environment, http://www.irfnet.ch/files-upload/events/studyday_june2011/Green_Public_Procurement_Note.pdf

[12] http://www.dft.gov.uk/ha/standards/dmrb/vol8/index.htm

1.2 Recommendations regarding revised definitions

It is recommended that the definitions in the previous criteria for a road construction are maintained concerning layer system.

Specifically for the diagrams showing the pavement layers it is recommended that the materials used are specified clearly:

Rigid pavements layer system

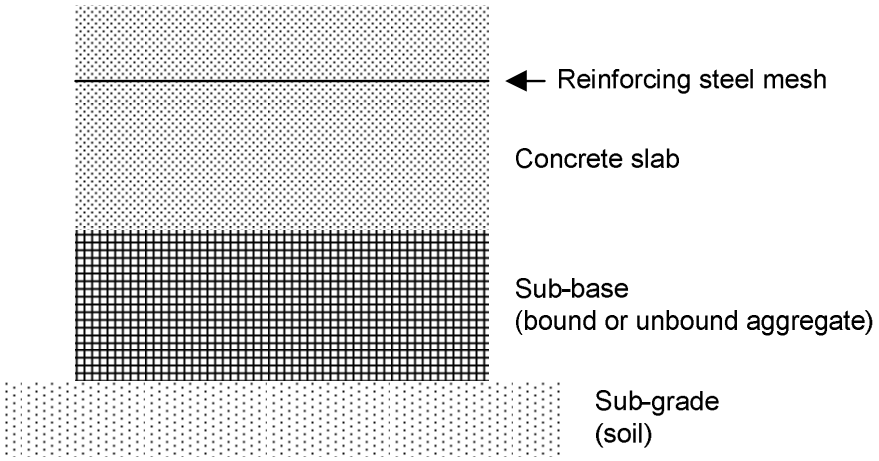

Figure 3: Rigid pavement layer system

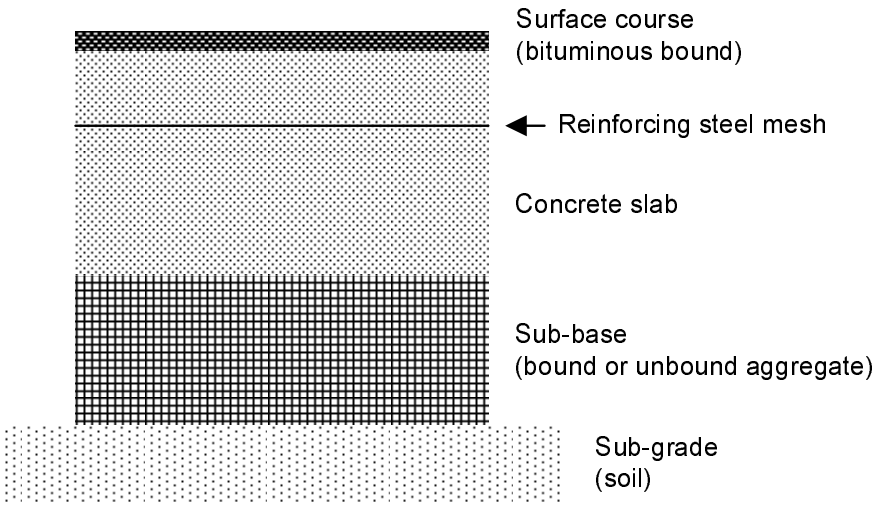

Figure 4: Rigid pavement layer system

Flexible pavement layer system

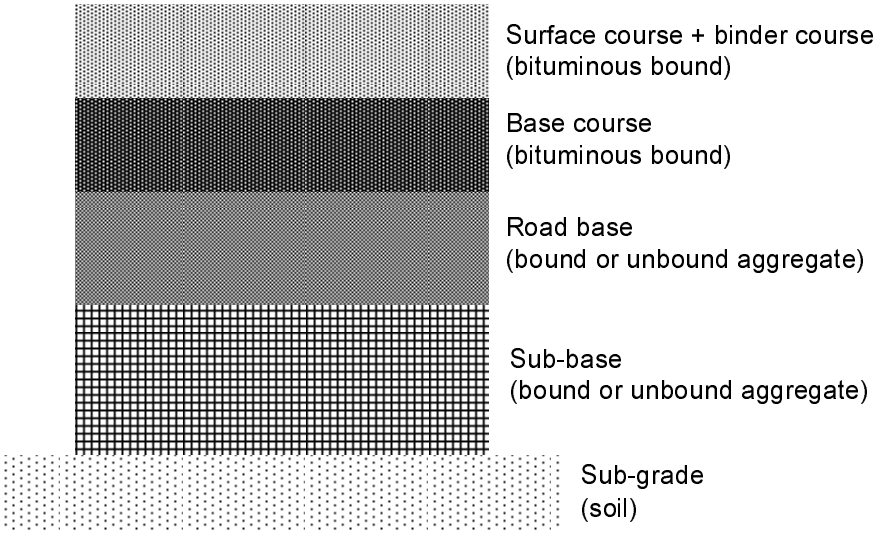

Figure 5: Flexible pavement layer system

Composite pavement layer system

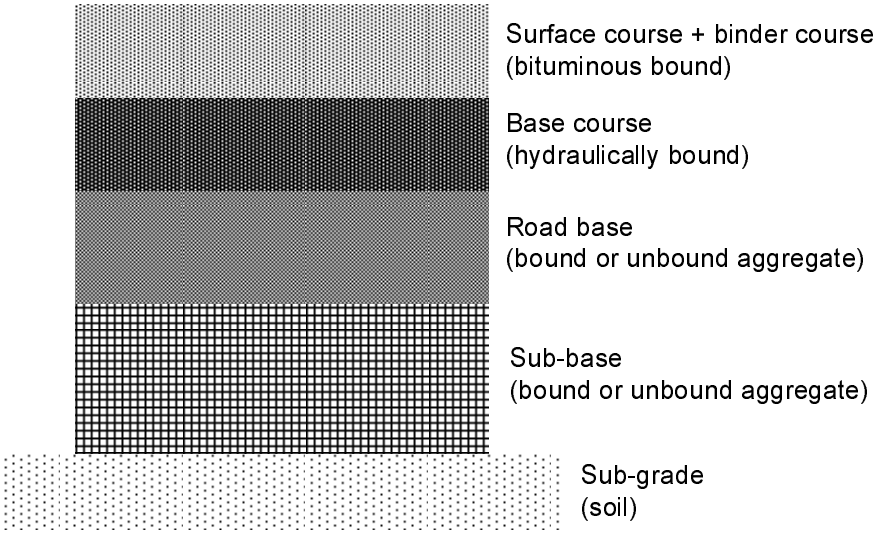

Figure 6: Composite pavement layer system

Material types used for the hydraulically bound base course can be found in EN 197-1 and 13282-1:2008.

1.3 Environmental key issues

1.3.1 Environmental key issues of road construction

This section briefly summarises the findings from a literature review regarding significant impacts related to the raw materials phase, materials production, construction, maintenance, furnishing, use and end-of-life of roads.

Regional climate, local design practices, geological and geotechnical conditions, budget, service life, material availability, sensitivity of the local environment, rolling resistance and many other factors play a role in the choice of road type, the design of the road construction etc.

Road constructions are thus a complex web of parameters which are individual in every road construction project. The complexity and thus diversified road projects makes the assessment of potential environmental impacts a challenging task. To identify the key environmental aspects, life cycle assessments of roads and construction materials have been studied along with other relevant publications.

These studies stress that the use phase is contributing to the largest potential environmental impacts caused by traffic (fuel consumption by cars and trucks) and indicate that this is the most important part of the road life cycle in terms of potential for improvements. The use phase should thus in any case be included in the product scope. An example is the Journal of Cleaner Production 33 (2012) "Life cycle energy consumption and GHG emission from pavement rehabilitation with different rolling resistance" by Ting Wang et al.: "omission of the use phase can lead to a major error in the analysis of the alternative pavement activities".

There are several technical aspects to consider when these environmental impacts must be reduced: rolling resistance, wind resistance, fuel type etc[13]. The use phase has to be considered at two different levels of the road design: the inclusion of the traffic has great significance when various routes are investigated during the early phases e.g. the planning phase. During the design and construction phases, the use phase has to be considered in relation to the choice of construction materials able to reduce the rolling resistance and hence to reduce the fuel consumption of vehicles. This topic has been investigated in several studies[14].

The second largest contributing phase is indicated to be the construction phase and thus caused by the use of materials (cement, bitumen, aggregate etc.). The main environmental impacts are resource

[13] "Energy use generated by traffic and pavement maintenance". VTI notat 36A-2012 by Robert Karlsson, Annelie Carlson and Ellen Dolk.
[14] http://re-road.fehrl.org/; http://miriam-co2.net/index.htm and http://tyrosafe.fehrl.org/

consumption, global warming, acidification and nutrient enrichment in the majority of the investigated studies[15].

Toxicity is not included in most of the obtained studies. One study indicates toxicity as an important potential environmental impact from the use of bitumen[16]. Another study indicates that toxicity can be a major contributor to the total environmental impacts due to leaching of salts to the groundwater. The primary reason for this potential environmental impact is road salting[17].

The transport of materials during the construction phase is also important when natural aggregate is compared to waste-derived materials (recycled or secondary aggregates) or by-products.

Maintenance and repair for road construction has varying environmental impact according to the literature review depending on the life time of the road, need for winter maintenance, traffic load etc. The main contributor to the impacts is the use of materials[18].

Several studies indicate that there is a clear connection between durability and sustainability aspects including environmental impacts. Thus when durable materials are used the need for maintenance is reduced.

1.3.2 Environmental key issues of traffic signs

As it is also highlighted in the previous EU GPP criteria, the literature indicates that there are no significant environmental gains, in a life cycle perspective, in using a particular material type over another in manufacturing a traffic sign during the full life cycle of a road. The greatest environmental gains can be reached by designing materials to be durable and recyclable, extending their lifetime and subsequently by recycling at their end of life. In the maintenance and operation phase, the main impacts are related to operations of re-plating and washing of traffic signs.

[15] "Life Cycle Assessment of Road. A pilot study for Inventory Analysis". Håkon Stripple, 2001 and "Life Cycle Assessment for road construction and use". EUPAVE, 2011.
[16] "Sensitivity of the LCA allocation procedure for BFS recycled into pavement structures" by Shahinaz Sayagh, Anne Ventura, Tung Hoang, Danis Francois and Agnés Jullien. 2010.
[17] Environmental assessment of roads constructed with and without bottom ash from minicipal solid waste incineration" from 2006. H. Birgisdóttir, K.A. Pihl, G. Bhander, M.Z. Hauschild and T.H. Christensen.
[18] "Life Cycle Assessment of Road. A pilot study for Inventory Analysis". Håkon Stripple, 2001

1.4 Proposed scope and definitions for the revision of the EU GPP criteria on road construction

In this section the proposed scope and definitions for the revised EU GPP criteria are described in detail.

Scope

Based on the literature review it is recommended to include all phases of the road construction in the product scope:

1. The raw materials phase
2. The production phase (manufacturing of materials for the road, transport of materials to the construction site etc.)
3. The road construction phase
4. The use phase
5. The maintenance and operation phase
6. The end-of-life phase

Furthermore, in addition to the road itself, it is suggested to include earth mounds (noise barriers of soil) in the product scope as they are an integrated part of the earth works during construction of a road, for a closed loop soil balance.

Also the drainage and run off systems must be included as it was also the case in the previous EU GPP for Road Construction and Traffic Signs.

The following is suggested to be excluded from the scope:

1. Road markings
2. Street lighting and traffic signals
3. Traffic signs
4. Information systems
5. Noise barriers requiring construction materials as metals, wood etc.
6. Foundations or lighting of traffic signs
7. Other types of road furniture (pedestrian walkways, bollards, overhead gantries and central reservations)

The reasons for excluding the above mentioned products and constructions are mentioned below. The reasons are based on the literature review.

- **Road markings** are products quite similar to paints and varnishes and for this reason they will be included in the EU GPP criteria for paints and varnishes[19].
- The reason for exclusion of **street lighting and traffic signals** is that these products are covered by separate EU GPP criteria[20].

[19] http://susproc.jrc.ec.europa.eu/paints/
[20] http://ec.europa.eu/environment/gpp/eu_gpp_criteria_en.htm

- It is recommended that **traffic signs** including foundations are excluded from the product scope because traffic signs are of minor importance to the total potential environmental impacts[21]. The conclusion is based on the results from the literature review where Stripple indicate approximate influence of the traffic signs below 1% of the phases raw materials extraction, construction, operation and maintenance. If the daily traffic is taken into account (including the fuel consumption of cars and trucks), the traffic signs only contribute to less than approx. 0,1% of the total potential environmental impacts during the full life cycle of a road. This exclusion was likewise settled within the Criteria for the Sustainable Public Procurement of Roads[22] developed by the Dutch Ministry of Housing, Spatial Planning and the Environment in 2010. Moreover, traffic signs are not taken into consideration in the GPP criteria for road construction actually under development by the Italian Environment Ministry[23].
- Typically, **information systems** are energy effective and therefore use relatively small amounts of energy compared to the energy consumption through the full life cycle of a road. Furthermore, information systems are of varying importance depending on the energy sources used for electricity production. It is thus recommended that information systems are excluded from this product scope - but it can be relevant to develop specific criteria for these products to ensure public green procurement for information systems.
- **Noise barriers requiring construction materials** and other road furniture have, based on the literature review, not been identified as contributing to large potential environmental impacts during the full life cycle of a road construction.
- **Foundations or lighting of traffic signs** are of minor importance to the total environmental impact. Lightning of traffic signs are energy effective and therefore use relatively small amounts of energy compared to the energy consumption through the full life cycle of a road.
- **Other types of road furniture** (pedestrian walkways, bollards, overhead gantries and central reservations) are based on the literature review typically of minor importance to the total potential environmental impacts. Therefore it is recommended that these products are excluded from the EU GPP criteria for road construction.

The criteria should be developed for roads in general and thus apply for all typical roads in all EU Member States.

Overall, it is thus suggested to focus the project resources on what is clearly indicated to be the major source of environmental impacts not covered by other criteria: The life cycle of the road itself.

Further, given the diversity of roads, it is already challenging to develop usable and clear criteria for road construction. Adding further issues to the scope would add further complexity, possibly resulting in separate criteria for those additions within the GPP criteria to be developed (as was the case in the previous GPP criteria for road construction and traffic signs).

---

[21] "Life Cycle Assessment of Road. A pilot study for Inventory Analysis" by Håkon Stripple. Second revised revision, March 2001.

[22] http://www.senternovem.nl/mmfiles/Criteriadocument%20Roads.doc_tcm24-330573.pdf

[23] Personal communication

LB-NA-XXXX-EN-C

As the Commission's in-house science service, the Joint Research Centre's mission is to provide EU policies with independent, evidence-based scientific and technical support throughout the whole policy cycle.

Working in close cooperation with policy Directorates-General, the JRC addresses key societal challenges while stimulating innovation through developing new standards, methods and tools, and sharing and transferring its know-how to the Member States and international community.

Key policy areas include: environment and climate change; energy and transport; agriculture and food security; health and consumer protection; information society and digital agenda; safety and security including nuclear; all supported through a cross-cutting and multi-disciplinary approach.

Publications Office

ISBN 978-92-79-22551-2