Indicators for the sustainability assessment of roads

ICS:

Descriptors:
Contents

Introduction ........................................................................................................................................ 3
1 Scope ........................................................................................................................................... 6
2 Normative references.................................................................................................................. 6
3 Terms and definitions .................................................................................................................. 6
4 Abbreviations ............................................................................................................................ 8
5 Indicators ..................................................................................................................................... 9
5.1 List of indicators ....................................................................................................................... 9
5.2 Environmental indicators ....................................................................................................... 10
5.2.1 SPI 1: Primary materials consumption ............................................................................. 10
5.2.2 SPI 2: Secondary materials consumption ...................................................................... 10
5.2.3 SPI 3: Materials to be reused or recycled ........................................................................ 11
5.2.4 SPI 4: Energy demand (use of renewable energy sources/non renewable energy sources) .............................................................................................................................. 11
5.2.5 SPI 5: Waste (Hazardous waste/non-hazardous waste/radioactive waste) ....................... 12
5.2.6 SPI 6: Global Warming Potential (GWP) ......................................................................... 12
5.2.7 SPI 7: Formation potential of tropospheric ozone (POCP) .............................................. 14
5.2.8 SPI 8 Depletion potential of the stratospheric ozone layer (ODP) .................................... 15
5.2.9 SPI 9: Acidification potential of soil and water (AP) ......................................................... 16
5.2.10 SPI 10: Eutrophication Potential (EP) ............................................................................. 17
5.2.11 SPI 11: ADP-elements ...................................................................................................... 19
5.2.12 SPI 12: ADP-fossil fuels ................................................................................................... 20
5.2.13 SPI 13: Human Toxicity (T) ............................................................................................ 21
5.2.14 SPI 14: Ecotoxicity (ET) .................................................................................................. 22
5.3 Economic indicators ................................................................................................................ 24
5.3.1 General ............................................................................................................................... 24
5.3.2 SPI 15: Whole life cost ...................................................................................................... 25
5.4 Social indicators ...................................................................................................................... 27
5.4.1 SPI 16: Comfort index ....................................................................................................... 27
5.4.2 SPI 17: Safety audits and safety inspections .................................................................... 29
5.4.3 SPI 18: Adaptation to climate change .............................................................................. 30
5.4.4 SPI 19: Tyre-pavement noise ........................................................................................... 31
5.4.5 SPI 20: Responsible sourcing .......................................................................................... 32
5.4.6 SPI 21: Traffic congestion due to maintenance activities .................................................. 32
6 Suggested deployment procedure .............................................................................................. 34

Annex I Example of Table of declared values ................................................................................. 35
Introduction

This document provides a recommended common set of indicators that can be used for sustainability assessment of roads and a suggested deployment procedure, with the aim of supporting National Road Authorities, private operators, contractors and engineering companies when considering sustainability for roads in their day to day business. These indicators are formulated to cover the three pillars in sustainability: environmental, economic and social. This list is drafted considering all current relevant initiatives for the sustainability assessment of road structures.

Starting point of this document was the indicators list produced in the LCE4Roads project: “Life Cycle Engineering for roads, the new sustainability certification system for roads”, funded by the European Commission via the 7th Framework Programme (FP7) in the call for “Innovative, cost-effective construction and maintenance for safer, greener and climate resilient roads” where standardization was encouraged.

LCE4Roads project carried out a study to identify and analyse the most relevant methods and indicators used for sustainability assessment of roads such as: Envision TM, FHWA INVEST, and European research projects like COST354, EVITA, SUNRA, among others and the work performed by the Joint Research Centre (EC) to develop the Green Public Procurement Criteria. On the other hand, results from the EDGAR project: “Evaluation and decision process for greener asphalt roads” currently funded by the Conference of European Directors of Roads (CEDR) Transnational Road Research Programme Call 2013 have been also considered for this document.

Sustainability is a current and multidisciplinary topic resulting in many (European) initiatives, standards, technical reports, policies and Directives in this field that are relevant when formulating a common set of indicators. In this introduction relevant initiatives that were taken into account are mentioned.

The “Europe 2020 Strategy” includes the Flagship Initiative’ Resource efficient Europe”, where European Commission presents proposals aiming at cleaner, more efficient and more sustainable transport through the adoption of measures such as research and innovation, setting current standards and developing the necessary infrastructure support as well as regulatory measures such as pricing.

The White Paper on Transport, takes into account major policy initiatives for a competitive and resource efficient transport system under sustainable developments. Furthermore, ERTRAC (European Road Transport Research Advisory Group) sets out the following ambition: “Towards a 50% more efficient road transport system by 2030”.

The construction and maintenance of roads in an energy and resource efficient way is an important policy objective for Europe. As a consequence the European Commission has developed a process to set the Green Public Procurement Criteria mentioned above (GPP criteria) for design, construction and maintenance of roads and provide guidance on how to effectively integrate these GPP Criteria into the procurement process.

Green Public Procurement is a voluntary instrument and has the ultimate goal of providing precise and verifiable criteria that can be used to procure low environmental impact roads.

Safety is at the core of EU transport policy with ambitious targets to reduce fatalities and injuries on land and sea throughout the European Union. With by far the highest number of accidents occurring on the road, the policy priority is to reduce road casualties, with a target of close to zero deaths by 2050.
The European Commission expressed in the White Paper: ‘European transport policy for 2010: time to decide’ the need to carry out safety impact assessments and road safety audits. The European Directive 2008/96/EC on road infrastructure safety management establishes the related procedures that shall be implemented by Member States.

Considering the challenges mentioned and the general principles of sustainability in construction described in ISO 15392:2008, all three dimensions of sustainability of civil engineering works (environmental, social and economic) are necessary elements in a systemic approach to a sustainable assessment. Statements on the sustainability performance of a civil engineering works shall address all three dimensions.

This implies that when dealing with the sustainability assessment of a civil engineering works, all three dimensions of sustainability shall be included in an assessment of the civil engineering works’ performance, and communication shall be made accordingly.

According to prEN 15643-5, for the assessment of the sustainability performance of a civil engineering works (including roads), the life cycle starts with the preparatory works and administrative processes. It proceeds through the contractual arrangements for design and specification, acquisition of raw materials, manufacturing and procurement of products, construction work processes, handover for use, commissioning, actual use including maintenance, repair, replacement and operation of the civil engineering works for roads and finally at the end of life, decommissioning, deconstruction or demolition, waste processing in preparation for reuse, recycling and energy recovery and other recovery operations, and disposal of waste. The following figure summarises this approach:

![Building Life Cycle Information](image)

**Figure 1 — Information modules applied in the assessment of environmental, social and economic performance according to prEN 15643-5**
CEN/TC 350 “Sustainability of construction works” has published standards for sustainability assessment of buildings and construction products. The TC 350 standards for civil engineering works (CEW) are now under development in its WG 6 and are expected to provide a horizontal approach for all CEW projects and constructed assets.

Regarding products and materials used in road construction and maintenance, CEN/TC 227 “Road materials” has numerous standards to measure the technical performance of road building materials and road surfaces and has recently created a working group dealing with sustainability (CEN/TC 227/WG 6). Although the standardisation process has started there is no standardisation document published for sustainability of roads.

For responsible sourcing, BES 6001 and other relevant document like the responsible sourcing scheme the Concrete Sustainability Council is were taken into account.

This document provides a recommended common set of indicators that can be used for sustainability assessment of roads and a suggested deployment procedure. It does not provide a full assessment methodology, as it does not include a complete set of indicators or the means to integrate the different life-cycle stages into one assessment. This document does not include benchmarks or recommendations for the weighting of indicators.

Finally these indicators shall be used according to CEN/TC 350 and CEN/TC 227 methodologies for the assessment of technical, environmental, social or economic performance and it should be mentioned that relevant standards from these TC were considered for the drafting of the indicators.
1 Scope

This document provides a recommended common set of indicators that can be used for the sustainability assessment of future or existing roads. The indicators include definitions, units and measurements and/or calculation methods.

The user can decide to use a part of the document or the complete set of indicators, and to use other parameters relevant for the scope of the assessment.

NOTE Intended users are Public Administrations, road designers, constructors, etc.

The list of indicators is formulated to deal with the whole the road structure. The information about materials or products is based on EN 15804 and EN ISO 14044 for environmental impact categories and indicators, and shall include relevant information derived from construction products, processes and services according to prEN 15643-5.

The information for costs is based on ISO 15686-5 and prEN 15643-5.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.


ISO 15686-5, Buildings and constructed assets — Service-life planning — Part 5: Life-cycle costing

EN 15804:2012+A1:2013, Sustainability of construction works — Environmental product declarations — Core rules for the product category of construction products

prEN 15643-5, Sustainability of construction works — Sustainability assessment of buildings and civil engineering works — Part 5: Framework for the assessment of sustainability performance of civil engineering works

FprCEN/TR 17005:2016, Additional Indicators for the declaration of environmental performance of construction products and for the assessment of the environmental performance of buildings

ISO 14050, Environmental management — Vocabulary

3 Terms and definitions

For the purposes of this document, the terms and definitions included in EN ISO 14050:2010, EN 15804:2012+A1:2013, ISO 15686-5, ISO 14050 and prEN 15643-5 and the following apply.
3.1 disposal
any operation which is not recovery even where the operation has as a secondary consequence the reclamation of substances or energy

[Directive 2008/98/EC on waste]

3.2 environmental aspect
element of an organization’s activities, products or services that interacts, or can interact, with the environment

3.3 environmental impact
change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization’s environmental aspects

3.4 environmental product declaration
EPD
verifiable claim regarding the environmental aspects of a product or service, providing quantified environmental data using predetermined parameters and, where relevant, additional environmental information

NOTE 1 The predetermined parameters are based on the international LCA standards (EN ISO 14040 and EN ISO 14044).

NOTE 2 The additional environmental information may be quantitative or qualitative.

NOTE 3 For construction products and services in Europe, EPD are based on EN 15804.

[Based on ISO 14025, 3.1 and 3.2]

3.5 hazardous waste
waste which displays one or more of the hazardous properties listed in Annex III of the Directive 2008/98/EC

[Directive 2008/98/EC on waste, modified]

3.6 impact category
class representing environmental issues of concern to which life cycle inventory analysis results may be assigned.

[EN ISO 14044:2006]

3.7 life cycle
consecutive and interlinked stages of a product system, from raw material acquisition or generation from natural resources to final disposal.

[ISO 14044:2006]
3.8 **life cycle assessment**

LCA

compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle

[EN ISO 14044:2006]

3.9 **1.4.33. re-use**

any operation through which products or components that are not waste are used again without reprocessing

[Directive 2008/98/EC on waste, modified]

3.10 **recovery**

any operation the principal result of which is waste serving a useful purpose by replacing other materials which would otherwise have been used to fulfil a particular function, or waste being prepared to fulfil that function, in the plant or in the wider economy

[Directive 2008/98/EC on waste]

3.11 **waste**

any substance or object which the holder discards or intends or is required to discard

[Directive 2008/98/EC on waste]

4 **Abbreviations**

CEW Civil engineering works

EPD Environmental product declaration

ESL Estimated service life

GPP Green Public Procurement

LCA Life cycle assessment

LCC Life cycle costing

LCI Life cycle inventory analysis

PCR Product category rules

RSA Road safety audit

RSI Road safety inspections

RSL Reference service life

SPI Sustainability performance indicators
5 Indicators

5.1 List of indicators

The sustainability performance indicators (SPI) defined in this document are included in Table 1.

<table>
<thead>
<tr>
<th>Sustainability Pillar</th>
<th>SPI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Environmental</strong></td>
<td>1. Primary materials consumption</td>
</tr>
<tr>
<td></td>
<td>2. Secondary materials used</td>
</tr>
<tr>
<td></td>
<td>3. Materials to be reused or recycled</td>
</tr>
<tr>
<td></td>
<td>4. Energy demand (use of renewable energy sources/non renewable energy sources)</td>
</tr>
<tr>
<td></td>
<td>7. Formation potential of tropospheric ozone</td>
</tr>
<tr>
<td></td>
<td>8. Depletion potential of the stratospheric ozone layer</td>
</tr>
<tr>
<td></td>
<td>9. Acidification potential of soil and water</td>
</tr>
<tr>
<td><strong>Economic</strong></td>
<td>15. Whole Life cost</td>
</tr>
<tr>
<td><strong>Social</strong></td>
<td>16. Comfort Index</td>
</tr>
<tr>
<td></td>
<td>17. Safety audits &amp; safety inspections</td>
</tr>
<tr>
<td></td>
<td>18. Responsible Sourcing</td>
</tr>
<tr>
<td></td>
<td>19. Adaptation to climate change</td>
</tr>
<tr>
<td></td>
<td>20. Tyre-pavement noise</td>
</tr>
<tr>
<td></td>
<td>21. Traffic congestion due to maintenance activities</td>
</tr>
</tbody>
</table>
For the indicators included in Table 1 the normative references included in clause 2 are applicable. If further references are necessary, they will be included in the SPI description.

NOTE 1 prEN 15643-5 is relevant for all indicators, the reference is not repeated for simplification.

NOTE 2 EN 15804 is relevant for all LCA environmental indicators, the reference is not repeated for simplification.

5.2 Environmental indicators

5.2.1 SPI 1: Primary materials consumption

Name
Primary materials consumption

Domain
Environmental indicator

Definition
This indicator includes a quantification of each one of the material components used in the road. It must be expressed by mass units (t).

This indicator can be calculated for a product or a process and preferably for an integral approach considering a road as a sum of product and processes across life cycle stages.

Measurement method, if not defined in a standard
The total material consumption per type of component \( MC_{T,i} \) is the sum of the individual quantities \( m_i \) per component \( i \).

\[
MC_{T,i} = \sum m_i
\]  

5.2.2 SPI 2: Secondary materials consumption

Name
Secondary materials consumption

Domain
Environmental indicator

Definition
This indicator includes a quantification of the recycled materials used in the project as material recovered from previous use or from waste which substitutes primary materials. It can be expressed in mass unit (t) or as percentage (%) of recycled materials used related to the total material consumption.

NOTE 1 Secondary material is measured at the point where the secondary material enters the system from another system.

NOTE 2 Materials recovered from previous use or from waste from one product system and used as an input in another product system are secondary materials.
**Measurement method, if not defined in a standard**

This indicator should be declared according to EN 15804:2012+A1:2013, Table 4.

The total recycled material consumption per type of component \((RMC_{T,i})\) is the sum of the individual quantities \((rm)\) per component \((i)\).

\[
RMC_{T,i} = \sum rm_i
\]  

(2)

These individual quantities include the use of Reclaimed Asphalt Pavements, and other products, by-products or waste used as alternative materials.

### 5.2.3 SPI 3: Materials to be reused or recycled

**Name**

Materials to be reused or recycled

**Domain**

Environmental indicator

**Definition**

This indicator includes a quantification of the waste materials or excess quantity of materials used in the project that has potential to be recycled at the end of life stage (where waste processing for re-use, recovery and or recycling is included) instead of being landfilled.

It can be expressed in mass unit \((t)\) or as percentage \((\%)\) of recyclability and percentage \((\%)\) of reusability (related to the total material sum \(o\)) that could be re-used and recycled in the future.

**Measurement method, if not defined in a standard**

The total material that could be recycled after end of life stage per type of component \((MSR_{T,i})\) is the sum of the individual quantities \((msr)\) per component \((i)\).

\[
MSR_{T,i} = \sum msr_i
\]  

(3)

### 5.2.4 SPI 4: Energy demand (use of renewable energy sources/non renewable energy sources)

**Name**

Energy demand

**Domain**

Environmental indicator

**Definition**

This indicator includes a quantification of the energy required for the construction, maintenance or rehabilitation of the road for developing the processes involved (transport of raw materials included) as defined EN 15804:2012+A1:2013, in Table 4. It is expressed in \(Mj\).
Measurement method, if not defined in a standard

The total energy demand \( (ED_{T,i}) \) is the sum of the individual quantities of energy consumed \( (ec) \) in the processes \( (j) \) per type of energy \( (i) \), thermal \( (t) \) or electrical \( (e) \) both renewable and non-renewable.

\[
ED_{T,t} = \sum ec_j \tag{4}
\]

\[
ED_{T,e} = \sum ec_j \tag{5}
\]

### 5.2.5 SPI 5: Waste (Hazardous waste/non-hazardous waste/radioactive waste)

**Name**

Waste

**Domain**

Environmental indicator

**Definition**

This indicator includes a quantification of the waste generated in the project as substance or object which the holder discards or intends or is required to discard.

It can be expressed in mass unit \( (t) \) or as percentage \( (%) \) of waste related to the total material consumption.

**Measurement method, if not defined in a standard**

The total waste per type of material is the sum of the individual waste per component.

\[
RMCT_{T,i} = \sum rm_i \tag{6}
\]

### 5.2.6 SPI 6: Global Warming Potential (GWP)

**Name**

Global Warming Potential (GWP)

**Domain**

Environmental indicator

**Definition**

The global warming potential is the generally accepted equivalent of greenhouse gas accumulation, describes the relevance of emissions for the global warming effect and is the characterisation factor describing the radiative forcing impact of one mass-based unit of a given greenhouse gas relative to that of carbon dioxide over a given period of time.

The geographic scope of this indicator is a global scale. It shall be expressed in kg \( \text{CO}_2 \) equivalent \( (\text{kg CO}_2 \text{ eq}) \), see EN 15804.

**NOTE 1** A list of greenhouse gases with their recognized global warming potentials is provided in ISO/TS 14067:2013, Annex A.

Global Warming Potentials (GWP) are used as characterisation factors to assess and aggregate climate change. The GWP of a substance, defined by the Intergovernmental Panel on Climate Change (IPCC) in 2007, is determined by taking the integral, over a given time period, of the radiative forcing (increase or decrease in the level of energy exchange by radiation) generated by 1 kg of this gas instantaneously injected into the atmosphere. It is expressed in kg CO₂ equivalent and calculated as follows:

\[
GWP_i = \frac{\int_0^T a_i c_i(t) dt}{\int_0^T a CO_2 c CO_2(t) dt} \quad (7)
\]

with

- \( a_i \): absorption of thermal radiation subsequent to an increase in the concentration of gas \( i \);
- \( c_i(t) \): concentration of gas \( i \) remaining at time \( t \) after its release; and
- \( T \): number of years over which the integral is performed.

The global impact on Global Warming Potential of a given process can be obtained as the sum of the contributions of each single substance involved.

\[
GWP = \sum_i m_i GWP_i \quad (8)
\]

where

- \( m_i \): is the mass of substance \( i \) released in kg, the Global Warming Potential (GWP) of the substance and Climate Change the indicator result, which is expressed in kg CO₂ equivalent.

The characterisation model developed by the IPCC is selected for the development of characterisation factors. Factors are expressed as GWP for time horizon 100 years (GWP100), in kg carbon dioxide equivalent/kg emission and are provided in EN 15804:2012+A1:2013, Annex C, Table C.5.

This indicator is calculated for a product or a process and also for an integral approach considering a road as a sum of product and processes.
5.2.7 SPI 7: Formation potential of tropospheric ozone (POCP)

Name

Formation potential of tropospheric ozone, POCP

Domain

Environmental indicator

Definition

The indicator POCP (for Photochemical Ozone Creation Potential) is the most widely used value in Europe for describing this phenomenon. This indicator is related to the formation of reactive substances (mainly ozone) by the action of sunlight which are injurious to human health and ecosystems and which also may damage crops.

It corresponds to the maximum quantity of ozone formed for each volatile organic compound taken individually, spanning the 5 days following its release, compared to the level of ozone produced for the same quantity of ethylene released. This problem is also indicated with "summer smog". Winter smog is outside the scope of this category. The geographical scale varies between local and continental scale.

It shall be expressed in kg ethylene-equivalents (kg Ethene eq), see EN 15804.

Reference (If possible to a standard, if not to Bibliographic sources)


Measurement method, if not defined in a standard

The numerous atmospheric species of VOC vary widely in their contribution to photo-oxidant formation. Photochemical Ozone Creation Potentials (POCP) are used as a characterisation factor to assess and aggregate the interventions for the impact category photo-oxidant formation:

\[ POCP_i = \frac{m_{O_3}^i}{m_{\text{ethylene}}} \]  

with

nPOCP \text{\_i} \text{ the indicator of potential ozone formation;
The resultant coefficient is then multiplied by the flow of target substances, yielding a final value expressed in terms of kg of equivalent ethylene.

\[ POCP = \sum_{i} m_i POCP_i \]  

(10)

where

- \( m_i \) (kg) is the mass of substance \( i \) released;
- \( POCP_i \) the photochemical ozone creation potential of the substance and Photo-oxidant formation is the indicator result, which is expressed in kg ethylene-equivalents.

The characterisation factors are provided in EN 15804:2012+A1:2013, Annex C, Table C.7.

This indicator is calculated for a product or a process and also for an integral approach considering a road as a sum of product and processes.

5.2.8 SPI 8 Depletion potential of the stratospheric ozone layer (ODP)

Name
Depletion potential of the stratospheric ozone layer, ODP

Domain
Environmental indicator

Definition
Ozone Depletion is the potential of a substance to destroy the ozone layer in the atmosphere.

The ozone depletion potential (ODP) of a chemical compound is the relative amount of degradation to the ozone layer it can cause, with trichlorofluoromethane (R-11 or CFC-11) being fixed at an ODP of 1.0. Chlorodifluoromethane (R-22), for example, has an ODP of 0.055. CFC 11, or R-11 has the maximum potential amongst chlorocarbons because of the presence of three chlorine atoms in the molecule.

Reference (If possible to a standard, if not to Bibliographic sources)


— Ozone-Depletion and Chlorine-Loading Potential of Chlorofluorocarbon Alternatives.

— Ozone-depleting Substances, EPA, retrieved 2015-10-01.
Measurement method, if not defined in a standard

The Ozone Depletion Potential (ODP) defined as the ozone depletion produced by a unit of the gas $i$ converted into ozone depletion values produced by the reference substance trichlorofluoromethane (CCl3F = CFC-11) is the meter which is used to assess the importance of the effect produced by the various gases in accordance with the following equation:

$$ ODP_i = \frac{\delta [O_3]_i}{\delta [O_3]_{FCKW-11}} $$

(11)

where

- $\delta [O_3]_i$ is the global ozone depletion produced by one unit of the gas $i$;
- $\delta [O_3]_{FCKW-11}$ is the global ozone depletion produced by one unit of CFC-11.

It shall be expressed in kg CFC-11 eq, see EN 15804. The characterisation factors are provided in EN 15804:2012+A1:2013, Annex C, Table C.4.

This indicator is calculated for a product or a process and also for an integral approach considering a road as a sum of product and processes.

5.2.9 SPI 9: Acidification potential of soil and water (AP)

Name
Acidification potential of soil and water, AP

Domain
Environmental indicator

Definition
Acidifying pollutants cause a wide variety of impacts on soil, groundwater, surface waters, biological organisms, ecosystems and materials (buildings). The major acidifying pollutants are SOx, NOx and NHx. It is is expressed in kg SO$_2$ equivalent.

Reference (If possible to a standard, if not to Bibliographic sources)

— Huijbregts, M., 1999b. Life cycle Impact assessment of acidifying and eutrophying air pollutants. Calculation of equivalency factors with RAINS-LCA. Interfaculty Department of Environmental Science, Faculty of Environmental Science, University of Amsterdam.

Measurement method, if not defined in a standard

The acidification potential is defined as the ratio of the number of potential $H^+$ proton equivalents per unit mass of substance to the reference sulfur dioxide value ($SO_2$):

$$AP_i = \frac{n_{H^+}^i}{M_i} \frac{M_{SO_2}}{n_{H^+}^{SO_2}}$$

(12)

with

- $n_{H^+}^i$: number of $H^+$ protons corresponding to the acidic form of substance $i$;
- $M_i$: molar mass of substance $i$;
- $n_{H^+}^{SO_2}$: number of $H^+$ protons corresponding to the sulfur dioxide ($n_{H^+}^{SO_2} = 2$); and
- $M_{SO_2}$: molar mass of the sulfur dioxide ($M_{SO_2} = 64$ g.mol$^{-1}$).

Acidification potentials ($AP_i$) are used as a characterisation factor to assess and aggregate the interventions for the impact category acidification:

$$AP = \sum_i m_i AP_i$$

(13)

where

- $m_i$ (kg): is the mass of substance $i$ released;
- $AP_i$: the Acidification Potential of the substance and Acidification Potential ($AP$) is the indicator result, which is expressed in kg $SO_2$ equivalent (kg $SO_2$ eq), see EN 15804.

The characterisation factors are provided in EN 15804:2012+A1:2013, Annex C, Table C.3.

This indicator is calculated for a product or a process and also for an integral approach considering a road as a sum of product and processes.

5.2.10 SPI 10: Eutrophication Potential (EP)

**Name**

Eutrophication Potential (EP)

**Domain**

Environmental indicator

**Definition**

Eutrophication (also known as nitrification) includes all impacts due to excessive levels of macronutrients (nitrogen and phosphorous) in the environment caused by emissions of nutrients to air, water and soil. Fate and exposure is not included. It is expressed in kg $PO_4^{3-}$ equivalent.
Reference (If possible to a standard, if not to Bibliographic sources)


— Huijbregts, M., 1999b. Life cycle Impact assessment of acidifying and eutrophying air pollutants. Calculation of equivalency factors with RAINS-LCA. Interfaculty Department of Environmental Science, Faculty of Environmental Science, University of Amsterdam.


Measurement method, if not defined in a standard

This indicator corresponds to the sum of all eutrophication precursors, through multiplying the measured mass by its equivalence factor, with these precursors being expressed in the form of phosphate equivalents ($PO_{4}^{3-}$). Equivalence factors are based on a constant mass ratio in the biomass, with Carbon-Nitrogen-Phosphorus (C:N:P) elements distributed 106:16:1

$$EI_i = \frac{m_i \mu_{PO_4^{3-}}}{m_{PO_4^{3-}}}$$  \hspace{1cm} (14)

with

- $EI_i$ the $PO_{4}^{3-}$ mass exhibiting the same potential eutrophic effect as 1 unit of mass of substance $i$;
- $m_i$ the biomass potential expressed in phosphate equivalents;
- $\mu_i$ molar mass of substance $i$;
- $m_{PO_4^{3-}}$ biomass potential of 1 unit of phosphate; and
- $\mu_{PO_4^{3-}}$ molar mass of phosphate ($\mu_{PO_4} = 95$ g.mol$^{-1}$).

Individual Eutrophication potentials ($EI_i$) are used as a characterisation factor to assess and aggregate the interventions for the impact category eutrophication, multiplying the coefficients is then multiplied by the flow of target substances:

$$EI = \sum_i m_i EI_i$$  \hspace{1cm} (15)

where

- $m_i$ (kg) is the mass of substance $i$ released;
The Eutrophication Potential of the substance and Eutrophication is the indicator result, which is expressed in kg $PO_4^{3-}$ equivalent.


This indicator is calculated for a product or a process and also for an integral approach considering a road as a sum of product and processes.

5.2.11 SPI 11: ADP-elements

Name
Abiotic depletion potential (ADP-elements) for non-fossil resources

Domain
Environmental indicator

Definition
This indicator is related to extraction of non-renewable resources such as minerals and metals due to inputs in the system.

It shall be expressed in kg of antimony (kg Sb eq), see EN 15804.

Reference (If possible to a standard, if not to Bibliographic sources)


Measurement method, if not defined in a standard

Abiotic Depletion Potentials of resources ($ADP_i$) are used as a characterisation factor to assess and aggregate the interventions for the impact category abiotic depletion:

$$ADP_i = \frac{DR_i}{R_i^2} \frac{(R_i)^2}{DR_{ref}} \frac{DR_{ref}}{(R_{ref})^2}$$

(16)

with

$ADP_i$ the abiotic depletion potential of the resource $i$;

$R_i$ the ultimate reserve of resource $i$ (kg);

$DR_i$ the extraction rate of the resource $i$;

$R_{ref}$ the ultimate reserve of the reference resource, set as antimony, in kg; and

$D_{ref}$ the extraction rate of the reference reserve (kg/year of Sb).
The total abiotic depletion potential of a given process can be obtained as:

$$ADP = \sum m_i ADP_i$$  \hspace{1cm} (17)

where

$m_i$ (kg) is the mass of the resource $i$ extracted;

$ADP_i$ the Abiotic Depletion Potential (kg Sb/kg) of the resource $i$ and abiotic depletion is the indicator result, which is expressed in kg Sb.

Specific guidelines and extended information can be found in the literature mentioned above.

The characterisation factors are provided in EN 15804:2012+A1:2013, Annex C, Table C.2.

This indicator is calculated for a product or a process and also for an integral approach considering a road as a sum of product and processes.

5.2.12 SPI 12: ADP-fossil fuels

Name
Abiotic depletion potential (ADP-fossil fuels) for fossil resources

Domain
Environmental indicator

Definition
This indicator is related to extraction of energy resources considering their Lower Heating Value. It is expressed in MJ.

Reference (If possible to a standard, if not to Bibliographic sources)

Measurement method, if not defined in a standard
Abiotic Depletion Potential of fossil fuels ($ADP_f$) were used as a characterisation factor to assess and aggregate the interventions for the impact category abiotic depletion-fossil fuel:

$$ADP_f = \sum m_i ADP_{fi}$$  \hspace{1cm} (18)

where

$m_i$ (kg) is the mass of fossil fuel $i$;
**ADP**<sub>i</sub> the Abiotic Depletion Potential (Lower Heating Value expressed in MJ per kg of fossil fuel) of the fossil fuel $i$ and abiotic depletion-fossil fuel is the indicator result, which is expressed in MJ (net calorific value), see EN 15804.

Specific guidelines and extended information can be found in the literature mentioned above.

The characterisation factors are provided in EN 15804:2012+A1:2013, Annex C, Table C.1.

This indicator is calculated for a product or a process and also for an integral approach considering a road as a sum of product and processes.

5.2.13 SPI 13: Human Toxicity (T)

**Name**

Human Toxicity (T)

**Domain**

Environmental indicator

**Definition**

This category concerns effects of toxic substances on the human environment. The geographic scope of this indicator determines on the fate of a substance and can vary between local and global scale. It can be expressed in kg of 1,4-dichlorobenzene equivalent. It is divided between “cancer effects” and “non-cancer effects” as it is considered in FprCEN/TR 17005.

**Reference (If possible to a standard, if not to Bibliographic sources)**

- FprCEN/TR 17005, Sustainability of construction works — Additional environmental impact categories and indicators — Background information and possibilities — Evaluation of the possibility of adding environmental impact categories and related indicators and calculation methods for the assessment of the environmental performance of buildings. Clause 4.2 Human toxicity: Cancer and non-cancer effects.


Measurement method, if not defined in a standard

Characterisation factors, Toxicity Potentials ($TP_i$), are calculated with USES-LCA, describing fate, exposure and effects of toxic substances. For each toxic substance, its $TP_i$ is expressed as 1,4-dichlorobenzene equivalents/ kg emission.

$$TP_{i,C_1\rightarrow C_2} = w_i \frac{RCR_{i,C_1\rightarrow C_2}}{RCR_{ref}}$$

(19)

where

- $TP_{i,C_1\rightarrow C_2}$ is the toxic potential of substance $i$ emitted into compartment $C_1$ and then transferred into compartment $C_2$;
- $w_i$ is a weighting factor dependent on the geographic scales of both compartments $C_1$ and $C_2$;
- $RCR_{i,C_1\rightarrow C_2}$ is the Risk Characterisation Ratio of substance $i$ emitted into compartment $C_1$ and then transferred into compartment $C_2$; and
- $RCR_{ref}$ is the Risk Characterisation Ratio of the reference substance, set as 1,4-dichlorobenzene (1,4DCB).

Again, the total toxicity is calculated as follows.

$$TP = \sum_i m_i TP_i$$

(20)

where

- $m_i$ (kg) is the mass of substance $i$ released;
- $TP_i$ the toxicity of the substance, expressed in kg of 1,4-DCB equivalent.

This indicator is calculated for a product or a process and also for an integral approach considering a road as a sum of product and processes.

5.2.14 SPI 14: Ecotoxicity (ET)

Name

Ecotoxicity (ET)

Definition

This category indicator refers to the impact on ecosystems, as a result of emissions of toxic substances to air, water and soil. Ecotoxicity (EP) is correlated with the toxic effects of substances causing the direct or indirect disappearance (e.g. through affecting reproduction) of the animal or vegetable species of an ecosystem. This indicator has three aspects: Freshwater aquatic ecotoxicity, Marine ecotoxicity, Terrestrial ecotoxicity. It can be expressed in kg of 1,4-DCB equivalent.
Reference (If possible to a standard, if not to Bibliographic sources)

— FprCEN/TR 17005, Sustainability of construction works — Additional environmental impact categories and indicators — Background information and possibilities — Evaluation of the possibility of adding environmental impact categories and related indicators and calculation methods for the assessment of the environmental performance of buildings. Clause 4.3 Ecotoxicity: Terrestrial, freshwater and marine.


Measurement method, if not defined in a standard

The Huijbregts' model outputs an ecotoxicity indicator for each major type of living medium affected: soft water (FAETP), seawater (MAETP), soft water sediments (FSETP), marine sediments (MSETP), the terrestrial environment (TETP), and human beings.

\[ EP_i = FAETP_i + MAETP_i + FSETP_i + MSETP_i + TETP_i \]  

(21)

The global ecotoxicity potential is obtained as:

\[ EP = \sum_i m_i EP_i \]  

(22)

where

\[ m_i \text{ (kg)} \]  

is the mass of substance \( i \) released;

\[ EP_i \]  

the ecotoxicity of the substance, expressed in kg of 1,4-DCB equivalent.

This indicator is calculated for a product or a process and also for an integral approach considering a road as a sum of product and processes.
5.3 Economic indicators

5.3.1 General

The framework of application of the economic indicators is the considered by the traditional whole life costing methodology, which means the systematic economic consideration of all whole-life costs and benefits over a period of analysis. The period of analysis considering ISO 15686-5:2008 includes all road stages as considered by prEN 15643-5:2015 (from A-0 to C-4).

![Diagram](image)

**Figure 2 — WLC and LCC elements in ISO 15686-5:2008**

General references (If possible to a standard, if not to Bibliographic sources)


5.3.2 SPI 15: Whole life cost

**Name**
Whole life cost

**Domain**
Economic indicator

**Definition**
All significant and relevant initial and future costs and benefits of the road asset, throughout life cycle, while fulfilling the performance requirements, as considered in ISO 15686-5.

**Measurement method, if not defined in a standard**
National Road Authorities, Private Operators and Contractors and Engineering companies following the design, building and operation (D.B.O.) procedures (such as the followed in DBO tenders), have their own LCC methodologies and measurement methods. If all the principles of the whole life cycle costing are followed, these methodologies and measurement methods will be appropriate for using.

If there is no particular approach available, specific guidelines and information to quantify this cost can be found in the literature described above, considering the whole life cost as the sum of the initial costs, maintenance costs minus residual asset value:

**— Initial cost**

This includes the total cost associated to the preliminary design, construction (such us infrastructure, machinery cost, raw material and labour, fitting out, etc.), and commissioning, evaluation and handover of the road. It can be expressed in Euros (€) or other local currencies.

The total Initial Cost \( (IC_T) \) is the sum of the costs associated to the design \( (DC) \), construction \( (CC) \) and start-up \( (SuC) \) stages of the road (commissioning, evaluation and handover).

\[
IC_T = DC + CC + SuC
\] (23)

The different costs involved in the estimation are mentioned in Table B.1 of the Annex B of prEN 15643: “Economic aspects of Civil Engineering Works performance through the life cycle of the Civil Engineering Works” for all Before Use Stage costs.
In order to express it as considered in ISO 15686-5 can be expressed and grouped as follows:

- The **design costs** \( (DC) \) is the sum of the individual costs related to preliminary design activities \( (dc) \):

\[
DC = \sum dc_i
\]  
(24)

- The **construction costs** \( (CC) \) include raw materials \( (RMC) \) and labour cost \( (LC) \).

\[
CC = RMC + LC
\]  
(25)

The cost associated to raw material consumption during the construction stage \( (RMC) \) includes both direct use of materials (such as gravel) and intermediate use to produce other materials (for instance, raw materials used during the asphalt production). The total raw materials cost \( (RMC) \) is the sum of the individual costs \( (i) \) associated to each raw material consumption during the road construction.

\[
RMC = \sum m_i rmc_i
\]  
(26)

with

\[
m_i = \text{consumption of the raw material } i \text{ and } rmc_i: \text{cost of the raw material } i.
\]

The labour cost \( (CC) \) is the sum of the individual costs \( (i) \) associated to each operation during the road construction \( (lc) \).

\[
LC = \sum lc_i
\]  
(27)

These individual costs include costs related to: use of machinery, manpower, consumption and transport of raw materials, fuel consumption during the works, earthworks, pavements, drainage systems, signs and safety systems, affected services ... and any other activity involved in the construction.

- The **start-up cost** \( (SuC) \) is the sum of the individual cost \( (suc) \) related to the start-up of the road derived from commissioning, evaluation and handover activities.

\[
SuC = \sum suc_i
\]  
(28)

- **Maintenance cost**

This takes into account the cost of the Total of necessarily incurred labour, material and other related costs incurred to retain a road or its parts in a state in which it can perform its required functions. Maintenance can include conducting inspections, corrective (repair cost) or preventative maintenance, and includes all associated management, cleaning, servicing, repainting (annual maintenance for example). It can be expressed in Euros (€) or other local currencies.

The total cost of the maintenance \( (MC) \) is the sum of the individual processes, labour or resources costs \( (mc) \) involved to fulfil the performance requirements.
The different costs involved in the estimation are mentioned in Table B.2 of the Annex B of prEN 15643: "Economic aspects of Civil Engineering Works performance through the life cycle of the Civil Engineering Works" for all Operation and Maintenance costs.

\[ MC_T = \sum mc_i \]  

(29)

Specific guidelines and information to quantify this cost can be found in the literature described above.

— **End of life cost**

This takes into account the cost of the Total of necessarily incurred labour, material and other related costs incurred to deconstruction, transport associated, end of life fee and taxes, waste processing for re-use, recovery and or recycling. It can be expressed in Euros (€) or other local currencies.

The total cost of the end of life cost \((EC_T)\) is the sum of the individual processes, labour or resources costs \((eol_i)\) involved to fulfil the performance requirements.

The different costs involved in the estimation are mentioned in Table B.2 of the Annex B of prEN 15643: “Economic aspects of Civil Engineering Works performance through the life cycle of the Civil Engineering Works” for all end of life costs.

\[ EOLC_T = \sum eolc_i \]  

(30)

Specific guidelines and information to quantify this cost can be found in the literature described above.

— **Residual asset value**

Estimated residual value of a depreciable asset or property at the end of its economical or useful life.

The value is used in accounting to determine depreciation amounts and in the tax system to determine deductions. The value can be a best guess of the end value or can be determined by a regulatory body such as the IRS, Internal Revenue Services, which is responsible for collecting taxes and the administration of the Internal Revenue Code.

In all methods for determining depreciation (except the double declining balance depreciation method) salvage value is deducted from the asset's purchase price. When the cost of an asset minus its accumulated depreciation equals its salvage value, no more depreciation may be taken.

### 5.4 Social indicators

#### 5.4.1 SPI 16: Comfort index

**Name**

Comfort index

**Domain**

Social indicator
Definition
Comfort is the subjective feeling of a vehicle driver or passenger while driving along a road, as this depends on multiple variables (vehicle type and performance, traffic, speed, weather, road geometry, pavement, surface course etc.). This project is pavement’s focussed, so only the related parameters are taken into consideration to define this SPI.

Comfort index is a combined performance indicator (CPI) dependent on pavement

Parameters such as those identified in the COST 354 model:

— Longitudinal evenness: International Roughness Index (IRI) or other methods covered by CEN/TC 227/WG 5 standards, or other accepted national methods provided in national or international standards, codes or regulations.
— Transverse evenness: Rutting (R).
— Texture (T).
— Surface defects (SD).
— Cracking (CR).

In order to facilitate its implementation, considering that data availability, local standards, measurement methods, priorities and regulations are different depending on the user of this document, they can define the level of application, measurement methods and revision periodicity as deterioration models are not included in this project.

Reference (If possible to a standard, if not to Bibliographic sources)
— EN 13036-1, Road and airfield surface characteristics — Test methods — Part 1: Measurement of pavement surface macrotexture depth using a volumetric patch technique.
— EN 13036-8, Road and airfield surface characteristics — Test methods. Part 8: Determination of transverse unevenness indices.
— prEN 13036-5, Road and airfield surface characteristics — Test methods — Part 5: Determination of longitudinal unevenness indices (project Abandoned in 2009).
Measurement method, if not defined in a standard

National Road Authorities can select the calculation method for this Combined Performance Indicator. As an example, the COST354 calculation model could be applied considering that the calculation method results in a cumulative value; the user of the standard can select the indicators to be included:

The cost model is mainly suitable for motorways and primary roads. Specific guidelines and information to quantify this indicator can be found in the literature described above.

According to the methodology proposed in COST354, a SPI for comfort can be calculated as:

$$\text{Comfort} = \text{MIN}\left[5; I_1 + \frac{P}{100} \times \text{MEAN}(I_2; I_3; \ldots I_n)\right]$$ (31)

Where $I_1 \geq I_2 \geq I_3 \geq \ldots \geq I_n$ and $I_1 = W_1 \times P_{I_1}$, $I_2 = W_2 \times P_{I_2}$, $I_3 = W_3 \times P_{I_3}$, $\ldots I_n = W_n \times P_{I_n}$. $p$ is the influence factor that controls the influence of the other weighted single performances indices than the maximum one; its value is between 10 and 20.

The $W$ values are the weights given to the different single performance indices $P_i$ (so to each parameter). For our assessment, we used the mean values of $W$ given in table 25 of the COST 354-WP3, 2008 report mentioned above. So, $W_{IRI} = 1$, $W_R = 0.7$ and $W_T = 0.4$.

We have also considered that "$p = 10$". The PI values are calculated with any equations given in the sheets related to each parameter. We have also considered that we have no element to calculate the PI values for surface defects and cracking parameters.

5.4.2 SPI 17: Safety audits and safety inspections

Name
Safety audits and safety inspections

Domain
Social indicator

Definition
Safety is one aspect of the social pillar. However, as safety deals with the possible loss of lives, it has a special position. It is socially unacceptable if a road owner provides a road to the public that is not safe. By definition all roads should be safe. This indicator is therefore specified by performing a check of the safety according to European guidelines.

The European Directive 2008/96/EC on road infrastructure safety management establishes procedures relating to road safety impact assessments, road safety audits (RSA) and inspections (RSI), the management of road network safety and safety inspections by the Member States for the TEN-T network.

For roads not included in the TEN-T network the methodology of RSA and RSI may be an added value and results might be considered for further implementation if necessary.

Reference (If possible to a standard, if not to Bibliographic sources)

Measurement method, if not defined in a standard

As a qualitative indicator the following must be answered:

— RSA or RSI report issued? Yes or No.

— RSA or RSI analysed for further implementation? Yes or No. If Yes, a breakdown of the recommendations to be implemented if necessary will be provided.

5.4.3 SPI 18: Adaptation to climate change

Name
Adaptation to climate change

Domain
Social indicator

Definition
The impacts of climate change such as sea level rise, increased risk of drought, increased risk of flooding, higher temperatures and increased frequency and intensity of storms have a significant influence in roads resilience. This indicator is defined as the percentage of the project budget dedicated to handle climate adaptation.

Issues covered by this indicator can be both engineering and non-engineering, e.g.:

1. Engineering: specific technical solutions to deal with climate change such as slope reinforcement, enhanced drainage systems and management, activities to reduce road foundations instability, changes on binders selection, etc.

2. Non-engineering: procedures and protocols such as particular risks and vulnerability assessments and mapping, threats identification, additional quality control etc.

CEN has established groups to work on adaptation to climate change, both for construction and for the transport sector. The results from these groups will provide relevant information to assess adaptation of road infrastructures.

Reference (If possible to a standard, if not to Bibliographic sources)

— CliPDaR CEDR project: Climate Projection Data base for Roads.

— ROADAPT CEDR project: Roads for today, adapted for tomorrow. Conference of European Directors of Roads (CEDR) Call 2012: Road owners adapting to climate change.

Measurement method, if not defined in a standard

This particular technical indicator deals with the adaption measures as response to the different vulnerabilities already identified for road infrastructures:

1. Change in average and extreme precipitation levels and frequency of extreme events (flooding and droughts).

2. Change in the average and extreme temperatures (both cold and warm).

3. Change in ground water level and soil moisture.
4. Increased wind speed.

5. Change to growing seasons and habitats.

6. Others.

CEDR projects like ClipDaR and Roadapt provide guidance on the use of climate data for the current and future climate, on climate change risks, vulnerability and socio-economic impact assessment and on how to select an adaptation strategy.

The sum of the road project budget allocated to any of these purposes and the calculated percentage against the total will be considered to define this indicator.

5.4.4 SPI 19: Tyre-pavement noise

Name
Tyre-pavement noise.

Domain
Social indicator

Definition
It is known that some pavement design features (macrotexture, mechanical impedance, air void content, etc.) can directly influence overall traffic noise. The type of pavement used has an impact on the tyre/road noise level on a given road. This indicator is expressed as reduction of tyre-pavement noise level in dB compared to the reference pavement.

The user of this document will need to define the level of application, measurement methods and revision periodicity as deterioration models are not included in this project.

Reference (If possible to a standard, if not to Bibliographic sources)
Measurement method, if not defined in a standard
One of the following measurement methods will be used to certify the claimed noise reduction.

— Statistical Pass-by method.
— Close Proximity method.

Other measurement methods must be used as long as they are covered in a national, European or international standardisation document.

5.4.5 SPI 20: Responsible sourcing

Name
Responsible sourcing

Domain
Social indicator

Definition
Voluntary commitment of an organization to take into account social and environmental considerations in the relation with suppliers to ensure long-term sustainability.

Responsible sourcing is concerned with managing a product or a service from the point at which component materials are mined or harvested, through manufacture and processing. It is based on a thorough appreciation of environmental, social and economic issues throughout the product's and service's supply chain and correct management of these issues.

Reference (If possible to a standard, if not to Bibliographic sources)
— BES 6001 — Responsible sourcing of construction products.
— The Concrete Responsible Sourcing Scheme (version March 8th 2016). Concrete Sustainability Council.

Measurement method, if not defined in a standard
The procurement of a material, product or service includes criteria for responsible/sustainable sourcing. These criteria should include the environmental and social performance of suppliers, and the identification of responsible/sustainable sources.

Certification schemes of responsible sourcing could help procurers setting the requirements.

5.4.6 SPI 21: Traffic congestion due to maintenance activities

Name
Traffic congestion due to maintenance activities

Domain
Social indicator
**Definition**

Traffic congestion is caused by several factors like bad weather conditions, accidents, ordinary management operations, maintenance activities and related works or just due to high traffic levels.

In the case of maintenance activities the congestion is caused by the reduction of the road’s capacity: which is the closure of at least one of the lanes of the road and/or one of the branch lanes. The selection of the maintenance technique will condition traffic congestion and as a consequence will have an impact on the sustainability of the road during the use stage.

This indicator defines the traffic congestion due to maintenance activities, expressed as the reduction of availability of the road.

**Measurement method, if not defined in a standard**

The reduction of availability of the road can be expressed considering the following.

When a lane is closed:

a) If it is a working day

   1) The hourly average traffic along the latest seven working days will be calculated for the time the lane is closed (N).

   2) The real hourly traffic will be measured during the closure of the lane (R).

b) If it is a non-working day:

   1) The hourly average traffic along the latest seven non-working days will be calculated for the time the lane is closed (N).

   2) The real hourly traffic will be measured during the closure of the lane (R).

The indicator shall be quantified as follows:

\[
RA = \sum_{i=1, h}^{j=1, l} (N_j - R_j) \cdot l_j
\]

(32)

where

- \( RA \) = Reduction of availability
- \( N \) = Hourly average traffic
- \( R \) = Hourly real traffic
- \( l \) = Length of the closed lane
- \( h \) = number of hours the lane is closed
- \( k \) = number of road sections affected

The indicator is expressed in (hours·m).

In case the time the lane is closed exceeds 24 hours, the indicator will be calculated every 24 hours and the final indicator will be the addition of single indicators.
If the reduction of the availability of the road is due to force majeure, this indicator is not applicable.

6 Suggested deployment procedure

This document merely provides a list of sustainability indicators. For the application to a road case a deployment procedure has to be defined, describing how and when these indicators need to be determined by whom.

The following steps are recommended when drafting the deployment procedure of a road.

1. A definition of an appropriate functional unit, along with an appropriate Reference Service Life (RSL) have to be defined, (see EN 15804 and EN 15978 guidelines provided in CEN/TC 350 standards).

2. Definition of the indicators to be applied. The document recommends a list of 20 indicators distributed over three pillars. For a specific road project it can be considered if all indicators are needed or if a selection can be made.

3. Description of the calculation/measurement methods and units considering national regulations, standards and testing accepted by the user.

   — If some modifications are necessary they should be carried specifying the references considered.

4. Declaration of the results of the assessment.

   — The information shall include the SPIs considered, the declared value considering the method used to measure the SPI and a reference to the report describing the estimation procedure of the indicator.

   — The declared values should be presented in a clear way like (e.g. using the table included in Annex I).

Taking into consideration that this document does not include benchmarks or recommendations for the weighting of indicators, users can consider defining a set of rules and/or methodologies to benchmark the road assessed and/or formulate weighting factors for the different indicators.
# Annex I

## Example of Table of declared values

<table>
<thead>
<tr>
<th>Sustainability Pillar</th>
<th>Sub-domain</th>
<th>Sustainability Performance Indicator (SPI)</th>
<th>Level</th>
<th>Declared value</th>
<th>Unit</th>
<th>Used method</th>
<th>Report name and number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Impact</td>
<td></td>
<td>1 Primary materials consumption</td>
<td></td>
<td>t</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Impact</td>
<td></td>
<td>2 Secondary materials used</td>
<td></td>
<td>%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Impact</td>
<td></td>
<td>3 Materials to be reused or recycled</td>
<td></td>
<td>%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Impact</td>
<td></td>
<td>4 Energy demand (use of renewable energy sources/non renewable energy sources)</td>
<td></td>
<td>MJ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Impact</td>
<td></td>
<td>5 Waste (Hazardous waste/non-hazardous waste/radioactive waste)</td>
<td></td>
<td>t</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Impact</td>
<td></td>
<td>6 Global Warming potential</td>
<td></td>
<td>kg CO&lt;sub&gt;2&lt;/sub&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Impact</td>
<td></td>
<td>7 Formation potential of tropospheric ozone</td>
<td></td>
<td>kg O&lt;sub&gt;3&lt;/sub&gt; (POCP)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Impact</td>
<td></td>
<td>8 Depletion potential of the stratospheric ozone layer</td>
<td></td>
<td>kg O&lt;sub&gt;3&lt;/sub&gt; (ODP)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Impact</td>
<td></td>
<td>9 Acidification potential of soil and water</td>
<td></td>
<td>kg SO&lt;sub&gt;2&lt;/sub&gt; eq.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Impact</td>
<td></td>
<td>10 Eutrophication potential</td>
<td></td>
<td>kg PO&lt;sub&gt;4&lt;/sub&gt; eq.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Impact</td>
<td></td>
<td>11 Abiotic depletion potential (ADP-elements) for non-fossil resources</td>
<td></td>
<td>kg of antimony</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Impact</td>
<td></td>
<td>12 Abiotic depletion potential (ADP-fossil fuels) for fossil resources</td>
<td></td>
<td>MJ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Impact</td>
<td></td>
<td>13 Human Toxicity</td>
<td></td>
<td>kg of 1,4-dichlorobenzene equivalent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Impact</td>
<td></td>
<td>14 Ecotoxicity</td>
<td></td>
<td>kg of 1,4-DCB equivalent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social</td>
<td>Cost</td>
<td>15 Whole Life cycle cost</td>
<td></td>
<td>local currency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social</td>
<td>Comfort</td>
<td>16 Comfort Index</td>
<td></td>
<td>—</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social</td>
<td>Safety</td>
<td>17 Safety audits &amp; safety inspections</td>
<td></td>
<td>—</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social</td>
<td>Sources</td>
<td>18 Responsible Sourcing</td>
<td></td>
<td>—</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social</td>
<td></td>
<td>19 Adaptation to climate change</td>
<td></td>
<td>—</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social</td>
<td>Noise</td>
<td>20 Tyre-pavement noise</td>
<td></td>
<td>dB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social</td>
<td>Congestion</td>
<td>21 Traffic congestion due to maintenance activities</td>
<td></td>
<td>hours</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>