Appendix C) Calculation of the emission of air pollutants:– description of methodology

Air pollution caused by traffic may only be quantified if we take into account all the parameters which essentially define this phenomenon (meteorological, topographical, traffic, construction, etc.).

Notwithstanding all the above-mentioned attitudes regarding difficulties in terms of quantification of air pollution parameters, as well as the non-existence of standard procedures, it is still possible to obtain data which can be useful, and which can provide enough accuracy in order to make conclusions about the negative impacts. However, we should outline that for the quantification of parameters of air pollution as the consequence of road traffic we have at present procedures of different level of details, primarily in the function of the number of characters which are included in the analyses. Decision on whether to simplify something or not is based on the design phase. In all situations in which analysis of air pollution should serve as the basis for estimating unfavourable impacts in the subject study area, presentation of this data must be done in the way that it points at the issues without any doubts.

Thus, it is useful to provide average values of emissions, which is usually done by defining average annual values, expressed in mg/m^3. Bearing in mind all the above-mentioned facts which relate to indicators of air pollution, significant factors, possibilities of their quantification, conditions from the area of study research as well as the level of the analysis defined in the phase of developing planning and design documents.

Calculation of emissions of air pollutants was performed on the level of average annual values, which were taken as the representative values, and the 98^{th} percentile, which was taken as the indicator of the expected short-lasting concentrations for the extracted characteristic sections.
Concentration of pollutants in the atmosphere may be determined by calculation, measurement and a combination of these procedures. Measurement is performed by sampling and analysing air, a certain number of times per year (minimum 52 samples, but not in the same day during the week), and statistical processing (calculation of the mean and 98^{th} percentile). The calculation is done by using the forecasting models.

Number of models for forecasting varies, and they can be classified in the following groups: (1) models based on differential equations of diffusion coefficients of turbulent diffusivity derived from atmospheric stability (determined on the basis of synoptic meteorological or climatological parameters). (2) models based on integral solutions of differential equations for the specific conditions of configuration and meteorological situations (classes of atmospheric stability), (3) statistical models, etc. It is best to use some of the models calibrated measurement results.
Calculation of the concentration of air pollutants for the M-18 Danilovgrad - Podgorica road is performed based on the model which is defined in the directions for defining air pollution on the roads (Merkblat uber Luftverunreinigungen an Strassen MluS-92). Parameters of the air pollutant components, in terms of the average annual values and the 98th percentile, were determined based on rules of the exponential function:

$$Ki(s) = Ki^* \times g(s) \times fvi \times fu \qquad mg/m^3 ,$$

whereby:

K*i - reference concentration of individual components (i) in the soil at the edge of the pavement; (s) – widening function of the damage materials;
f vi – function that takes into consideration specific data on the traffic;
fu - function which takes into consideration the speed of the wind.
This equation for concentration on the soil is not applied for nitrogen dioxide.
Change in concentration of components of air pollutants, in terms of distances for which there is a possibility of analysis for the area of impact, is given in the form of:

$$g(s) = 1-0.166 \ln(1+s),$$

whereas:
g (s) – widening function of damage materials,
s – coefficients.

Gasses of the vehicles contain 97% to 98% nitrogen-monoxide, and only 2% to 3% nitrogen dioxide. With increase of distance from the source of contamination there is a conversion of NO into NO_2. Due to these circumstances, the function of decrease which is valid for inert damage materials cannot be applied to nitrogen-dioxide. Conversion of NO into NO_2 with dilution of the damage material is a complex process. With help of static regression procedure, which is based on the multiyear measurements on highways, emissions of NO_2 can be accurately determined, by using the following formula.

$$g\,NO_2(s)=1-0{,}088\times \ln(1+s)$$

Concentration of emission of NO_2 cannot be determined in terms of emission factors, nor can it be determined depending on the traffic intensity, because NO2 is not emitted directly from the vehicle. Due to this, in order to determine average annual value and percentile value 98 based on the performed measurements on site, the following correction functions for intensity of the traffic were developed.

$$M\,NO_2(DTV)=4{,}47\times10^{-3}\times DTV^{0{,}514}\times\exp(-4{,}14\times10^{-6}\times DTV)$$

Taking into consideration reference concentration on the edge of the pavement and reduction factor for the year for which the forecast is made, absolute concentration of NO_2 can be calculated in the following way:

$$K\,NO_2(s,DTV)=K^*_{NO_2}\times g_{NO_2}(s)\times M_{NO_2}(DTV)\times rnj$$

whereas

rnj.....reduction factor of NO_2 in the year.
Reference concentration of $K^*_{NO_2}$ is:
$K^*_{NO_2}=0{,}052\ mg/m^3$ for average annual value
$K^*_{NO_2}=0{,}110\ mg/m^3$ for 98^{th} percentile