

# The issue on environmental assessment of air quality of residential areas near traffic flows

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**Abstract.** A significant role in ensuring comfortable living conditions in the urban environment is played by the competent organization of the transport and road complex, which is aimed at ensuring road safety, reducing the load on highways for car density and improving the efficiency of traffic in the city when performing planning and technological measures. At the same time, the current state of the city's traffic flows as sources of increased chemical pollution of the air environment requires an increase in the distance from streets and roads to residential buildings. This distance should be normalized by chemical and physical indicators of the state of atmospheric air and should be taken into account when red lines are established. In this article we analyze: functional state of the city, road network, composition and intensity of traffic flows for Tyumen. The traffic flows of the city are concentrated mainly in the central part of it. A particularly critical situation is formed at the intersections of cargo-loaded main streets at the hours of maximum traffic intensity and on the main highways of the city. We substitute the provision of regulatory requirements for the chemical pollution level at a distance from the border of the carriageway to the border of residential buildings in order to achieve sustainable urban development.

## 1 Introduction

Competent organization of the city's road network plays a significant role in providing comfortable living conditions in an urban environment [1-5]. It is aimed not only at ensuring road safety, reducing the traffic load on car density and improving the efficiency of traffic in the city, but also serves as a measure to reduce the impact on adjacent residential areas.

Environmental problems are raised due to the adverse effects of vehicle emissions on human health in urban areas [6-12], especially for pedestrians and residents living in buildings located near roads. Every year the number of controlled vehicles increases, which leads to serious traffic jams [13-16], as a result of which a large number of various pollutants are released into the air.

Estimation of the air pollution level in cities, taking into account the influence of motor transport, is an extremely top issue [17, 18], since every second a person needs quality

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atmospheric air. The level of exposure to polluted air in the surrounding areas depends on the load on the road network.

## 2 Materials and methods

The environmental problems of road transport for the city of Tyumen have become particularly relevant in the last decade. In the city, there is a high saturation of motor vehicles, emissions of which make up more than 80% of the total gross emission, while the car park increases every year.

The leading position of vehicles on the impact on the urban environment is due to the following main reasons:

- Features of formation and current state of the city transport network;
- Dynamics of the motorization level in recent years;
- Increase in the traffic intensity caused by the above-mentioned and some other socio-economic reasons.

Traditional research methods (mapping and comparative description) were used for analysis of the loading level of the main highways for the presented general plan of Tyumen and published literature data.

To understand the characteristics of the composition and intensity of traffic flows, we carried out a visual survey of segments and junctions of the road network of Tyumen with the aid of students and postgraduates of Tyumen Industrial University and analyzed long-term research programs for Tyumen.

The following materials were studied:

- The results of survey of passenger and transport flows conducted by ZAO Petersburg NIPIgrad in December 2009 (at 30 posts selected in such a way that it was possible to identify the traffic structure at the entrances to the central business part of Tyumen, on the bridges over the Tura River, connections through the Trans-Siberian Railway, and entrances to the city);
- The results of passenger turn-overs survey conducted by NTPI TI, 2008 (project "Development of a Program for Development the Transport and Road Complex of the City of Tyumen for 2010-2015 with a forecast up to 2020").

The study of the road network of the city of Tyumen shows that it mainly has capital construction (asphalt concrete). In the areas of individual development the lower and transitional type of road surfacing prevails.

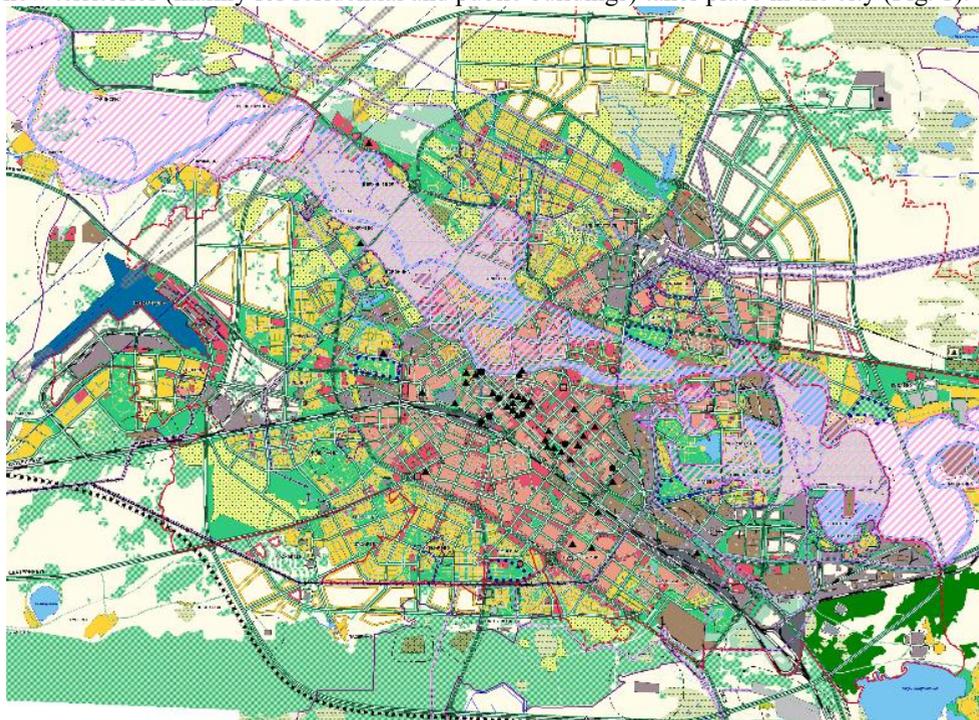
The indicators of the existing road network are calculated according to topographic data and are shown in Table 1.

**Table 1.** The indicators of the existing road network.

Indicator	Meas. unit	Amount
The length of the road network in total	km	1865.0
Including:		
- main streets of citywide significance	km	209.0
- main streets of regional significance	km	97.0
- streets and roads of local significance	km	1230.0
- streets and roads without categories	km	329.0

The existing functional state of the Tyumen territory is rather chaotic and unbalanced (for example: the territories occupied by residential buildings are extensive enough, and the territories of public green spaces are much lower than regulatory, etc.). In the modern city center, two space-time formations are quite clearly revealed - the historical core, the spatial composition of which is focused mainly on the Tura River, and the modern part, the main

compositional axis of which is the Respubliki Str. This part of the city's territory is most actively reconstructed: the construction of high-rise buildings and multifunctional complexes takes place, as well as consolidation of residential areas. A fairly large-scale development of new territories (mainly for residential and public buildings) takes place in the city (Fig. 1).



**Fig. 1.** The scheme of usage and state of the territory ([www.tyumen-city.ru](http://www.tyumen-city.ru)).

Traffic flows of the city of Tyumen are mainly concentrated in the central part of the city. A particularly critical situation is taking place at the intersection of cargo-loaded main streets at the hours of maximum traffic intensity and on the main highways of the city Respubliki Str., Lenina Str., Melnikayte Str., Pervomaiskaya Str., Profsoyuznaya, Str., 50 let Oktyabrya Str. Since the majority of cars are concentrated in the city, transport has an impact on the area adjacent to highways. In these areas air is not only oxygen-depleted, but is also polluted by harmful components of the exhaust gases.

Emissions from motor vehicles in urban areas enter the surface air layer, where its dispersion is difficult. In addition, under certain meteorological conditions, the concentration of impurities in air increases and can reach dangerous values. This is confirmed by the annual collection, analysis of observational data and assessment of the state of air pollution in most cities of the world [19], including Russia. The data shows that almost 70% of cities have a high or extremely high degree of pollution, and the average annual concentration of one or several impurities exceeds the established sanitary and hygienic standard.

### 3 Results

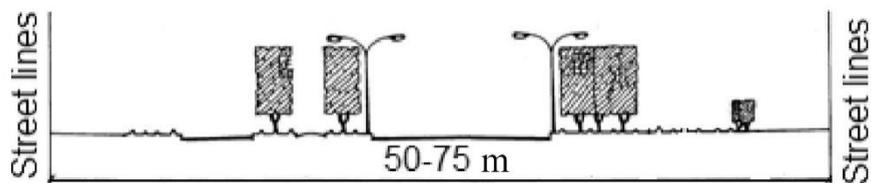
The mass and constantly growing rates of the motorization process will lead to a change in the categories of existing roads and streets (this situation is typical not only for Tyumen, but also for many cities, which are developing from the central region in all directions, as a result of which the center begins to experience increased traffic load at impossibility of expanding the existing roads and streets).

The future development of the territory of Tyumen, which tends to placement of the main social and cultural facilities in the central part of the city, will also provide a high intensity of traffic.

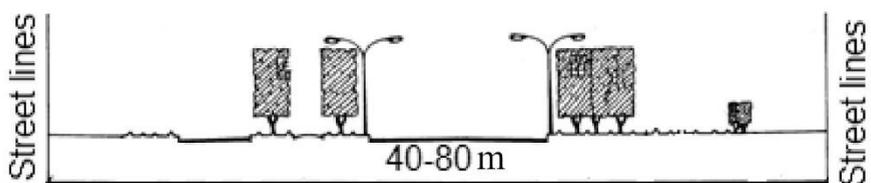
Analysis of the intensity and composition of traffic flows shows that the most unfavorable situation was developed at the territories adjacent to the streets, where the intensity of traffic flow reaches from 1.6 to 8.1 thousand units per hour [20] (Respubliki Str., Melnikayte Str., 50 let Oktyabrya Str.) With such intensity of traffic flows, the state of atmospheric air in the adjacent territories to the roadway is characterized by a dangerous level of pollution.

The regulation of quality of the city atmospheric air is carried out via establishment of standards for emission sources, as well as by controlling the compliance with the established standards. In the areas adjacent to the highways, it is necessary to comply with achievement of regulatory requirements and standards [21-23] that ensure environmental safety when planning and building settlements.

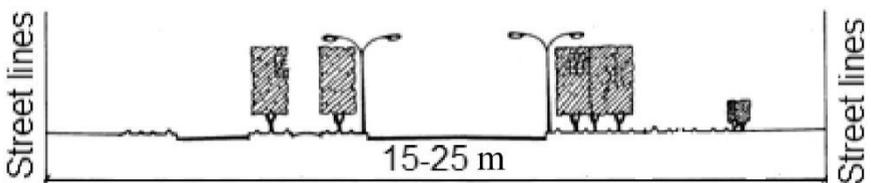
In addition, it is necessary to maintain the recommended requirements for gaps from the border of the carriageway to the border of residential buildings (Figs. 2-4).



**Fig. 2.** The width of main roads in red lines



**Fig. 3.** The width of main streets in red lines



**Fig. 4.** The width of local roads and streets in red lines

At increasing traffic intensity on the transport arteries of the city of Tyumen, a discrepancy between the developing roads and streets categories and the real state of affairs is observed. The cases when building line of residential buildings is located practically on the red line are not uncommon. In the current practice, city planning design standards exist only in a small number of regions and municipalities, and in most cases they do not meet modern requirements. At the same time, it is profitable to place newly designed objects in built-up areas at the expense of house territories, which leads to the approach of emission sources to residential facilities or public use by the city population.

## 4 Discussion

Thus, the assessment of the level of air pollution in cities, taking into account the impact of road transport, is an extremely top issue, since a person every second needs quality atmospheric air.

The quality of the air environment in which a person stays depends on his health, well-being and performance. Comfortable conditions for moving around the city should not be achieved at the expense of comfortable from a sanitary-ecological point of view living conditions in the city. It should be kept in mind that according to the Constitution of the Russian Federation every citizen has the right to a favorable environment, reliable information about its condition and compensation of damage caused to his health or property by environmental offense.

## 5 Conclusions

Environmental monitoring of urban areas at formation of the city road network is extremely necessary, since the road complex is one of the main sources of environmental pollution. The peculiarity lies in the fact that neither a car nor a road can be isolated from people's habitats and the greater is the population density, the higher the need for road transport is. At the same time, the observed mass and constantly growing rates of the motorization process lead to a discrepancy between the existing categories of roads and streets in the city. As a consequence the city begins to experience an increased traffic load at impossibility to expand the existing roads and streets. In addition, the steadily increasing traffic load is responsible for the increased level of chemical pollution both in the areas adjacent to traffic flows [24–25] and at a distance from them.

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