Institut za gradevinarstvo "IG" Banja Luka

Naucno-istraživacki Institut

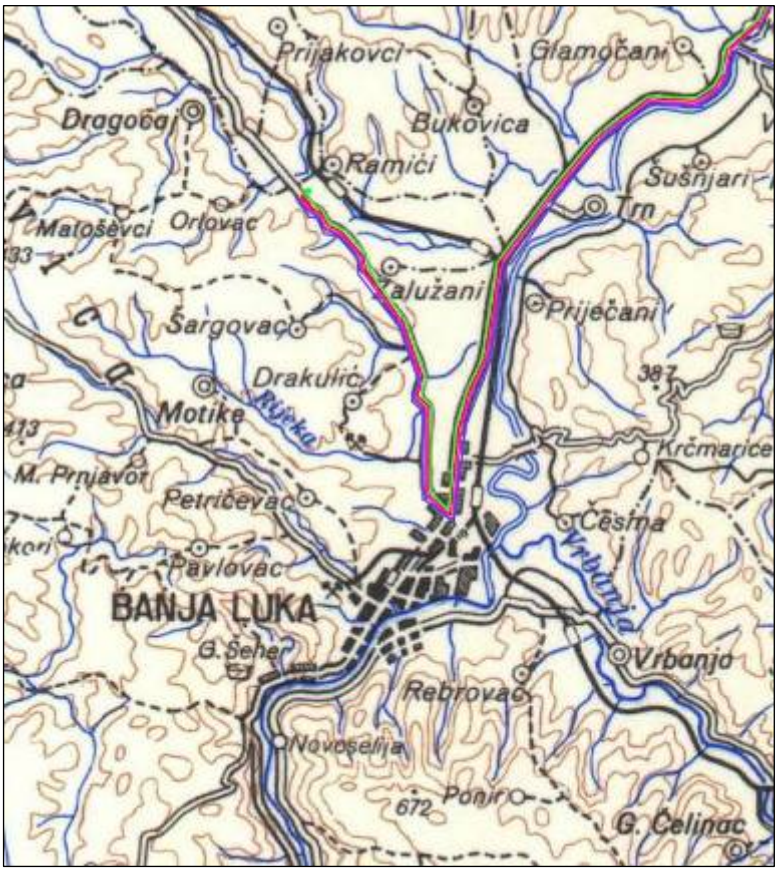
DVOKUT ECRO

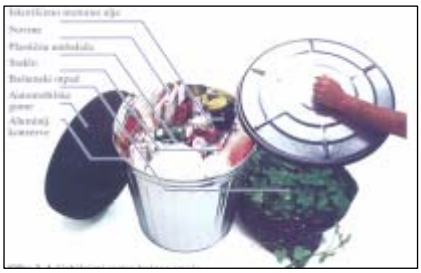
ZAŠTITA OKOLIŠA I ODRŽIVI RAZVOJ

ENVIRONEMNT IMPACT STUDY

OF REGIONAL LANDFILL IN RAMIĆI

FINAL VERSION





August 2007

CLIENT:	PC „DEP-OT“ REGIONA LANDFILL BANJA LUKA
PROJECT:	**ENVIRONMENT IMPACT STUDY OF REGIONAL LANDFILL IN RAMIĆI** ***FINAL VERSION***
CONSULTANT:	**Civil Engineering Institute „IG“ LLC Banja Luka and Dvokut Ecro, Zagreb**
PREPARATION PERIOD:	September – November 2006
Ref. No:	SU-IGBL-IN-EK-1050/06
RADNI TIM:	Prof. PhD Zdravko Milovanović, B.Sc.M.E. Nebojša Knežević, B.Sc. Technology Milenko Plivčević, B.Sc. Environment Protection Željka Stojanović, B.Sc. Agriculture Čedomir Pogarčić, B.Sc.C.E.
	General Manager Prof. PhD Zdravko Milovanović, B.Sc. M.E.

CONTENTS

1. GENERAL PART

1.1. INTRODUCTORY EXPLANATION

P.C."DEP-OT" was founded as a company in 2003 by City of Banja Luka and 7 municipalities of the region (Gradiška, Laktaši, Srbac, Prnjavor, Čelinac, Kotor Varoš and Kneževo) with aim to rehabilitate the existing landfill of communal waste in Ramići, within the World Bank project "Solid waste treatment".

By rehabilitation and expansion, the landfill in Ramići should be brought to the level of a modern landfill that will satisfy all criteria of "The Law on Waste Treatment" of Republic of Srpska and European Union with regard to waste stockpiling.

Having in consideration that the issue goes about construction of a communal waste landfill, and based on Article 2 Regulations on projects requiring preparation of EIA and criteria for determination of obligation about preparation and scope of a EIA ("Official gazette" of Republic of Srpska, no. 07/06), the subject landfill falls into the group of projects for which the Ministry for spatial planning, civil engineering and ecology of RS establishes a need for preparation of Environment Impact Assessment.

Environment Impact Study is based on the Law on the environment protection – Revised version (Official Gazette RS, no 28/07), which creates a legal framework for ecological permit issue procedure including articles about auxiliary procedures such as Environment Impact Assessment, based on a concept of integral prevention and pollution control.

Environment Impact Study is an integral part of the Project for rehabilitation and expansion of landfill in Ramići. Therefore the Investor initiated the procedure for Environment Impact Assessment, and the Preliminary Environment Impact Assessment was prepared by the Consortium of companies: „GWCC" Vienna, HIDROTEHNIKA LLC Banja Luka and „DVOKUT PRO" Sarajevo.

The Investor appealed to the Ministry for spatial planning, civil engineering and ecology with request no. 08-389/06 for preliminary environment impact assessment for the project of rehabilitation and expansion of the Landfill in Ramići, Banja Luka Municipality accompanied with the Preliminary Environment Impact Assessment.

Based on the above said, the competent Ministry issued the Decision on determination of obligation for impact assessment and preparation of Study on Environment Impact Assessment, no: 16-92-81/06 dated June 13th 2006 ordering PC „DEP-OT" Regional Landfill Banja Luka to deliver the Ministry the Study on Environment Impact Assessment.

1.2. STARTING BASEMENTS FOR THE STUDY PREPARATION

As the Preliminary Assessment indicates that the conflict with regard to the space purpose is solved, and indicates the scope and specifics of the impact, at the same time the impact study pays attention to the impacts mitigation, usually throughout technological solutions, based on legal requirements and available knowledge.

The basic task and aim of the analysis regarding the environment impact assessment is to clearly present all potential impacts of the project on rehabilitation and expansion of the Ramići Landfill, Municipality Banja Luka, on the environment and to predict all required protection measures and monitoring system.

The Investor initiated the environment impact assessment procedure based on a decision of the Ministry for spatial planning, civil engineering and ecology of Republic of Srpska no: 16-92-81/06 dated 13th June 2006, about determination of obligation for impact assessment and preparation of a Study on Environment Impact Assessment with expert opinions of the subjects as described by the following: the Article 60 of the Law on environment protection – revised version, the Decree on projects requiring an environment impact assessment as well as criteria for decision on obligation and scope of environment impact assessment.

A request with documentation was sent to the following subject in order to carry out the procedure for preliminary environment impact assessment:

- Administration Department of Town of Banja Luka,
- Ministry of agriculture, forestry and water management,
- Ministry of health and social protection,
- Institute for protection of cultural – historical and natural inheritance.

In the period foreseen by the Law, the only subject that sent their opinion was the National Institute for protection of cultural – historical and natural inheritance – Expert opinion no: 1-03/3-624-243/06 dated 06th June 2006, and the Ministry of health and social protection, Ministry of agriculture, forestry and water management and Administration Department of Town of Banja Luka sent no comment within the period foreseen by the Law.

Taking in consideration that this Environment Impact Study should also include comments on Preliminary Environment Impact Study, the below stated comments were taken from Decision no: 16-92-81/06 dated 13th June 2006 of the Ministry for spatial planning, civil engineering and ecology of Republic of Srpska.

„The aim of rehabilitation and expansion of the current landfill in Ramići is to solve the issue of deposition of solid communal waste from the Banja Luka region in accordance with EU Directive CD 1999/31. The rehabilitation of the existing landfill and its expansion with new departments would enable proper linear expansion of the landfill. The proposed solution for rehabilitation and linear expansion of the landfill shall provide safe solution for waste disposal in

this area for the next 20 years. Besides that, measures for monitoring of the environment elements are foreseen as well as measures for mitigation of unfavourable effects of the landfill over the environment.
A basic aim of the subject project is deposition of solid communal waste from the Banja Luka area, which would:

- Improve sanitary – epidemiologic safety of the population in the sense of prevention of contagious diseases and prevention of the waste negative impact over people's health;
- Prevent aggravation of the air, water and soil quality, prevent explosion of gases produced by waste decomposition process, in the period during and after the landfill exploitation;
- All additional occurrences and by-products concerning waste decomposition would be under control"

Comment of Institute for protection of cultural – historical and natural inheritance of RS:

„The area which is the subject of the Project of rehabilitation and expansion of the landfill in Ramići there are no structures of cultural – historical and natural inheritance.

In the area of Ramići Local Community there are registered archaeological locations (out of the landfill area), so it is necessary that the Environment Impact Study includes the obligation of the Investor to report any archaeological location found during the works execution to the Institute for protection of cultural – historical and natural inheritance of RS. The map of wide area of the Ramići Local Community including archaeological locations can be found at the Institute".

According to the Contract no: BA-SWM-CQ-102-S-06-3672-BOS/BL concluded between Public Company „DEP-OT" Regional landfill Banja Luka (Investor) and Institut za građevinarstvo „IG" LLC Banja Luka (Contractor), preparation of the Environment Impact Study of Regional landfill in Ramići was contracted.

The Environment Impact Study of Regional landfill in Ramići has been made in accordance with regulations of the Instructions about contents of an Environment Impact Study ("Official Gazette" of Republic of Srpska, no. 118/05).

As the Environment Impact Study required valorisation of the environment existing condition, the Civil Engineering Institute „IG" Banja Luka carried out 24h/10 days continual air quality measuring starting from 05 September 2006 on the object of Ramići Regional Landfill owned by P.C. «DEP-OT» Banja Luka.

All water testing were carried out in »Tatić laboratory« certified for water analysis Osječani, Doboj.

The analysis results of the water samples taken from the Main sewage under the landfill dam and the samples taken from the Glogovac brook channel are

commented in accordance with the Book of Rules on conditions for release of waste water into surface water streams (Official Gazette RS, no: 44/01), and the analysis results of water from the Dragočaj River, before and after the Glogovac brook estuary are in accordance with the Decree on classification and categorization of water streams (Official Gazette RS, no. 42/01).

The water samples from the landfill vicinity were taken on 12th, 22nd and 25th September 2006. The sampling was carried out by the expert team from „Tatić Laboratory“ on the following four locations:

- Main sewage under the existing landfill dam (starting point of the Glogovac brook channel),
- 300 m downstream in the Glogovac brook channel, in the culvert under Banja Luka main road, near „Unis“ factory,
- At the estuary of the Glogovac brook into Dragočaj river, water of Dragočaj river before the Glogovac brook estuary and
- At the estuary of the Glogovac brook into Dragočaj River, water of Dragočaj River after the Glogovac brook estuary.

Physical-chemical quality parameters as well as microbiological indexes of water pollution were determined from the taken samples.

In order to define the condition of the land quality in the vicinity and at the landfill, on 13 September 2006 the authors of this Study carried out the sampling of 10 soil samples from the vicinity and from the landfill.

In order to define „initial“ condition of the soil from the landfill, the sampling was carried out by division of total surface into five plots, and from each of them one surface composite sample and one deep composite sample was taken.

Physical-chemical features, analyses of microelements and heavy metals were determined from the taken samples.

All soil testing were carried out in Agricultural Institute of Republic of Srpska, Banja Luka, in the laboratory for pedology.

Institut za građevinarstvo „IG” LLC Banja Luka (Consultant) prepared Draft Environment Impact Study of the Ramići Regional Landfill, and PC “DEP- OT”, REGIONAL LANDFILL BANJA LUKA, applied to the Ministry for spatial planning, civil engineering and ecology for approval of the Environment Impact Study.

In accordance with the Article 64. Paragraph 2 of the Law on environment protection, the Ministry forwarded a copy of the request and the Draft Environment Impact Study to the subjects stated in the Article 60 paragraph 1 in order to give their opinion, especially about the Study contents. On 24 April 2007 a copy of the request was forwarded to the Banja Luka Town

Administration Service, Department for Spatial Planning – for inspection of the interested public.

In 30 days period it was posted on the bulletin board of the Banja Luka Town Administration Service and there were no comments by the public.

The Institute for Health Protection RS sent their opinion within the period foreseen by the Law. Their opinion is that the Study should include the obligation of the concessionaire to inform the public in case of any negative impact upon the people's health and environment in accordance with regulations of the Law on environment protection and competencies of the Ministry of health and social protection of Republic of Srpska.

As the issue goes about the health of people, in the process of preparation of spatial and other plans or basements and other investment-technical documentation (Official Gazette RS no. 56/02) related to the National Environment and Health Action Plan for RS (NEHAP) adopted by the RS Government (Official Gazette RS, no1/02) it is necessary to obey the Health policy and strategies for health in Republic of Srpska up to 2010 and recommendation of the Strategy 5 for monitoring and reduction of risk factors of living and working environment and strengthening of infrastructure and function of institutions for Health protection.

The first public hearing of the request and the Draft Environment Impact Study took place in the facilities of the Dragočaj Local Community on 18 June 2007 at 11.00 am.

In accordance with the Article 65 paragraph 3 of the Law on environment protection, the project leader delivered minutes from this hearing within the period prescribed by the Law. According to the minutes the participants in the public hearing asked various questions that were not directly related to the subject of the public hearing. There were no concrete questions or comments on the Environment Impact Study of the Ramići Landfill.

In accordance with Article 65 paragraph 4, a 30 days deadline was given for comments in written with regard to the request and the Draft Study.

Department for Spatial Planning – Banja Luka Town Administration Service had no comments to approval of the Environment Impact Study of the Ramići Regional Landfill.

A Commission from the Ministry inspected the Study and found neither omission nor mistakes in the Study.

Taking in consideration all the above said the Ministry made an Evaluation no: 16-92-116/07 dated 20 July 2007 ordering the Investor PC "DEP- OT",

REGIONAL LANDFILL OF BANJA LUKA, to deliver the amended Environment Impact Study of the Ramići Regional Landfill.

The amended Environment Impact Study was produced by Institut za građevinarstvo „IG" Banja Luka and delivered to the Ministry on 07 August 2007 by the Investor.

After this the Commission for revision of Environment Impact Studies carried out revision of the Amended Study, in accordance with the Law on environment protection – Revised version – Official Gazette RS 28/07 and produced a *Report on revision of the Environment Impact Study of the Ramići Regional Landfill, Banja Luka*, no: 16-92-116/07 dated 10 August 2007, attached to this Study.

According to the Report on revision, the Commission had no comments on the Environment Impact Study and ordered the Investor to deliver the final version of the Environment Impact Study of the Ramići Regional Landfill in accordance with the Law on environment protection – Revised version – Official Gazette RS 28/07, which resulted in preparation of this Final version of the Environment Impact Study of the Ramići Regional Landfill, Banja Luka.

1.3. ATTACHED DOCUMENTATION

In the process of preparation of the Environment Impact Study of rehabilitation and expansion of the Ramići Regional Landfill we used the documentation provided by the Investor.

Documentation provided by the Investor:

1. Preliminary solution Rehabilitation and expansion of Landfill in Ramići, Banja Luka Region, Consortium of companies „GWCC" Vienna, HIDROTEHNIKA LLC Banja Luka and „DVOKUT PRO" Sarajevo, 2006:

   - Technical report, calculation;
   - Graphic attachments;
   - Preliminary Environment Impact Assessment.

2. Regulatory plan for the area of Regional Sanitary Landfill of solid waste on the location of Ramići in Banja Luka, Town Planning Institute of Republic of Srpska, Banja Luka, 2002;
3. Report on the results of field and laboratory geo-mechanical testing carried out in the area of town landfill „Ramići" Banja Luka, Institute for testing of Materials of Republic of Srpska, 2005;
4. Report on Revision of Environment Impact Study of Regional Landfill in Ramići, Banja Luka, no: 16-92-116/07 dated 10 August 2007, Ministry for spatial planning, civil engineering and ecology of RS.

List of applied legal regulation of RS which treats environment protection:

1. Law on environment protection – Revised version – Official Gazette RS, 28/07;
2. Law on nature protection – Official Gazette RS, 23/02;
3. Law on water – Official Gazette RS, 50/06;
4. Law on waste management – Official Gazette RS, 53/02;
5. Book of Rules on conditions for perform of activities from the field of environment protection – Official Gazette RS, 02/03;
6. Book of Rules on changes and amendments of the Book of Rules on conditions for perform of activities from the field of environment protection – Official Gazette RS, 34/04;
7. Law on changes and amendments of Law on fire protection – Official Gazette RS, 02/05;
8. Decree on limit values of emission of polluting substances into the air – Official Gazette RS, 39/05;
9. Book of Rules on content of plan for adoption of plants and devices for waste management activities and activities taken by the competent body – Official Gazette RS, 39/05;
10. Book of Rules on monitoring of polluting substances emission into the air – Official Gazette RS, 39/05;
11. Book of Rules on monitoring of the air quality – Official Gazette RS, 39/05;
12. Book of Rules on waste types and waste management activities requiring a permit – Official Gazette RS, 39/05;
13. Book of Rules on waste categories with catalogue – Official Gazette RS, 39/05;
14. Book of rules on waste categories, characteristics that classify it to dangerous waste, activities of return components and waste disposal – Official Gazette RS, 39/05;
15. Book of rules on conditions for work of plant for waste combustion – Official Gazette RS, 39/05;
16. Book of Rules on limit values of the air quality – Official Gazette RS, 39/05;
17. Book of Rules on emission of evaporating organic compounds – Official Gazette RS, 39/05;
18. Book of Rules on limit values of emission into the air from combustion plants – Official Gazette RS, 39/05;
19. Book of Rules on changes and amendments of Book of Rules on manner and methods for determination of pollution level of waste water as a base for determination of water management fee – Official Gazette RS, 65/05;
20. Decree on projects requiring Environment Impact Assessment and criteria for obligation and scope of Environment Impact Assessment – Official Gazette RS, 07/06;
21. Decree on plants that can be construction and put in commission only if issued ecological permit – Official Gazette RS, 07/06;
22. Book of Rules on conditions for a request filing for an ecological permit for affiliated companies and plants that were issued a permit before the Law on environment protection become valid – Official Gazette RS, 24/06;

23. Book of Rules on terms for request filing for ecological permit issuing for affiliated companies and plants that were issued a permit before the Law on environment protection become valid – Official Gazette RS, 24/06;
24. Book of Rules on changes and amendments to Book of Rules on monitoring of pollution substances emission into the air – Official Gazette RS, 90/06,
25. Book of Rules on amendments to Book of Rules on conditions for performances of activities of legal persons from the field of environment protection – Official Gazette RS, 03/07;
26. Book of Rules on amendments to Book of Rules on waste types and activities for waste management requiring a permit – Official Gazette RS, 03/07;
27. Book of Rules on permitted limits of sound and noise intensity – Official Gazette SRBiH, 46/89;
28. Law on health protection – Official Gazette RS, 18/99;
29. Book of Rules on permitted quantities of dangerous and harmful substances in soil and their testing methods – Official Gazette of Republic of Montenegro, 18/97;
30. Decree on classification of water and categorization of water stream – Official Gazette RS, 42/01;
31. Book of Rules on conditions for release of waste water into surface water – Official Gazette RS, 44/01;
32. Book of Rules on conditions for release of waste water into public sewage system – Official Gazette RS, 44/01;
33. Book of Rules on manner and methods for determination of pollution level of waste water as a basis for determination of water management fee – Official Gazette RS, 44/01;
34. Book of Rules on protection measures, determination and maintenance method for zones and belts of sanitary protection of areas with springs, as well as water structures and water for human resources – Official Gazette RS, 7/03.

In the course of preparation we used information and other data from the Decision on determination of obligation to carry out environment impact study as well as European Directives.

2. TECHICAL PART

2.1. DESCRIPTION OF THE LOCATION AND AREA OF POSSIBLE PROJECT IMPACT TO THE ENVIRONMENT

"Ramići" Landfill is located in the area of Banja Luka, in the settlement of Ramići. According to "Strategy of waste control in B&H" the landfill is foreseen as a regional landfill for stockpiling of communal waste from the entire region of Banja Luka consisting of City of Banja Luka and the following municipalities: Gradiška, Kneževo, Kotor Varoš, Laktaši, Prnjavor, Srbac and Čelinac. The subject area is defined by regional organization of Republic of Srpska in the RS Spatial Plan (Picture no. 1).

Picture no. 1. Position of the Banja Luka region

The region represents about 19 % of Republic of Srpska territory, which is 4 718 km^2. The population of this region is 440 000, which undoubtedly means that this region is the most inhabited comparing to other parts, because about 30% of Republic of Srpska population lives here. Within the Banja Luka region, City of Banja Luka distinguishes itself by size, number of citizens and economic power. City of Banja Luka makes about 26 of the region territory, 50% of the region population lives there and it produces 66% of the region Gross Domestic Product (GDP). City of Banja Luka is the most significant economic, cultural, health, trade, administrative and financial centre with a lot of people moving in.

"Ramići" Landfill is located in northwest from Banja Luka centre, about 10 km from the city centre, on the location of Crkvina in the settlement of Ramići, on the left side of M4 Banja Luka – Prijedor Main Road, near the "Unis" Factory. The location connection with the main road is realized by an auxiliary access road with two lanes, which is located in the valley of Pranjići village, where Glogovac brook has its headwaters.

The basic landfill construction concept is made for the micro location, which has amphitheatrical shape with drainage pipes of Ø 600 mm diameter for intake and drainage of rainfall water out of the area and drainage pipes for intake of filtrates from the landfill and drainage through a small catch basin before releasing into Glogovac brook.

According to the transcript of ownership certificate 316/2 dated August 25th 2004 issued by the Banja Luka Municipality, Zalužani Cadastral Municipality, no. 10-952-2-9545/2004 the following lots are owned by City of Banja Luka, the Fond for management of construction land which has legal status of public property, and which has been allocated to the P.C. J.P. „DEP-OT" Banja Luka to manage them, and the subject landfill is located there:

Table no 1. Lots allocated to the P.C. „DEP-OT" Banja Luka

Lot no.	Area (m^2)	Class
79/1	194	
	278 445	
92/1	720	3
113	9 408	
129	297	5
	3 095	4
270/2	2 447	4
751	1 399	4
752	5 362	5
776	836	3
777/1	5 045	5
	5 407	4
2	484	3
778/1	139	
778/	563	4
889/2	276	
		Total: 314 617 m^2

2.1.1. COPY OF CADASTRE PLOTS PLAN FORESEEN FOR CONSTRUCTION OF THE STRUCTURE OR REALIZATION OF ACTIVITIES, WITH DRAWN IN PLAN OF ALL STRUCTURES IN THE COMPLEX

Attachment no.2 attached to this Study presents cadastre plots where the existing landfill is located and which are planned for rehabilitation and activities of expansion of the Ramići Regional Landfill.

Disposition of these structures and departments for deposition of the existing and future landfill which is drawn in on the *Plan of area organization on the Ramići Landfill after expansion and rehabilitation over 44 ha* is attached to this Study.

2.1.2. DATA ABOUT LAND SPACE IN m2 REQUIRED FOR CONSTRUCTION, WITH DESCRIPTION OF PHYSICAL CHARACTERISTICS AND MAP SURVEY OF APPROPRIATE SCALE AS WELL AS SPACES INCLUDED ONCE THE STRUCTURE IS BUILT

The existing Regional Landfill covers the area of 29 ha. The project of rehabilitation and expansion foresees expansion to 44 ha that borders with the existing Landfill.

During the existing landfill rehabilitation, the existing waste from certain sections will be excavated and transferred to the existing sections, the first section base will be rehabilitated and again the waste will be returned to a rehabilitated section, so in this way no new land will be occupied apart from the land used for deposition.

The landfill parts that will exist after the finished process of rehabilitation and expansion are as follows:

- Compartment A1 at 2.8 ha,
- Compartment A2 at 2.9 ha,
- Canon K at 2.3 ha, between compartments A1 and A2,
- Compartment B1 at 3.0 ha,
- Compartment B2 at 2.8 ha,
- Compartment C at 8.5 ha,
- Part D of the landfill foreseen for deposition and collection of precipitation and fire fighting water,
- Part E of the landfill foreseen for precipitation water treatment,
- Part F of the landfill foreseen for gas combustion,
- Landfill entrance zones and parking spaces,
- Part of EXPANSION in the first phase at 3.29 ha,
- Part of EXPANSION in the second phase at 1.78 ha,
- Part of EXPANSION foreseen for waste treatment at 0.86 ha
- Part of EXPANSION foreseen for waste recycling and sorting at 0.45 ha.

Disposition of all structures and compartment for deposition of the existing and future landfill is inscribed in drawing *Plan of area organization on the Ramići Landfill after expansion and rehabilitation over 44 ha* which is attached to this Study.

2.1.3. REASONS FOR SELECTION OF THE PROPOSED LOCATION

From the aspect of planning in the process of communal waste evacuation, the biggest problem is selection of the landfill location. When it comes to the location selection, there are a number of limitations caused by natural characteristics of the location and infrastructural equipment of the location.

In 1973 City of Banja Luka started the initiative to find a location for sanitary stockpiling of communal waste. About 20 potential locations for stockpiling of communal waste on the territory of City of Banja Luka were analyzed in that process.

In the process of the location determination the following was analyzed:

- Space purpose established by the town plan,
- Hydrographic situation,
- Geological characteristics of ground based on geological, hydrological and engineering map,
- Ground configuration,
- Roads network and concept of the landfill connection to the existing roads,
- Hydro-meteorological characteristics important for location of the landfill such as: wind rose, wind frequency and speed,
- Water capacity of the ground in sense of both over ground and underground water,
- Ground stability with possible landslides on the landfill location,
- Seismic characteristics,
- Underground infrastructure (water supply installations, other possible installations and other infrastructural structures),
- Number of citizens according to the last census,
- Waste sources,
- Total quantity and type of waste.

The current location in Ramići was selected as the most favourable location from the point of view of local conditions, ground morphology, hydro-geological, hydrological, climatic conditions, and possibilities for the environment protection as well as transportation distances.

Detailed hydrological testing were carried out for the subject location in order to determine the water tightness level of the landfill underlying stratum with aim to define possible pollution of underground and over-ground water. The subject testing was carried out by "INDUSTROPROJEKT" from Zagreb in 1974, and the Investor was Utility Company "Čistoća" – Banja Luka which then was in charge

of collection and stockpiling of communal waste in the city. Besides these investigations, other investigations resulting in establishment of the coal reserves were carried out in 1973 by Institute for Mining and Chemical-Technological Research from Tuzla, in order to establish coal deposit in Ramići.

Based on the performed investigation works, it was concluded that the ground on the selected location was suitable for construction of a sanitary landfill for stockpiling of communal waste.

The ground is stabile, and the rocks participating in the ground composition are watertight and serve as hydro-geological isolation which prevents seepage of water into the ground. According to the ground configuration, the location is favourable because it is located in an amphitheatric valley and it is sheltered by side relief.

„Ramići" Regional Landfill was one of the first landfills in Bosnia and Herzegovina that was fenced in and had controlled entrance, and at the same time it was the best organized landfill for sanitary stockpiling of communal waste.

The subject landfill has been in exploitation for about 30 years. The space was neither used for other function nor the land was reclaimed and by the basic planning documents such as: Strategy for solid waste control in B&H, Regulation plan for the area of Regional sanitary landfill on the location of Ramići in Banja Luka and Spatial Plan of Republic of Srpska, this area was intended for stockpiling of solid waste.

Based on inspection of the field situation, perception of the environment technical side, particularly geological, hydro-geological and morphological characteristics, and transportation distance, as well as taking in consideration expenses assessment for the land rehabilitation that would be required if the landfill is reallocated to another location, both the Designer and the Investors have chosen the subject location where rehabilitation of the existing communal waste landfill will be carried out as well as expansion of its capacities.

Based on the adopted regulation plan of Town of Banja Luka, "PROJEKT" Banja Luka Shareholding has prepared Town planning – Technical terms for phase realization of the construction lot for the area of the regional sanitary landfill, which was verified by Spatial Planning Department of Banja Luka City Administration on January 10th 2005.

Town planning – Technical terms encompass the area of the existing landfill on the area of about 29 hectares and enlargement to total area of 44 hectares.

2.1.4. PEDOLOGICAL, GEO-MORPHOLOGICAL, GEOLOGICAL AND SEIZMIC CHARACTERISTICS OF THE SOIL

2.1.4.1. Pedological characteristics of the soil

P.C. Regional Landfill „DEP-OT“ in the 6th months of 2006 carried out geotechnical works on the regional landfill of communal waste in Ramici - Banja Luka.

During that action, bore holing and laboratory sampling was carried out on the soil samples in order to determine physical-mechanical and filtration characteristics of the soil.

The following was carried out on the micro location:

- Drilling of 9 boreholes, the depth from 7,0 to 23,0 m under the level of new-formed surface of deserted waste,
- Rough identification of communal waste,
- Ground identification, AC classification of original soil and sampling.

Based on the taken boreholes cores, we determined the presence of the following layers:
- deposited waste,
- marly clay, degraded.

The 1st layer represents the landfill of non-selective organic and inorganic communal and industrial waste, the thickness more then 22 m.

The 2nd layer (the ground on which the landfill is formed) represents marl clay, degraded- neogene (ng), which are represented by degraded marl lime-stones with the trace of carbon, in the zone of drilling on the depth from 18.3 to 19.0m. The clay is usually in grey colour, then brown, brown-grey, brown-yellow, in very hard pressing consistent condition.

By grain size analysis of clay layer we determined the following participation of some fractions in percentage:

Table no. 2. Grain composition of clay in the landfill base

FRACTION	PARTICIPATION (%)
clay, fragments under 0,002 mm	23-40
dust, fragments of 0,002-0,0202 mm	45-60
sand ,fragments of 0,02-2,00 mm	0-20

On the base of analysis of diagram we can conclude that the investigated samples belong to inorganic clay of high plasticity -*CH-.* Coefficient of water

permeability k = 4.0-9.2 x 10^{-9} cm/s in eugenic clay , which represent the base of landfill, show that the base is with very small almost insignificant level of water permeability that is ,it is regarded as hydro geological insulator.

On the excavation at the landfill entrance (picture 6) the depth about 2 - 3 m it is possible to see that the soil is made from pro-alluvial stream materials, represented by weak consolidated sandy to muddy clay, with organic components as well as clayey and badly elaborated stream gravel and detritus.

Table no. 3. Grain composition of soil

FRACTION	PARTICIPATION (%)
clay, fragments under 0,002 mm	10-40
dust, fragments from 0,002-0,02mm	20-60
sand, fragments from 0,02-2,00mm	5-30
Gravel – detritus, fragments from 2,00mm	0-45

- W= 26-54% - natural humidity
- γ = 18,45-18,95 kN/m^3 - weight by volume – wet
- γ_d = 13,25-14.75 kN/m^3 - weight by volume – dry

According to the mentioned characteristics, we can conclude that the soil on the landfill location belongs to the 3rd category, while on some places it can be selected under the 5th category.

According to SFRY Pedological map (Section Banja Luka 2) the entire area is located on terrace soil.

By analysis of the soil present condition it can be concluded that it is possible to use materials from the existing surrounding waste dumps as borrow-pits when forming the landfill upper layer in the preparation of biological reclamation phase. From ecological and economical aspects it is very profitable because of vicinity and natural soils preservation.

2.1.4.2. Morphological characteristics of the ground

The closer landfill area in Ramići, which is now being used for stockpiling of communal waste is a steeply hillside, with inclinations of 15°, while the hillsides of north and northeast side are mildly laid with inclination of about 10°. The surrounding area of the landfill in Ramići is an amphitheatric valley, with the absolute heights of 167,5 m.a.s. on east and up to 250 m.a.s. on west.
The absolute height above sea level of the subject landfill area in Ramići is between 165 – 250 meters with slope inclination of 15°. The east amphitheatric side is opened and represents a natural entrance into the landfill.

The wider area of amphitheatric valley encompasses about 60 hectares, and it makes an integral part of, so called, Banja Luka neogenic basin. The area encircled by local watersheds, is drained by Glogovac brook which runs through the landfill central part, and drainages collected water into Dragočaj River which empties into Vrbas River. The amphitheatric slope ravines are temporary flood streams which as well empty into Glogovac brook.

2.1.4.3. Geological structure of the ground

Wider vicinity of the Ramići Landfill, in the structural-tectonic sense, falls into the structural unit of Central ophiolitic zone of inland Dinaric geo-tectonic unit, which mainly consists of Mesozoic rock, from Triassic to Cretaceous periods.

Young rocks of Cenozoic age appear in neogenic basins of north Bosnia, among which, although covers relatively small space comparing to others, stand out Banja Luka neogenic basin. Quaternary stratums of Cenozoic appear either as relatively thin cover of surrounding mountains and hillsides or as quite thick alluvial stratums of river valleys.

The oldest discovered rocks are upper-Triassic (T_3) dolomites and limestone, which caused by tectonic activities come out on the ground surface far in south, in the vicinity of Šeher and Novoselija, in the south part of Banja Luka region. In the other parts of wider landfill vicinity the base consists of younger sediments. Immediately above them lays Triassic-Jurassic (T, J) cherk, shale and silificed limestone with manganese, which were discovered in northwest part of the landfill vicinity, in the area of Dragočaj, Piskavica and Slavićka.

Stratums of Jurassic (J), represented by “ophiolitic thin layer” volcanic-sediment diabase - cherk formation of Central ophiolitic zone, were discovered on the huge area northwest, north and east from the landfill area. They are represented by sandstone, shale and cherks with inserted “olistolites” of diabase, spilites and limestone of small dimensions.

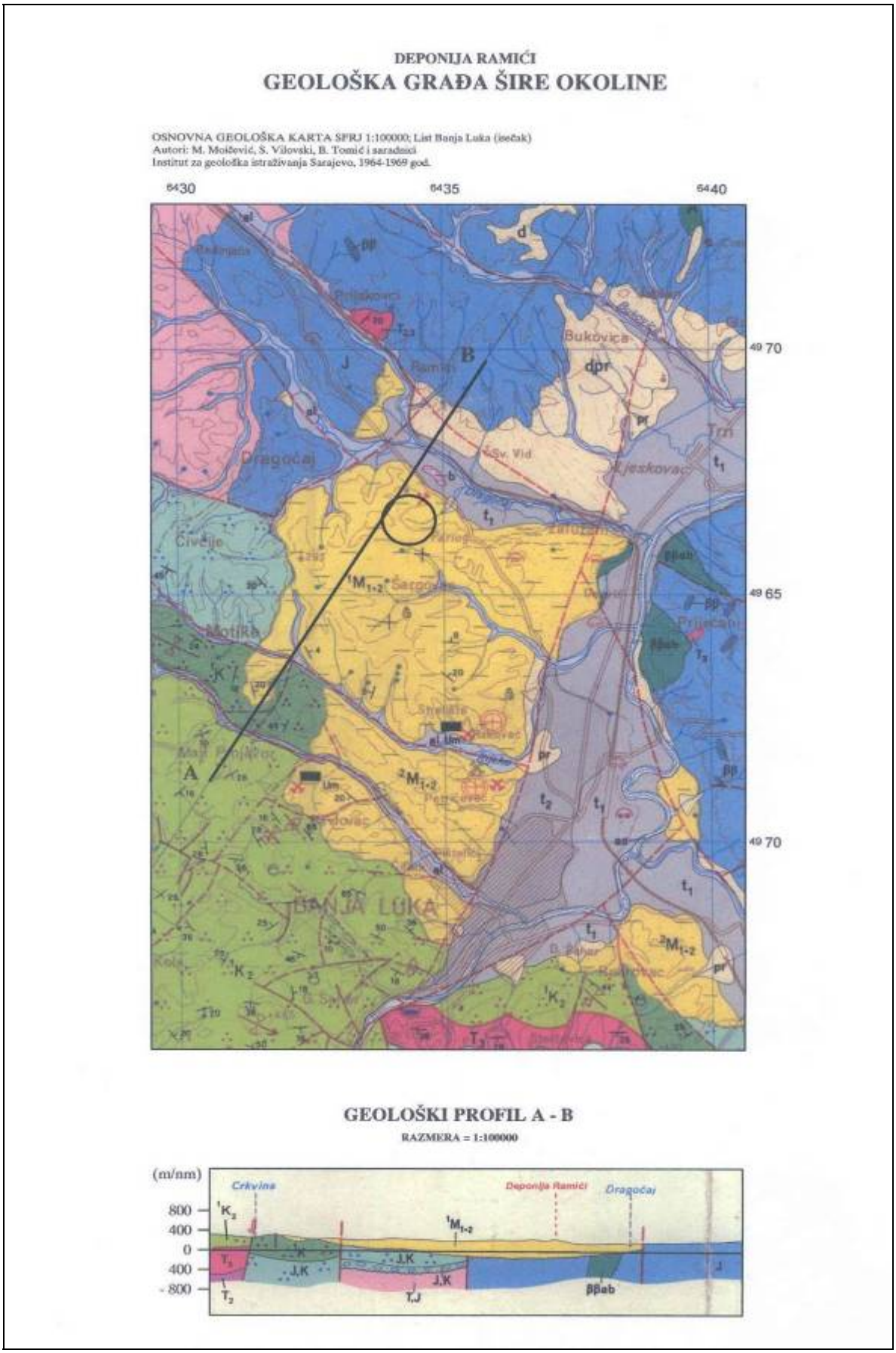
Jurassic-Cretaceous stratums, represented by clastic flysch, were discovered in small area, in the area of Motika and Čivčija. The stratums are made of breccias, conglomerates, marls, shale and calcirudites.

Cretaceous stratums appear in big area in south and southwest part of the landfill wider vicinity. They are present in clastic stratums; older flysch stratums of bottom cretaceous (^1K) represented by marls, marl-sandy limestone, calcirudites and conglomerates in the closer area on the left valley side of Crkvena in the area of Motike settlement as well as in the area of Rebrovac settlement, and young flysch stratums of middle Cretaceous ($^1K_2$) represented by micro-breccias limestone, marls and calcirudites in the wider area of south and southwest part of Banja Luka region.

Young Cenozoic rocks, sediments of Banja Luka neogenic basin, were discovered in big area of the middle part of the landfill wider vicinity, on the location where landfill of solid waste in Ramići was formed. They transgressively lay on old Jurassic-cretaceous stratums. Their thickness is quite big; according to data from previous geo-physical investigation (N. Gaćeša, 1970 – 1972). In the area of Šargovac, in plain part, their thickness exceeds 100 meters. The region of Banja Luka, the wider landfill area, the area of Motike, Rakovac, Šargovac and Zalužani are made of low- to middle-Miocene ($^1M_{1+2}$) marls, marl limestone and rarely clay with coal, and the area of Pavlovac, Lauš, Petrićevac and Rebrovac little younger, as well low - to middle-Miocene ($^2M_{1+2}$), marls, clays and sands.

The youngest quaternary stratums represent, on one hand, quite thin, up to one meter, surface diluvium – proluvium dusty-sandy-clayey cover of the surrounding mountains and slopes, and on the other hand, they represent thicker clayey-sandy-gravely alluvium stratums of river plateaus of rivers Vrbas, Crkvena, Široka Rijeka, Dragočaj and Bukovica.

Geological structure of the wider vicinity of Ramići landfill is presented in geological map and geological profile in the following picture.



Picture no. 2 Geological structure of wide vicinity of the subject landfill

The restricted area of landfill Ramici are made from lower to the middle-**Miocene** ($^{1}M_{1+2}$) marls, marl lime-stone, and the clay with coal (picture. 4 – the big canal in **Miocene** layers on the entrance of landfill). The thickness of **Miocene** layers in the area of landfill is over 100 meters. The base is made of Jurassic layers (J), represented by **"**ophiolitic mélange" volcano-sediment wide diabase of horny formation of Central of ophiolitic zone, represented by sandstones, feldspars and cherk with insert "olistolite" diabase of spilite and lime-stones of smaller dimensions.

Picture no. 3. The landfill Ramići, the view on the land south from wasteland

Miocene layers and layers of diabase-horny formation, which are in tectonic relation north from landfill, which suggested that on that area the thickness of Miocene layers comes to a few hundred meters.

Picture no.4 The Ramići landfill, the view on the land west from landfill

The surface humus cover of Miocene layers on the narrow area of landfill is very thin, up to 30 cm (picture 4 and 6 – the big canal (the source of earthen materials) in Miocene layers on the landfill entrance with thin surface humus cover). In the north area of the landfill, in the lowlands-part of the valley Dragočaj, Miocene layers are covered by alluvial earthen-sandy gravel layers with relatively small thickness, up to 5 meters, while in riparian parts of the ground it is covered by relatively fat layer, up to 10 meters, diluvia –proluvial over-deposited layers, with small participation of crumbly parts of hard fundamental rock.

Picture no.5 The Ramići landfill, the view on the land east from landfill (in the background of the picture) and the water-gate with base waste water outlet (in the middle of the picture)

2.1.4.4. Engineering -geological characteristics of rocky mass

In engineering-geological sense the rocky mass in the vicinity of the landfill is represented by tied marl-clayey rocks, with the certain participations parts of marl lime-stones as if hard rock (picture 6), which are known for its good geo-mechanical characteristics – relatively high weight by volume (from 20 to 24 g/cm^3), relatively big internal friction angle (from 25^0 to 350) and relatively big cohesion (from 20 to 30 kN/m^2).

With the regard to small incline of riparian slopes (up to 20^0), slopes are safe and in vicinity there is no sliding or land-sliding of the ground.

The surrounding slopes are cultivated or captivated, and the higher parts of the land are overgrown by high vegetation, forest and groves so that the landfill is safe from possible sliding and land-sliding of the ground.

Picture no. 6 the Ramici landfill, the view on the canal on the landfill entrance

2.1.4.5. Hydro-geological characteristics of the ground

In the hydro geological sense, rocky mass in the vicinity of landfill are water-porous to the certain depth, also Miocene and the layers of diabase-horny formations and they represent hydro geological insulator. Coefficient of water permeability of marl-earthen layers is approximately 1×10^{-5} to 1×10^{-8} m/s. So, the main characteristic of location is its small permeability of earthen material and the sediments of substrates are water-porous if are talking about marl lime-stones complex or carbonic zone. According to that fact, we can say that all rocks which are participated in the composition of the ground are hydro geological insulator.

Lower down, on the north of the close landfill area, alluvial layers in the valley of Dragočaj are famous for its water permeability, approximately 1×10^{-2} to 5×10^{-4} m/s.

Atmospheric waters which usually are collected in the material of the slope, depending on intensity of precipitation have periodical character. These waters usually in the process of drainage when they are in the contact with water - porous sediments of substrates like periodical water-springs and rises of periodical character.

2.1.4.6. Seismic-tectonic characteristics and seismic level of the ground

The wider area of landfill Ramici is a part of Banjaluka's neogenic depression (Banjaluka's neogenic basin) which encircles quite large territory of Vrbas and Prijedor's neogenic basin, which is restricted by tectonic faults from all sides. The most striking chasms are deep faults on the south and eastern edge of depression.

Neo-tectonic movement in the end of Pliocene and Quaternary had the prominent differential character, leading to the different levels of lowering that is, rising of some parts of the ground. These processes are present even today, leading tectonically to the movement of some made blocks and resulting in high vibration of ground, and the seismic activity of the wider and narrow areas of the Ramici landfill closely connected to the seismic activity of Banjaluka's focal region.

The most catastrophic earthquakes from the 1969. with the focal in the vicinity of landfill Ramići on 26th October 1969, with the co-ordinations 44.9^0 N and 17.25^0 E, magnitude 5.6, intensity 7^0 to 8^0 MCS-64 and on the 27th of October 1969. with co-ordinations 44.8^0 N and17.2^0 E, magnitude 5.6, intensity in the epicentre 8 to 9^0 MCS-64, determines the degree of vibration of the ground.

According to seismograph chart for the period in the last 100 years (regulations about the exchanges and amendments of Book of rules about technical norms for constructing of objects of high-rise building in seismic inclined to grounds, next. page SFRJ no. 52/90), narrow and wider area of landfill Ramici is placed in zone of 9^0 MCS-64.

According to that, the fundamental degree of vibration of wider and narrow area of landfill, defined on "the basic rock", to the middle Miocene layers are 9^0 MCS-64.

2.1.5. DATA ABOUT WATER SUPPLY SOURCE (DISTANCE, CAPACITY, ENDANGERING, SANITARY PROTECTION ZONES AND DATA ABOUT BASIC HYDROLOGICAL CHARACTERISTICS

The settlements and landfill location supply with saturate water is carried out by town water supply system, with Φ 200 mm pipeline, so in the subject landfill area there are neither water supply sources nor sanitary protection zones.

2.1.5.1. Hydrological characteristics

Eastern from the landfill in Ramici, on about 800 meters, there is the river Dragočaj. 5 kilometres downstream this river empties into Vrbas River.

On the vary locality of the landfill there is a water-spring Jazovac from which further on appears a small brook Glogovac. Capacity of the spring is about 0, 10

– 1.5 l/s depending on season and amount of precipitations. The spring is sealed and with the tubes conducted under the water-gate (Closed regulation). These works were carried out before any waste was stockpiled on the locality.

The surface of the river-basin of Dragočaj River is about 95 km^2, and the volume of the river-basin is about 55 km. The main course of the water-flow Dragočaj is long about 6 km and it is made from the right affluent so called Dragočaj, long about 9,5 km and the left affluent, called Ivaštanka ,long about 11 km. River-basin area of the right affluent is about 47 km^2 , and river basin area of the left affluent is about 37,3 km^2.

On the mouth of the brook Glogovac maximal flow of the river Dragočaj is about 230 m^3/s (together right and left tributary, Dragočaj and Ivaštanka).

The approximately specific flowing (through) river-basin of Vrbas (in which there is landfill, according to information from Spatial Plan of Republic of Srpska) is 19,90 $l/s/km^2$.

Estimated amount of flowing off of the surface waters due to precipitations for big water, appearing 1/100 for certain river-basin surfaces, i.e. for some phases of landfill is ranging from 0.90 to 1.25 $m^3/$, depending on the phase of the construction of landfill.

2.1.6. DESCRIPTION OF CLIMATE CHARACTERISTICS WITH APPROPRIATE METEORLOGICAL

Meteorological data for Town of Banja Luka for the following parameters:

- Average monthly air temperature,
- Absolute maximal air temperature,
- Absolute minimal air temperature,
- Average value of relative air humidity,
- Average value of air pressure,
- Precipitation amounts
- Winds Rose

are from the Republic Meteorological Institute of RS, Banja Luka and they represent the result of long-time measurement and recording (for the period 1961-1999 and especially for the year 2000.), in the further text it will be represented in table and diagrams .

2.1.6.1. Air temperature

Table no. 4 the average monthly temperature of air (^{0}C) for the period from 1961. to 1999. and especially for the year 2000. (Table no. 3 and Diagram no.1)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Av. value
61/99	-0.3	1.7	6.3	10.8	15.7	19.1	20.8	20.3	16.1	10.9	5.9	1.0	10.8
2000	-1.7	4.1	7.4	14.2	17.4	21.5	21.8	23.2	16.7	13.9	10.7	4.6	12.8

Table no. 5 absolute maximal air temperature (0C) for the period from 1961. to 1999. especially for the year 2000

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Av. value
61/99	21.2	23.7	29.6	29.2	35.4	35.2	39.6	40.4	37.0	34.8	26.7	23.5	40.4
2000	16.2	21.8	25.0	29.3	31.9	37.6	40.9	41.2	33.2	28.4	23.9	19.2	41.2

Table no. 6 absolute minimal air temperature (^{0}C) for the period from 1961. to 1999. especially for the year 2000

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Av. value
61/99	-26.4	-21.0	-15.6	-6.8	-1.4	0.9	5.3	5.0	-1.0	-6.0	-14.3	-20.4	-26.4
2000	-22.0	-7.5	-4.7	-0.3	4.7	4.4	7.2	7.8	4.3	-1.3	-2.2	-10.2	-22.0

In the area of Banja Luka there is modestly-continental climate, with the warm summers and very cold winters, because of the openness toward continent and confinement toward the sea.

The average monthly value of air temperature in period from 1961 to 1999 was 10.8 ^{0}C. The value of the same parameter in 2000 was 2^{0}C higher which amounts to 12.8 ^{0}C.

The value of monthly absolute temperature in mentioned period was 40.4 ^{0}C in August. The absolute value of monthly temperature in 2000 was 0.8 ^{0}C higher, that is, 41,2 ^{0}C, also in August.

The value of monthly absolute minimal temperature in the mentioned period was -26.4 ^{0}C in January. The value of absolute minimal temperature in 2000 was 4,4 ^{0}C higher, that is -22,0 ^{0}C, also in January.

2.1.6.2. Relative air humidity

Table nor. 7 Average value of relative air humidity (%) for period from 1961 to 1999 and especially for 2000

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Av. value
61/99	83	79	73	71	72	73	71	74	79	82	84	85	77
2000	86	76	68	68	71	63	63	59	75	83	77	86	73

The average value of relative air humidity in the period from 1961 to 1999 amounted to 77 %. The same parameter value in 2000 was smaller for 4%, and amounted to 73 %.

2.1.6.3. Air pressure

Table no.8 Average value of air pressure (mbar) for the period from 1961 to 1999 and especially for 2000

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Av. value
61/99	1002,5	1001,4	999,2	995,7	944,5	1049,7	998,1	997,9	999,2	1001,2	1001,3	1001,5	999,3
2000	1006,2	1005,0	1000,5	991,9	998,7	1000,7	994,7	999,0	998,1	999,9	996,2	998,6	999,1

The average value of air pressure in the period from 1961 to 1999 amounted to 999.3 mbar. The same parameter value in 2000 was smaller for 0,2 mbar, and amounted to 999,1 mbar.

2.1.6.4. Monthly value of precipitation

Table no. 9 Average value of monthly precipitation value (l/m^2) for the period from 1961 to 1999, and especially for 2000

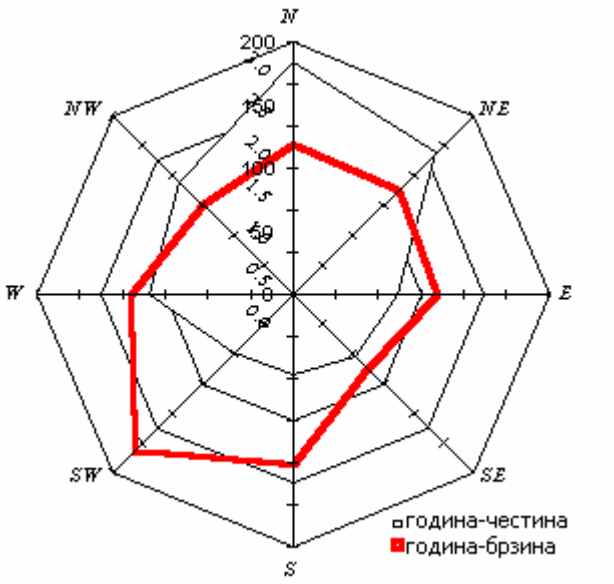
Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Av. value
61/99	70.1	62.8	80.3	87.5	96.3	113.9	96.9	86.6	89.7	81.1	97.8	91.1	105.41
2000	42.9	38.9	73.7	58.1	67.2	35.7	83.2	13.2	68.7	47.7	97.3	81.6	70.82

The average value of monthly precipitation amounts in the period from 1961 to 1999 amounted to 105,41 l/m^2. The same parameter value in 2000 was smaller for 34,59 l/m^2 , and amounted to 70,82 l/m^2. Most precipitations during one month, of the mentioned period, were in June and the value was 113,9 l/m^2 , while in 2000 the most of precipitation was measured in November that is 97, 3 l /m2 .

2.1.6.5. Wind – winds roses

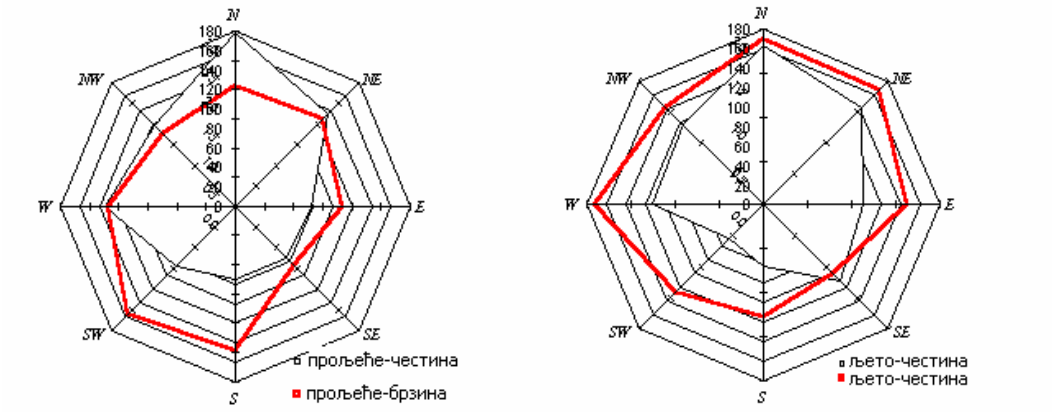
Table no. 10 The frequency of wind direction with the speed and silences (in promiles) for a year and per seasons, Banja Luka 1961 – 1990

		N	NE	E	SE	S	SW	W	NW	C
Year	Frequency	184	159	82	70	64	65	113	126	138
	Speed	1.8	1.8	1.7	1.2	2.0	2.6	1.9	1.5	
Autumn	Frequency	185	157	75	54	59	60	107	133	170
	Speed	1.6	1.6	1.7	1.1	1.8	3.4	1.7	1.3	
Summer	Frequency	164	142	102	112	63	50	113	116	138
	Speed	1.9	1.9	1.6	1.1	1.3	1.4	1.9	1.6	
Spring	Frequency	178	135	78	74	75	87	134	119	120
	Speed	2.1	2.1	1.8	1.4	2.5	2.6	2.2	1.8	
Winter	Frequency	210	202	71	41	59	64	97	135	122
	Speed	1.5	1.5	1.6	1.3	2.6	3.2	1.9	1.4	

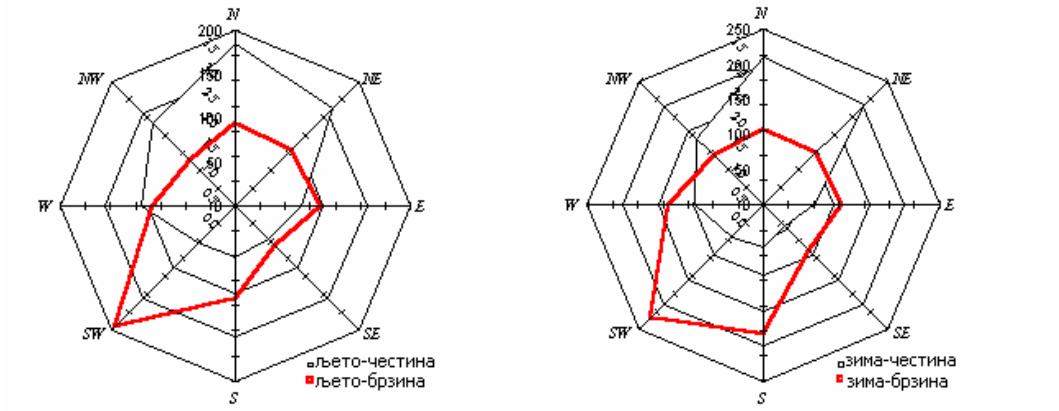


silent=13,8%

Picture no. 7 Winds Rose (per year), Banja Luka 1961 – 1990



Silence=12,0% Silence=13,8%



Silence=17,0% Silence=12,2%

Picture no. 8 Winds Rose (per seasons), Banja Luka 1961 – 1990

When looking at Winds Rose as a whole per one year, according to the results of climatological observing of wind direction and the strength of winds in the period from 1961 to 1990, in Banja Luka, there were many windy periods. Silence, the weather condition without winds, has its places in annual allocation with 13,8%. During the year there are many winds from the north and north-east, with the frequency from 18,4 and 15,9%. After them, according to frequency the most present winds are from northwest and the west. In annual allocation they participate with 12,6 and 11,3% of frequency. The allocation of the middle speed according directions shows us that the most prominent winds do not have the biggest speed. According to the mentioned results, the biggest middle speed has the winds from the southwest, south and the west, that is: 2,6; 2,0 and 1,9 m/s.

The seasonal division of frequency of winds' directions and silence shows that in spring and in winter there is more wind then in summer and autumn. During the winter (December, January and February) the silence appeared 12,2% cases , and during the spring silence appeared (March, April and May) in 12,0% cases.

In autumn (September, October and November) the silence appeared is the most quiet with 17,0% of silence. During summer represented with (June, July and August) 13,8% cases.

During the winter in Banja Luka, according to mentioned observations, the most frequent winds are from north and northwest directions, 21,0 and 20,2%. Insignificantly rare winds are winds from northwest with 13,5% cases. The winds from southeast and south are the rarest during the winter. During the winter the most average speed have winds from southwest, the south and the west.

In the spring division of wind direction frequency mainly appear in the north and northeast winds with17,8 and 13,5% cases. The insignificantly rare in frequency are west winds with 13,4% cases. During the spring the biggest average speed have the winds from southwest, the south and the west.
Comparing to the value in other seasons, during the spring, the average speed of winds from north and northeast direction are biggest.

During summer the most frequent winds are from north and northeast but its dominance is less exposed. It is because of the increase of winds from southeast and the east. Comparing with the last season, the average speed is lower and maximal speed is not above1,9 m/s.

The division of frequency of winds' directions during autumn is similar as in winter. The more frequent are the winds from north and northeast and after them the winds from northwest and the west. On an average the biggest speeds have the winds from southwest, 3,4 m/s. It is at the same time the biggest average speed in seasons divisions.

The windiest months of the year are June and February with 9,6 and 10,7% of silence. On the other hand to them the most of silence there is in September and August 21,5 and 18,4%.

The division of winds directions frequency of per months with some exceptions follows the season's divisions.

2.1.7. DESCRIPTION OF FLORA AND FAUNA, NATURAL PROPERTIES AND SPECIAL VALUES OF (PROTECTED) RARE AND ENDANGERED PLANT AND ANMAL SPIECES

The expert team of Civil Engineering Institute „IG" visited close and wider surroundings of the mentioned landfill in order to record and describe all fauna and flora species which exist in the landfill vicinity.

In the subject area we did not register or notice and rare or endangered plant and animal species or their domicile.

In the further elaboration all collected pieces of information were systematically elaborated and presented in the following text.

2.1.7.1. Flora

According to eco-vegetation re-ionization of B&H the area of Banja Luka belongs to Pre-panonian region but on the northwest belongs to the Bosnian region (Stefanović, et al., 1983). These regions are mostly lowlands and rising grounds, which according to orthographic characteristics belongs to lowland and highland belt from 130 to 500 m of height above sea level. The region according its fit geographic characteristics represent Pre-panonian sector of the north-European provinces, which are mostly famous according its lowland oak-woods in the next union:

- Carpinion betuli,
- Alno – Quercion,
- Alnion glutinosae,
- Salicion albae and
- Quercion robori – petraeae

Typical for the west parts of the region is the existence of atlantics flora elements such as Calluna vulgaris, and on the east there are mostly pontic and pontic-mesic flora elements (Tilia tomentosa, Quercus cerris, Prunus mahaleb and ect.) which are not very usual in the area of Banja Luka.

Very important woods are the beech forests in the highland belt, which mostly belong to the union of Fagetum submontanum sinctonomocally.

The northwest Bosnian region has the characteristics of modestly continental climate that is slightly influenced by Atlantic climate which is not so expressed. Coefficient of the continental climate is smaller then 5 % and the relation of potential evapotranspiration and precipitations in the flora period is more convenient and it is about 0.98. The alluvial level surface in the valley of Vrbas and Vrbanja Rivers has the influence on appearance of specific vegetation for that kind of environmental conditions with the representation of the species from the union of Salicion albae and Alnion glutinosae. Pseudogley- the ground with district cambium are mostly represented, what have the direct influence on the development of real vegetation ,mostly, climatogenic forest of fir-tree and hornbeam (Querco – Carpinetum) and with them alternate on the cold position of the beech forest (Fagetum montanum).

In the lowland and on the diluvial balcony are represented the forest of the hornbeam and oak (Carpino betuli – Quercetum roboris). On the orthographic expressed grounds there are the woods of hornbeam and oak wood (Quercetum petraeae montanum).

Taking in consideration the potential flora, the region belongs to the climatogenic forest of oak and simple hornbeam with the mosaic arranged hornbeam forest and the oak wood, and on the rising cold grounds and on the mesiophil environment of beech forest.

In the region of Banja Luka the most important union of flora is the oak-forest and the common hornbeam (Querco petraeae – Carpinetum illyricum). It is very climatogenic forest. This forest can not be found on very steep grounds and on

very wet grounds which are very cold and sour. It can be found in the region of Banja Luka on the different base of lime-stones and sour brown grounds.
Because of the climate this forest has the following characteristic: the stratification and because of that it is considered one of the phitocentologicaly richest woods in the Europe. There are no many preserved forests of this kind. The great problem is drying of oak wood which resulted from different bio and anti-bio factors. In the vicinity of Banja Luka the most represented woods are the hornbeam woods. They are more represented then oak when it comes to volume and number.

As the real example of the zone there are the woods of hornbeam and oak-woods (Carpino betuli-Quercetum roboris), which were destroyed by anthropogenic influence and transformed into the brushwood. The vegetation periods lasts for 195 days.

When it comes to the area of the regional communal waste landfill „Ramići“ the issue goes about these flora union in which the most prominent are the following species of trees and shrubbery:
Quercus petraea, Carpinus betulus, Acer campestre, Ulmus campestris, Tilia platiphyllos, , Quercus cerris, Corylus avelana, Evonymus europaeus, Daphne mezereum, Lonicera caprifolium, Crataegus monogyuna, Ligustrum vulgare, Staphylea pinnata.

The next species should be found in the layer of lowland flora:

Lamium orvala, helleborus atrorubens, Epimedium alpinum, Erythronium dens – canis, Anemone nemorosa, Primula vugaris, Stellaria holostea, Crocus vernus, Galium silvaticum, Galium vernum, Carex pilosa, Carex silvatica etc.

However on the landfill domination belong to the nitrophile plants mostly weeds:

1. *Chenopodium album*
2. *Urtica dioica*
3. *Atriplex patula*
4. *Matricaria chamomilla*
5. *Anthemis arvensis*
6. *Poligonum aviculare*
7. *Portulaca oleracea*
8. *Arctium lappa*
9. *Sambucus ebulus*
10. *Rubus sp.*
11. *Rosa canina*
12. *Papaver rhoeas*
13. *Chelidonium majus*
14. *Convolvulus arvensis*
15. *Sonchus arvensis*
16. *Cirsium arvense*
17. *Plantago media*
18. *Plantago major*
19. *Plantago lanceolata*
20. *Trifolium repens*
21. *Pontentilla reptans*
22. *Stellaria media*
23. *Lamium maculate*
24. *Ranunculus arvensis*
25. *Setaria glauca*
26. *Poa annua*

2.1.7.2. Fauna

The extent and biodiversity of fauna depends from the region. This dependence is conditioned by their way of breeding, nutrition, and adaptation during the change of eco-factors. Every change and disturbance of the existing life conditions resulted in migration or disappearance of many animal species, which can result in change of some populations in the analyzed area.

The habitation represents a very complex natural system, which is very sensitive to various impacts and changes that can result in migration of some animal species.

The most important kinds of game in the region of Banja Luka are:

Hairy game

- fox,
- rabbit,
- wolf,
- roe deer,
- wild boar,
- badger,
- stone marten,
- wild cat.

Game birds

- mallard,
- buzzar,
- raven,
- magpie,
- crow,
- gray crane,
- heron etc.

Besides that the next important species are: vole, small weasel, field mouse, and mole-cricket .

Based on the analysis of representation of flora and fauna in the vicinity of regional landfill of communal waste in Ramici the determined numeral condition and presence of some kinds of game, vole and reptile can be concluded:

- The most represented of all the hairy game are foxes (3-5 pcs)
- Stone marten (2-4 pcs)

Crow, ravens, magpie, and pigeons are very prominent game birds. It is quite difficult to estimate the numeral condition of the game birds but it is possible to conclude that the magpies are the most dominant specie.

2.1.8. OWERVIEW OF BASIC LANDSCAPE CHARACTERISTICS

Wider area of landfill in Ramići is multifarious from aspect of relief and landscape characteristics. There are mostly lowland and rolling areas, which according to orthographic characteristics belong to lowland and mountain zone from 130 to 500 m height above sea level. Shattered mountainous rolling terrain is characteristic for the area that has many built-up, forestry and agricultural areas that interweave.

Closer area is rolling, with miscellaneous forests in which open shapes (plough lands and pastures) appear as micro identity elements. This is rolling area where peaks do not go over 300 m height above sea level.

Landfill is located on steeply hillside with incline of around 15^{o} while hillsides on north and northeast side are mildly laid, with incline of around 10^{o}. Closer area represents amphitheatric basin with absolute heights of 167,5 m above sea level on east and up to 250m above sea level on west.

Wider area of intervention is mostly natural and cultivated landscape that should be preserved and additionally ennobled by protecting and regenerating of its environmental components.

Natural landscape on wider area means area of forest. *Cultivated landscape* on wider area is plough lands, pastures, orchard and rural settlements.

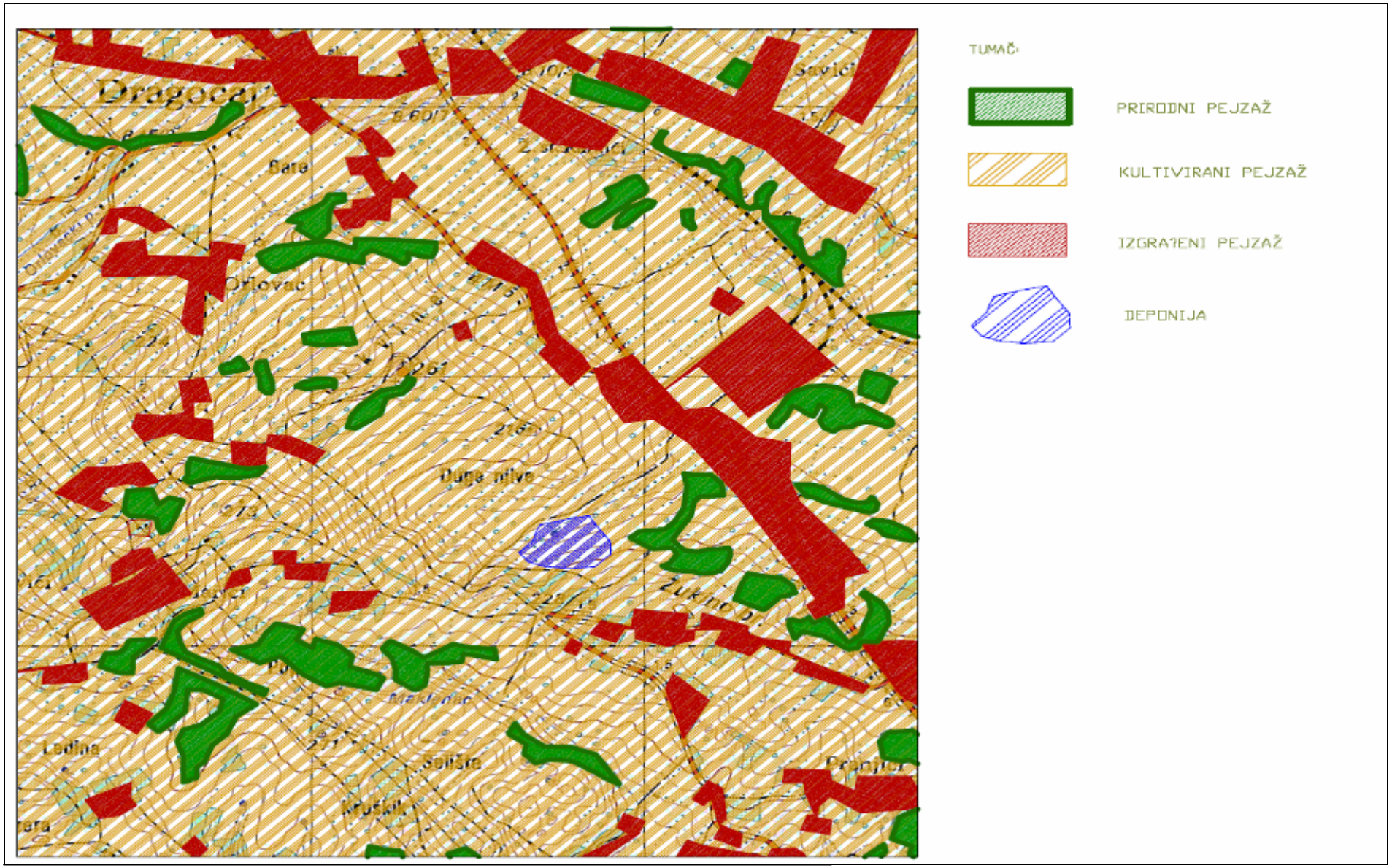
Primary vegetation characteristic, completely natural ecological system of forestry areas on this location is altered with dominant human activity in far past. Anthropogenic impacts however weren't so strong to cause total destruction pf primary ecological systems, yet on contrary, they've contributed to visual diversity and genesis of new, respectively secondary ecological systems of plough lands, pastures, orchard and settlements, which aren't only spatial values of landscape but they contribute to biodiversity of this area.

It can be seen from **graphical annex 1 Landscape naturalness/built** that **closer area around landfill is in grater part cultivated landscape;** overlapping with natural and constructed. Agricultural surfaces and grassland makes cultivated landscape, while remains of forest vegetation – small forests make natural one. Constructed landscape form scattered settlements of longitudinal shape placed near transport routes.

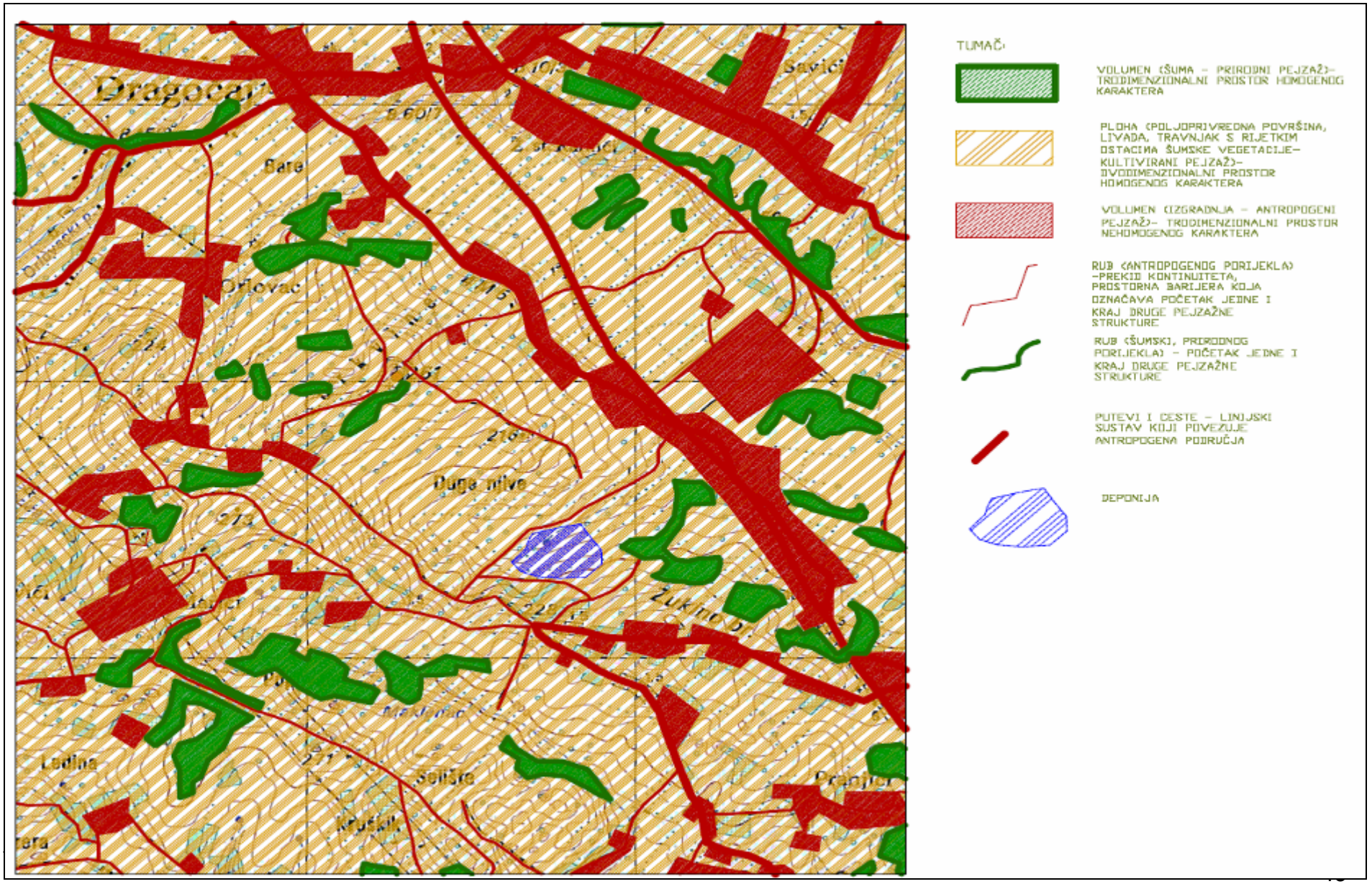
Area near the landfill has cultivated landscape that in some places overlaps with natural (forest areas). From north, south and west side the landfill area is surrounded with agricultural land in combination with remains from forest vegetation (photographs 11, 12 and 13). On east, area of the landfill is open to partially built area in combination with agricultural land (photography 14). Built area is made from settlements and highway Banja Luka – Prijedor.

In context of landscape structures **(photography 10 Landscape structures), wider area is formed from mosaic combination of volume from natural source** (forest, small forest - three dimensional structures with homogeneous character) **and volume from anthropogenic source** (scattered settlements – inhomogeneous structures) **and surfaces** (cultivated areas – agricultural land, lawns, grasslands visually enriched with trees – two dimensional structure with homogeneous character. Continuity of single structures interrupts ways, roads, and smaller watercourses.

Area of intervention **has already been visually degraded with existing landfill,** namely intervention in space, which contrasts from environmental characteristics and this ruins landscape picture of the concerned area. Great part of landfill has green vegetation and does not significantly contrasts from surrounding landscape. In addition, it is important to mention that entry zone is ennobled with vegetative material whereby quality visual impression of the concerned area is accomplished. (photographs 15 and 16).



Photograph no. 9 Landscape naturalness/built



Photogrph no. 10 Landscape structures

2.1.8.1. Visual exposure

Analysis of visual exposure defines exposure of space and its bigger or smaller perceptiveness with most traffic places and places where people stay more often.

Analyses of visual exposure from potential points of visual exposure (mentioned further in text) come up with following conclusion:

1. In the landfill wider surroundings, smaller number of houses for individual living is placed. These houses are situated on margin of amphitheatric location of the landfill from south and west side, distant from the landfill around 1000 m.
   From north side, on entrance into circle of the landfill, one living house is situated.
   From direction of mentioned housing objects the landfill is exposed in high angle of visibility but number of potentially who could see the landfill is extremely low therefore degree of exposure from direction of mentioned housing objects is review to be moderate.

2. East from the landfill is main road Banja Luka – Prijedor of high intensity of traffic and represents potential area from which degree of visual exposure could be high. Along the mentioned road, housing objects and industrial zone with number off production and service capacities are situated.

   However, as it can be seen from photographs 9 and 10 from direction of mentioned highway, the landfill is exposed in very small angle of visibility (in vertical and horizontal direction) therefore there are not any negative impact, especially because visually exposed part is east end of the landfill which is currently overgrown with vegetation. Degree of visual exposure from direction of main road Banja Luka – Prijedor and housing objects and industrial zone placed near it is considered low.
3. The landfill is also visually exposed from direction of access road (photographs 7,8), but also in small angle of visibility. Near this road, few housing objects and business-transport objects are placed. Degree of visual exposure from direction of accessing road and object placed near it is evaluated as very low.
4. From places that are more distant, the landfill is not visually exposed owing to topography of terrain and great distance of habitat zones.

Photograph no. 11: The view on area situated north from the landfill (Combination of agricultural and forest surfaces)

Photograph no. 12 The view on area situated west from the landfill (Combination of agricultural and forest surfaces)

Photograph no. 13 The view on area situated south from the landfill (Combination of agricultural and forest surfaces)

Picture no. 14 The view on area situated east from the landfill (In background is situated built area near main road Banja Luka –Prijedor)

Photograph no. 15 The view on ordered entrance zone

Photograph no. 16 The view on ordered entrance zone (built area is situated in background)

Photograph no. 17 The view on the landfill from direction of accessing road

Photograph no. 18 The view on the landfill from direction of accessing road on junction with main road Banja Luka - Prijedor

Photograph no. 19 The view on the landfill from direction of main road Banja Luka - Prijedor

Photograph no. 20 The view on the landfill from direction of main road Banja Luka - Prijedor

2.1.9. OVERVIEW OF BASIC NATURAL PROPERTIES AND SPECIAL VALUES, IMMOBILE CULTURAL PROPERTIES

In the near vicinity of the location there are no structures of cultural-archaeological- historical value which can be an obstacle to construction, revitalization and expansion of the landfill of communal waste or structures that could impact by the landfill.

According to the Decision of the RS Ministry on Spatial Planning, Civil Engineering and Ecology on determination of obligation to carry out environment impact assessment, The Institute for cultural-historical and natural heritage gave the following comments: „there are no structures of cultural-historical and natural heritage in the area that is the subject or rehabilitation and expansion of the Ramići Landfill".

However, in the area of local community Ramici there are registered archaeological locations, and in the case of works execution the Investor is obligated to inform Republic Institute for protection of cultural-historical and natural heritage of Republic of Srpska if comes across any archaeological find.

2.1.10. DATA ABOUT INHINBITATION, POPULLATION CONCENTRATION AND DEMOGRAPHIC CHARACTERISTICS WITH REGARD TO STRUCTURES AND ACTIVITIES

The migration movement in the region of BIH is a kind of tradition, so that the great part of the region has the migration character. The migration of population is mostly caused by war and post war situations and it resulted in movement of population from countryside to towns which created unreal picture of urban country what is visible through the big difference in number of population in towns and villages and the big pressure on the environment.

In the post-war period many people settled down in the wider vicinity of the landfill especially in the settlements of Dragočaj, Ramići and Zalužani, and having in consideration that the last census took place in 1991 it is very difficult to estimate the number of population which settled down in the wider area of the landfill.

In the wide vicinity of the landfill there are few residential houses. These houses are disposed along the edge of the amphitheatric landfill location from the northern and western side, at distance of about 1000m.

There is one house on the northern landfill side at the entrance to the landfill. There is a residential settlement Crkvena on the north-east at distance of 500m. There are several residential and business structures on the landfill east side, under the dam.

In the close vicinity of the landfill there are not many residential objects and the closest and the most imperilled houses are placed on the east and on the northeast of the landfill.

2.1.11. DATA ABOUT THE EXISTING BUSINESS, RESIDENTIAL AND INFRASTRUCTURAL STRUCTURES

As the landfill has been in function for the last 30 years there is an access road from Banja Luka main road. This road will be used for the approach to the main road to location of the Ramići landfill.

On the eastern side of the landfill there is very frequent main road Banja Luka – Prijedor, M4.

The water supply of this region is solved by town water supply with ∅200 mm tubes for the settlement of Ramići, and one ∅100 mm separated tube for the landfill. The existing controlling structure on landfill is located on the height of 189,5 above sea level, i.e. at the end of the first height zone for water supply from town water supply resource of Banja Luka and we can conclude that the water supply of the landfill is very weak due to low pressure in the system.

Disposition of waste water from the landfill control object is directed into a septic tank because there is no sewage system. The settlement in the vicinity has no solution for foul waste water drainage through sewage system and use individual septic tanks on their private properties.

There is middle voltage transmission line in the area of the landfill, and its route comes across the new landfill area.

In the active belt of Banja Luka – Prijedor main road there are 2 high voltage cables „Banja Luka 4 – Banja Luka 6". The cables are in very bad condition because of sliding of ground on the section from TS „Banja Luka 4" to „Unis".

In the landfill area there are no telephone cables which could obstruct the planned construction. Along the belt of main road Banja Luka – Prijedor there is TT pipe system with phone and optical cables.

In the wider vicinity there is small number of private houses. They are located on the edge of the landfill amphitheatric location from the southern and western side, 1000 m far from the landfill.

On the north side of the landfill at the entrance there is one private house. Further on the north-eastern from the landfill there is a settlement of Crkvena, 500 m from the landfill. On the landfill east side under the dam there are several business facilities.

On the other side of Banja Luka – Prijedor main road, on the east, there is an industrial zone with many production and service capacities.

The former factory for cold rolled strips „Unis" is transformed in a military base used by international stability forces in Bosnia and Herzegovina.

Next to the military object there is factory of synthetic materials „Sintetik" which

is not in function now.

Further on the north there is terminal and warehouse of liquid oil products „Krajina Petrol".

In the wide vicinity there are many export-import companies but beyond the landfill impact.

2.1.12. DATA ABOUT OTHER PROTECTED AREAS, AREAS FORESEEN FOR SCIENTIFIC RESEARCH, ARCHEOLOGICAL FINDS AND PARTICULARY SENSITIVE AREAS

According to the Law on environment protection, the following are considered protected areas:

- Protected natural areas established for the purpose of science or protected wilderness,
- National parks established for the purpose of protection of ecological system and recreation,
- Nature monuments established for the purpose of preservation of specific natural characteristics,
- Protected landscapes established for the purpose of dry landscapes, seaside areas and recreation.

According the inspection of the field there are no registered protected areas, areas specified for science research and particularly sensitive regions.

2.2. SUMMARY AND ASSESMENT OF THE EXISTING ENVIRONMENT CONDITIONS

2.2.1. IDENTIFIED EMISSION SOURCES

The biggest identified emission source in this area in the existing landfill of communal waste. The emissions from this unrehabilitated landfill go to the landfill water, through weekly tapped Jazavac spring in the landfill body that collects all seepage and precipitation water from the landfill and drains them by the Glogovac brook channel further to Dragočaj and Vrbas Rivers. The emissions from the landfill get to the air as well, caused by transport and unload of waste, its deposition and covering and afterward disintegration of the deposited waste. These emission to the air are as follows: noise, suspended particles and landfill gases.

Disposition of sanitary waste water from the landfill control structure is carried out to a septic tank as there is no sewage system. The surrounding settlement have no sewage system for foul water either and use individual septic tanks on their properties or waste water are drained directly into the Glogovac brook channel and further to Dragočaj and Vrbas Rivers.

The identified emission source in this area is a very busy main road Banja Luka – Prijedor, M4. Emissions into the environment from this road can be perceived through emission of internal combustion engines products, noise, vibrations and suspended solid particles as well as through waste water emissions from the road pavement structure.

On the other side of Banja Luka – Prijedor main road, from the landfill east there is industrial zone where a number of production and service capacities are located.

The former factory for cold rolled strips „Unis" is transformed in a military base used by international stability forces in Bosnia and Herzegovina.
This facility emissions can be perceived through emission into the air over suspended particles, internal combustion engines products, noise and vibrations, and then emissions through water because sanitary waste water from this facility are treated in a system of type "PUTOKS", and the overflow is drained into Dragočaj River.

Next to the military object there is factory of synthetic materials „Sintetik" which is not in function now.

Further on the north there is terminal and warehouse of liquid oil products „Krajina Petrol".

There is middle voltage transmission line in the area of the landfill, and its route comes across the new landfill area. The existing transmission line is a source of non-ionizing radiation, and the radiation intensity is irrelevant.

2.2.2. LEVEL OF AIR POLLUTION WITH BASIC AND SPECIFIC POLLUTION SUBSTANCES

In order to determine the air quality on the location of Regional landfill in Ramići, Civil Engineering Institute „IG“ Banja Luka carried out 24hours/10 days continuous measuring of the air quality starting from 05 September 2006 on the location of the Ramići Regional Landfill owned by PC «DEP-OT» Banja Luka.

The mentioned measuring were carried out by Mobile Ecological Laboratory (MEL) in the zone of the Ramići Landfill impact, that is on the landfill exactly, (on the plateau above container made for workers, which is located on a plateau 100m above the entrance toward the landfill body).

Measuring of emission concentration of relative factors of the air quality was carried out and they included: measuring of pollutants emission concentrations, together with measuring of micro-meteorological parameters: speed and direction of wind, temperature and relative air humidity.

In order to asses the air quality on the landfill location it was necessary to carry out continuous measuring of emission concentrations by Mobile Ecological Laboratory (MEL).

The air quality measuring included the following parameters:

Nitrite oxide	NO_x, NO_2, NO
Carbon oxide	CO_2, CO
Sulphur dioxide	SO_2, CS_2
Total suspended particles	(TSP)
Hydrocarbons	CH_4, $C_nH_{2n+2,}$ saturated hydrocarbons

Measuring of micro-meteorological parameters included the following parameters:

- Wind speed and direction
- Temperature and relative air humidity
- Air pressure
- Global sun radiation

2.2.2.1. Measuring instruments and methods

The following measuring instruments and methods that were used during the air quality determination in the Ramići landfill impact zone, i.e. at the very landfill:

HORIBA APHA 360	s/n 801004
	Analyzer for measuring total hydrocarbons and methane
Measuring areas :	: 0-5 / 0-10 / 0-25 / 0-50 ppm
Bottom limit of detection	0.05 ppm C (2 sigma)
Measuring methods:	Fire ionization

HORIBA APMA 360	s/n 909001
	Analyser for measuring of carbon monoxide (CO)
Measuring areas :	0-10 / 0-20 / 0-50 / 0-100 ppm
Bottom limit of detection	0.05 ppm (2 sigma)
Measuring methods:	Infrared absorption

HORIBA APSA 350	s/n 107009
	Analyzer for measuring of SO_2 concentration
Measuring areas :	0-0,1 / 0-0,2 / 0-0,5 ppm
Bottom limit of detection	0.5 ppb (2 sigma)
Measuring methods:	UV fluorescence

HORIBA APNA 350E	s/n 564362085
	Analyser for measuring of NO , NO_2 , NOx concentration
Measuring areas :	0-0,1 / 0-0,2 / 0-0,5 / 0-1 ppm
Bottom limit of detection	0.5 ppb (2 sigma)
Measuring methods:	hemiluminiscencia

HORIBA APOA 350E	s/n 564118075
	Analyser for measuring of O_3 concentration
Measuring areas :	0-0,1 / 0-0,2 / 0-0,5 / 0-1 ppm
Bottom limit of detection	0.5 ppb (2 sigma)
Measuring methods:	UV absorption

HORIBA APBA 250E

Analyser for measuring of CO_2 concentration

Measuring areas :	0-3000 ppm
Bottom limit of detection	1.0 ppm (2 sigma)
Measuring methods:	Infrared absorption

FH 62 I-N

Analyzer for measuring of total suspended particles, diameter < 10μm

Measuring areas :	0-2,4 mg/m^3
Bottom limit of detection	1.0 μg/m^3 (2 sigma)
Measuring methods:	Absorption of β^- radiation

NETZ "ALCYON"

3-components anemometer for wind speed and direction

Measuring areas:	0-30 m/s
Bottom limit of detection	0.1 m/s (2 sigma)
Measuring methods:	Optho-electric

THOMMEN M-105.04

Barometer

Measuring areas:	900 - 1100 hPa
Measuring methods:	Mechanical-electronical

KIPP & ZONEN CM5

Solar meter for measuring of global sun radiation

Measuring areas:	0 – 1000 W/m^2
Measuring methods:	piranometric

Picture no. 21 Mobile Ecological Laboratory on the location of Ramići landfill measures the air quality

Picture no. 22 Interior of MEL with all necessary equipment for rapid and precise measuring

The air quality control is made in accordance with the Law on environment protection (Official Gazette RS, no. 53/02), Book of Rules on limit air quality values (Official Gazette RS, no. 39/2005) and the Book of Rules on air monitoring (Official Gazette RS, no. 39/05). Air quality control means monitoring over 24hours – measuring and analysis of emission parameters of air quality.

2.2.2.2. Measuring values markings

The collected data was elaborated and analyzed in accordance with the Book of Rules on limit air quality values (Official Gazette RS no. 39/05), and the decision on air protection in the Banja Luka Municipality area (Official Gazette BL no. 13/87). The following markings were used in that process:

GVV (24 h)	limit air values	average time	24 *h*
GVV (1 *h*)	limit air values	average time	1 *h*
CVV (24 h)	aimed air values	average time	24 *h*
CVV (1 *h*)	aimed air values	average time	1 *h*

The following statistic indexes were used for presentation of the measured values:

CVV (24 *h*)	arithmetic middle of measured values	average time	24 *h*

- where: letter “C” means “aimed”, and
- letter “G” means “limit”.

The limit air quality values are defined by the Book of Rules on limit air quality values – Official Gazette RS, 39/05;

Table no. 11 Limit air values

Polluting substance	Sampling period	Average annual value (μ/m^3)	High value (μ/m^3)
SO_2	1 hour	90	500
SO_2	24 hours	90	240
NO_2	1 hour	60	300
NO_2	24 hours	60	140
Suspended particles 10	24 hours	50	100
Total suspended particles	24 hours	150	350
smoke	24 hours	30	60
CO	8 hours		10.000
O_3	8 hours		150

The following table presents the aimed air quality values for some pollutants:

Table no. 12 Aimed air values

Polluting substance	Sampling period	Average annual value (μ/m^3)	High value (μ/m^3)
SO_2	1 hour	60	350
SO_2	24 hours	60	160
NO_2	1 hour	60	200
NO_2	24 hours	40	90
Suspended particles 10	24 hours	40	60
Total suspended particles	24 hours	40	120
smoke	24 hours	75	120
O_3	8 hours	-	

Limit air values – GV for the purpose of ecological system protection are:

Table no. 13 Limit air values – GV for the purpose of ecological system protection

Polluting substance	Sampling period	Average annual value (μ/m^3)	High value (μ/m^3)
SO_2	Calendar year and winter	20 (remark 1)	-
NOx	Calendar year	30	-
O_3	Five years	18000 (remark 2)	-

Remark 1: Winter means period from 1 October to 31 March
Remark 2: Refers to the sum of hour value exceeding from 80 μg /m^3
In the period May – July within five years

2.2.2.3. Measuring results of the air quality

By inspection of statistic indicators of measured values on the location of regional landfill of communal waste «Ramići» - Banja Luka for measuring period 05.09. – 15.09.2006. and comparing with aimed and limit values according to the mentioned Book of Rules we come to the following results and facts:

LOCATION – RAMIĆI LANDFILL

Measuring period 05 September – 15 September 2006

Pollutant	Sampling period	Measured value	Unit	Aimed value (µg/m3)	Limit value (µg/m^3)
SO_2	24 hours	7	(µg/m^3)	60	90
	1 hour	23	(µg/m^3)	60	90
TSP	24 hours	21	(µg/m^3)	40	150
	1 hour	99	(µg/m^3)		
NO_2	24 hours	8	(µg/m^3)	40	60
	1 hour	12	(µg/m^3)	60	60
CO	8 hours	563	(µg/m^3)	-	High value 10.000 (µg/m^3)
O_3	8 hours	117	(µg/m^3)	High value 120 (µg/m^3)	High value 150 (µg/m^3)
H_2S	24 hours	5,6	(µg/m^3)		
	1 hour	9,5	(µg/m^3)		
CO_2	24 hours	824	ppm Arithmetic middle		
	1 hour	990	ppm Maximal value		
NO	24 hours	4	(µg/m^3) Arithmetic middle		
	1 hour	11	(µg/m^3) Maximal value		
CH_4	24 hours	1,307	(mg/m^3) Arithmetic middle		
	1 hour	1,795	(mg/m^3) Maximal value		
nCH_4	24 hours	0,615	(mg/m^3) Arithmetic middle		
	1 hour	1,934	(mg/m^3) Maximal value		

Graphic presentation of the achieved values of pollutant concentration in the air on the subject location is attached to this Study.

2.2.2.4. Meteorological parameters analysis

During the time of measuring of air quality on the specified location, the weather was mostly dry, with some rain. The average humidity of the air was about 61 %. Daily temperature was about 20 °C. During the entire measuring period the low air pressure was dominating with the average values from 1009 mbars.

The wind has a typical direction for this time of year and mostly, during the measuring we registered many wind directions, with the wind toward southwest dominating. The wind direction is conditioned by seasons and ground configuration and geographical position of the measuring .

The average speed of wind blowing during the measuring period was about 1.90 m/s from different directions, with dominating direction toward southwest and the south.

2.2.2.5. The air pollution analysis on the subject location

The average concentration of total suspended particles during the entire measuring was 21,0 μg/m^3. The biggest registered concentration was about 108,0 μg/m^3, on the first measuring day, and after that the maximal reached concentrations were up 78,0 μg/m^3.

The average registered concentration of CO was 563 μg/m^3. It is quite low concentration and it can not present a problem for the surrounding atmosphere because they are concentration below limit values. The spreading direction of carbon-monoxide was mostly toward south-east .

Concentration of CO_2 during the measuring has the constant value, without extremes from 824 μg/m^3.

The average daily concentration of nitrate-monoxide (NO) during the measuring was 4,0 μg/m^3, while maximal registered value was from 12,6 μg/m^3.

The average concentration of NO_2 in mentioned measuring period was 8,0 μg/m^3. During the measuring the maximal concentration were registered couple times of 26,0 μg/m^3. Maximal concentration is a consequence of increased traffic intensity on Banja Luka – Prijedor main road.

The average concentration of NO_x during the measuring was 13,0 μg/m^3. The maximal registered concentration of NO_x was up to 39,0 μg/m^3. The regularity of increase and reduction of concentration of NO_x is the same as if regularity for concentration of NO_2, which is logical.

Average 24 – hour concentration of SO_2 was 7,0 μg/m^3. The regularity of oscillations of sulphur-dioxide concentration coincides with oscillations of traffic intensity on Banja Luka – Prijedor main road, which brings us to conclusion that

the oscillation intensity is caused by internal combustion engines, i.e. from the main road.

Higher concentrations are registered in the afternoon period of the first measuring day, with tendency for decreasing and continuous oscillations in the further measuring. The maximal concentration 27,0 µg/m^3 was registered then.

Average 24 – hour concentrations of H_2S were 5,6 µg/m^3. Concentration of H_2S had regular and balanced oscillations during the entire measuring period. Maximal registered H_2S concentration was 15,0 µg/m^3.

Average emission concentrations of methane originating mostly from the landfill where it is created as a product of segregations of waste organic components amounted to 1,307 mg/m^3 and the oscillation during the measuring was quite balanced.

With the non-methane carbon-oxygen the average 24-hours concentration was 0,615 mg/m^3, while the maximal registered concentration was 2,000 mg/m^3 and it was registered several times during the measuring .

The average ozone concentration during the measuring was 117,0 µg/m^3, and the maximal registered concentration was up to 160 µg/m^3, which is quite high concentration exceeding limit high values prescribed by the Book of Rules on limit air quality values (Official Gazette of RS no. 39/05) of 150 µg/m^3. The maximal registered concentration was reached several times and it was caused by atmospheric discharging and raining .

The achieved results of the measured pollutants do exceed neither limit nor aimed values according to the Book of Rules on limit air quality values (Official Gazette of RS, no. 39/05). The concentration of pollutants with higher values is the consequence of increasing traffic intensity on Banja Luka – Prijedor main road. Although all concentration is below the limit values it still represents a certain level of pollution of the surrounding air.

The measurement of air can be indicative and imply to the air quality on this location in this period. However they can represent the base for registration of real previous state of life environment before the revitalization and expansion of landfill of communal waste »Ramići«
According to the Book of Rules on aimed and limit air quality values, in order to asses air quality it is necessary to carry out measuring for long period of time, and this measuring can be indicative and imply to the air quality on the subject location in this period. However they can represent a base for determination of real initial condition of the environment before the rehabilitation and expansion of the landfill of communal waste »Ramići«.

2.2.3. LEVEL OF TRAFFIC AND INDUSTRIAL NOISE

On the east from the landfill there is a very busy main road M4 Banja Luka – Prijedor as well as former factory of cold rolled strips "Unis" which is now turned into a military base used by the international military forces for stability in Bosnia and Herzegovina, so the level of traffic and industrial noise in this area is very high during the majority of a day.

2.2.4. LEVEL OF IONIZATION AND NON-IONIZATION RADIATION

There are no identified sources of ionization radiation in the subject area. The only source of non-ionization radiation is a middle-voltage transmission line which route overlaps with the new landfill area, and two high-voltage cable of „Banja Luka 4 – Banja Luka 6" laid in the road belt of Banja Luka – Prijedor main road, but the intensity of this radiation is irrelevant.

2.2.5. SURFACE WATER QUALITY AND JEOPARDIZATION OF INDUSTRY, SETTLEMETNS AND AGRICULTUTAL PRODUCTION BY WASTE WATER

Picture no. 23 Field team of „Tatić" Laboratory on the Ramići Landfill location

The first four water samples from the landfill vicinity were taken on September 12th 2006. The sampling was carried out by "Tatić" laboratory expert team on the following four locations:

- On main sewer under the existing landfill's dam (beginning of the Glogovac brook),
- 300 m downstream in the Glogovac brook channel, in the culvert under Banja Luka – Prijedor main road, close to "Unis" factory,
- At the estuary of Glogovac brook into Dragočaj river, water from Dragočaj River before the Glogovac brook empting into Dragočaj River.
- At the estuary of Glogovac brook into Dragočaj river, water from Dragočaj River after the Glogovac brook empting into Dragočaj River.

The following three samples were taken from the landfill vicinity on 22 September 2006. The sampling was carried out by "Tatić" laboratory expert team on the following three locations:

- On main sewer under the existing landfill's dam (beginning of the Glogovac brook),
- At the estuary of Glogovac brook into Dragočaj river, water from Dragočaj River before the Glogovac brook empting into Dragočaj River.
- At the estuary of Glogovac brook into Dragočaj river, water from Dragočaj River after the Glogovac brook empting into Dragočaj River.

The last three samples were taken from the landfill vicinity on 25 September 2006. The sampling was carried out by "Tatić" laboratory expert team on the following three locations:

- On main sewer under the existing landfill's dam (beginning of the Glogovac brook),
- At the estuary of Glogovac brook into Dragočaj river, water from Dragočaj River before the Glogovac brook empting into Dragočaj River.
- At the estuary of Glogovac brook into Dragočaj river, water from Dragočaj River after the Glogovac brook empting into Dragočaj River.

Picture no. 24 Main sewer under the dam of the Ramići existing landfill

Picture no. 25 Field team of „Tatić“ Laboratory taking water samples from the Glogovac brook close to “Unis” factory

Picture no. 26 Water sampling of Dragočaj River before estuary of Glogovac brook into Dragočaj River

Picture no. 27 Water sampling of Dragočaj River after estuary of Glogovac brook into Dragočaj River

Physical-chemical quality parameters as well as microbiological indicators of water pollution were determined in the taken samples:

2.2.5.1. Permitted parameters values in waste water

Permitted parameters values in waste water that can be released into surface water are defined by the Book of Rules on conditions for release of waste water into surface water streams (Official Gazette RS, no. 44/01).

This Book of Rules determines conditions for release of waste water or effluents from treating plants, limit values of harmful and dangerous substances that can be released into surface water streams, as well as the method for determination of coordination between measured and permitted values.

The Book of Rules includes release control of treated and untreated urban, industrial and other exploited polluted water that contains harmful and toxic substances regulated by limit values for release into natural water or there is an obligation to treat this water in accordance with international conventions.

Regulation of dangerous substances release into natural water flows must be in accordance with the Law on water of Republic of Srpska, with Decree on classification of water and categorization of water flows, and all other regulations about environment protection, regulations for waste water and water treatment plants and in the course of that all local conditions have to be taken in consideration in sense of technology, ecology and economy.

Standards for quality of water and treatment plants effluents that can be released in natural water are defined by this Book of Rules as limit values in the following table and represent a minimal requirement for quality of effluents.

The permitted values are presented in the following table and/or refer to daily concentrations diversified by flow capacity at the spot of release.

Table no. 14 Permitted limit parameters values in waste water that can be released to surface flows

Parameter	Unit	Permitted value
A. General parameters		
Temperature	^0C	30
PH		6.5-9.0
Sediment after 0.5 hour of sedimentation	$ml.l^{-1}$	0,5
Total suspended particles	$g.m^{-3}$	35
B. Oxygen regime		
BPK5	$g.O_2.m^{-3}$	25
HPK	$g.O_2.m^{-3}$	125
C. Nutrients		
Ammonium nitrogen	$g.m^{-3}N$	10
Nitrite nitrogen	$g.m^{-3}N$	1
Nitrate nitrogen	$g.m^{-3}N$	10
Total nitrogen	$mg.m^{-3}N$	15

Total phosphorus	$g.m^{-3}P$	3
Toxic organic substances **D1. Highly risky priority substances, Coun. Direct. 86/280/EEC**		
Carbon-tetrachloride	$mg.m^{-3}$	3000
DDT	$mg.m^{-3}$	400
Pentachlorophenol	$mg.m^{-3}$	2000
Aldrine	$mg.m^{-3}$	10
Dieldrine	$mg.m^{-3}$	10
Endrine	$mg.m^{-3}$	10
Izodrine	$mg.m^{-3}$	10
Hexachlorbenzen	$mg.m^{-3}$	2000
Hexachlorbutadien	$mg.m^{-3}$	3000
Chlorophorm	$mg.m^{-3}$	1000
1,2-dichloretan	$mg.m^{-3}$	200
Trichloretilene	$mg.m^{-3}$	200
tetrachloretilene	$mg.m^{-3}$	200
hexachloricikloheksan	$mg.m^{-3}$	4000
trihlorbenzen	$mg.m^{-3}$	100
Total of polycyclic chlorofied hydrogen (RAN)	$mg.m^{-3}$	200
Total of polichlorified bifeniles	$mg.m^{-3}$	20
D2. Other toxic substances		
Phenol index	$mg.m^{-3}$	100
Benzene	$mg.m^{-3}$	150
Toluene	$mg.m^{-3}$	150
Xylene	$mg.m^{-3}$	70
Formaldehyde	$mg.m^{-3}$	80
Mineral oils	$mg.m^{-3}$	500
Detergents	$mg.m^{-3}$	1000
E. Toxic inorganic substances **E1.Metals and metalloids (total contents)**		
Silver Ag	$mg.m^{-3}$	50
Aluminium, Al	$mg.m^{-3}$	1000
Arsenic, As	$mg.m^{-3}$	100
Cadmium, Cd	$mg.m^{-3}$	10
Cobalt, Co	$mg.m^{-3}$	500
Total chromium, Cr	$mg.m^{-3}$	100
Six-valent chromium, Cr	$mg.m^{-3}$	100
Copper, Cu	$mg.m^{-3}$	300
Iron, Fe	$mg.m^{-3}$	2000
Mercury, Hg	$mg.m^{-3}$	500
Nickel, Ni	$mg.m^{-3}$	10
Lead, Pb	$mg.m^{-3}$	10
Selenite, Se	$mg.m^{-3}$	50
Antimony, Sb	$mg.m^{-3}$	100

Stannic, Sn	$mg.m^{-3}$	500
Zink, Zn	$mg.m^{-3}$	1000
E2. Other inorganic substances		
Fluoride	$g.m^{-3}$	2
Cyanide	$g.m^{-3}$	0,1
Sulphide	$g.m^{-3}$	0
Sulphate	$g.m^{-3}$	200
Chloride	$g.m^{-3}$	250
Sulphites	$g.m^{-3}$	1
Toxic bio-test Daphnia magna Straus	% waste water, diluted	> 50 %

2.2.5.2. Determined water quality condition

All water testing were carried out in "Tatić" certified laboratory for water analysis, Osječani, Doboj, and the results were elaborated and presented in the enclosed Tables 15, 15a, 16, 16a, 17, 17a, 18, 18a, 19, 19a, 20, 20a, 21, 21a, 22, 22a, 23, 23a, 24 and 24a.

The results of water samples taken from the main sewer under the landfill dam and samples taken from the Glogovac brook channel were commented in accordance with the Book of Rules on conditions for release of waste water into surface water (Official Gazette RS no: 44/01), and analysis results of Dračočaj river water, before and after Glogovac brook estuary were commented in accordance with Decree on classification and categorization of water flows (Official Gazette RS, no. 42/01).

2.2.5.2.1. LOCATION: Main sewer under the existing landfill dam (beginning of the Glogovac brook channel)

Date of sampling: 12 September 2006

Table no. 15 Physical – chemical parameters of water quality

No	PARAMETER		Result (± meas. uncertainty)	MDK of waste water	Method code
1.	Temperature	°C	20	30	JUS H.Z1.106:1970; EPA 170.1
2.	Colour	°Co-Pt scale	>60		BAS ISO 7887:2002; EPA 110.2
3.	Turbidity	NTU	51,4		BAS ISO 7027:2002; EPA 180.1
4.	pH		7,43	6,50 – 9,00	BAS ISO 10523:2002; EPA 150.1
5.	Consumption of $KMnO_4$	mg/l	289,0		BAS ISO 8467:2002
6.	Residue evaporation – total	mg/l	2528		EPA 160.3:1971
7.	Residue – nonfiltrable	mg/l	-	35	BAS EN 872:2002; EPA 160.2
8.	Residue – filterable	mg/l	-		EPA 160.1:1971
9.	Suspended particles according to Imhoff	ml/l	<0,1	0,5	EPA 160.5
10.	Electrical conductivity /20°C	μS/cm	4130		BAS EN 27888:2002; EPA 120.1
11.	Dissolved oxygen	mg/l	0,8		BAS EN 25814:2000; EPA 360.1
		% of saturation	8,8	Up to 50	BAS EN 25814:2000; EPA 360.1
12.	Biological consumption of oxygen after 5 days (BPK_5)	mg/l	24	25	BAS ISO 5851-1 BAS ISO 5851-2
13.	Residual chlorine	mg/l	-		BAS ISO 7393-2:2003
14.	Water hardness	°dH	-		BAS ISO 6059:2000; EPA 130.2
15.	Alkalinity			1705,91	BAS ISO 9963-1:2000;EPA 310.1
16	Acidity	mg/l $CaCO_3$		127,47	BAS ISO 9963-1:2000;EPA 305.1
17.	Ammonia	mg/l	63,09		BAS ISO 6778:2002; EPA 350.3
18.	Nitrite	mg/l	0,93		BAS EN ISO 10304-1:2002
19.	Nitrate	mg/l	23,88		BAS EN ISO 10304-1:2002
20.	Chloride	mg/l	402,56	250	BAS EN ISO 10304-1:2002
21.	Sulphate	mg/l	121,36	200	BAS EN ISO 10304-1:2002
22.	Ortho-phosphate	mg/l	29,88		BAS EN ISO 10304-1:2002
23.	Fluoride	mg/l	-	2	BAS EN ISO 10304-1:2002
24.	Bromide	mg/l	-		BAS EN ISO 10304-1:2002
25.	Iron	mg/l	>5	2	BAS ISO 6332:2000
26.	Manganese	mg/l	1,85	0,5	BAS ISO 6333:2003
27.	Calcium	mg/l	-		BAS EN ISO 14911:2002
28.	Magnesium	mg/l	-		BAS EN ISO 14911:2002
29.	Calcium	mg/l	-		BAS EN ISO 14911:2002
30.	Sodium	mg/l	-		BAS EN ISO 14911:2002
31.	Lithium	mg/l	-		BAS EN ISO 14911:2002
32.	Ammonium iodine	mg/l	-		BAS EN ISO 14911:2002
33.	Copper	mg/l	-	0,3	BAS ISO 8288
34.	Cobalt	mg/l	-	0,5	BAS ISO 8288
35.	Nickel	mg/l	-	0,01	BAS ISO 8288
36.	Lead	mg/l	<0,012	0,01	BAS ISO 8288
37.	Zink	mg/l	0,034	1	BAS ISO 8288
38.	Cadmium	mg/l	0,060	0,01	BAS ISO 8288
39.	Chromium	mg/l	-	0,1	BAS EN 1233
40.	HPK*	mg/l	536,8	125	JUS ISO 6060

Date of sampling: 22 September 2006

Table no. 16 Physical-chemical parameters of water quality

No	PARAMETER		Result (± meas. uncertainty)	MDK of waste water	Method code
1.	Temperature	°C	20	30	JUS H.Z1.106:1970; EPA 170.1
2.	Colour	°Co-Pt scale	>60		BAS ISO 7887:2002; EPA 110.2
3.	Turbidity	NTU	59,4		BAS ISO 7027:2002; EPA 180.1
4.	pH		7,43	6,50 – 9,00	6,50 – 9,00
5.	Consumption of $KMnO_4$	mg/l	389,84		BAS ISO 8467:2002
6.	Residue evaporation-total	mg/l	2422		EPA 160.3:1971
7.	Residue -non-filter	mg/l	-	35	BAS EN 872:2002; EPA 160.2
8.	Residue -filter	mg/l	-		EPA 160.1:1971
9.	Suspended substance according to Imhoff	ml/l	<0,1	0,5	EPA 160.5
10.	Electric conductance/20°C	µS/cm	4340		BAS EN 27888:2002; EPA 120.1
11.	Dissolved oxygen	mg/l	0,2		BAS EN 25814:2000; EPA 360.1
		% of saturation	2,2	Up to 50	BAS EN 25814:2000; EPA 360.1
12.	Biological consumption of oxygen after 5 days (BPK_5)	mg/l	27	25	BAS ISO 5851-1 BAS ISO 5851-2
13.	Residual chlorine	mg/l	-		BAS ISO 7393-2:2003
14.	Hardness of water	°dH	-		BAS ISO 6059:2000; EPA 130.2
15.	Alkalinity	mg/l $CaCO_3$	1737,32	1705,91	
16	Acidity	mg/l $CaCO_3$	133,44	127,47	
17.	Ammonia	mg/l	22,38		BAS ISO 6778:2002; EPA 350.3
18.	Nitrite	mg/l	5,72		BAS EN ISO 10304-1:2002
19.	Nitrate	mg/l	67,09		BAS EN ISO 10304-1:2002
20.	Chloride	mg/l	460,37	250	BAS EN ISO 10304-1:2002
21.	Sulphate	mg/l	129,93	200	BAS EN ISO 10304-1:2002
22.	Ortho-phosphate	mg/l	35,93		BAS EN ISO 10304-1:2002
23.	Fluoride	mg/l	-	2	BAS EN ISO 10304-1:2002
24.	Bromide	mg/l	-		BAS EN ISO 10304-1:2002
25.	Iron	mg/l	6,5	2	BAS ISO 6332:2000
26.	Manganese	mg/l	3,75	0,5	BAS ISO 6333:2003
27.	Calcium	mg/l	-		BAS EN ISO 14911:2002
28.	Magnesium	mg/l	-		BAS EN ISO 14911:2002
29.	Potassium	mg/l	-		BAS EN ISO 14911:2002
30.	Sodium	mg/l	-		BAS EN ISO 14911:2002
31.	Lithium	mg/l	-		BAS EN ISO 14911:2002
32.	Ammonium iodine	mg/l	-		BAS EN ISO 14911:2002
33.	Copper	mg/l	-	0,3	BAS ISO 8288
34.	Cobalt	mg/l	-	0,5	BAS ISO 8288
35.	Nickel	mg/l	-	0,01	BAS ISO 8288
36.	Lead	mg/l	<0,012	0,01	BAS ISO 8288
37.	Zinc	mg/l	0,08	1	BAS ISO 8288
38.	Cadmium	mg/l	0,015	0,01	BAS ISO 8288
39.	Chromium	mg/l	-	0,1	BAS EN 1233
40.	HPK*	mg/l	396,74	125	JUS ISO 6060

Date of sampling: 25 September 2006

Table no. 17 Physical/chemical parameters of water quality

No	PARAMETER		Result (± meas. uncertainty)	MDK of waste water	Method code
1.	Temperature	°C	20	30	JUS H.Z1.106:1970; EPA 170.1
2.	Colour	°Co-Pt scale	>60		BAS ISO 7887:2002; EPA 110.2
3.	Turbidity	NTU	59,6		BAS ISO 7027:2002; EPA 180.1
4.	pH		7,43	6,50 – 9,00	BAS ISO 10523:2002; EPA 150.1
5.	Consumption of $KMnO_4$	mg/l	342,72		BAS ISO 8467:2002
6.	Residue evaporation-total	mg/l	2478		EPA 160.3:1971
7.	Residue -non-filter	mg/l	-	35	BAS EN 872:2002; EPA 160.2
8.	Residue -filter	mg/l	-		EPA 160.1:1971
9.	Suspended substance according to Imhoff	ml/l	<0,1	0,5	EPA 160.5
10.	Electric conductance/20°C	µS/cm	4410		BAS EN 27888:2002; EPA 120.1
11.	Dissolved oxygen	mg/l	0,4		BAS EN 25814:2000; EPA 360.1
		% of saturation	4,4	Up to 50	BAS EN 25814:2000; EPA 360.1
12.	Biological consumption of oxygen after 5 days (BPK_5)	mg/l	25	25	BAS ISO 5851-1 BAS ISO 5851-2
13.	Residual chlorine	mg/l	-		BAS ISO 7393-2:2003
14.	Hardness of water	°dH	-		BAS ISO 6059:2000; EPA 130.2
15.	Alkalinity	mg/l $CaCO_3$	1714,39	1705,91	BAS ISO 9963-1:2000;EPA 310.1
16	Acidity	mg/l $CaCO_3$	128,16	127,47	BAS ISO 9963-1:2000;EPA 305.1
17.	Ammonia	mg/l	28,18		BAS ISO 6778:2002; EPA 350.3
18.	Nitrite	mg/l	6,72		BAS EN ISO 10304-1:2002
19.	Nitrate	mg/l	59,24		BAS EN ISO 10304-1:2002
20.	Chloride	mg/l	458,37	250	BAS EN ISO 10304-1:2002
21.	Sulphate	mg/l	124,72	200	BAS EN ISO 10304-1:2002
22.	Ortho-phosphate	mg/l	35,42		BAS EN ISO 10304-1:2002
23.	Fluoride	mg/l	-	2	BAS EN ISO 10304-1:2002
24.	Bromide	mg/l	-		BAS EN ISO 10304-1:2002
25.	Iron	mg/l	7,0	2	BAS ISO 6332:2000
26.	Manganese	mg/l	3,87	0,5	BAS ISO 6333:2003
27.	Calcium	mg/l	-		BAS EN ISO 14911:2002
28.	Magnesium	mg/l	-		BAS EN ISO 14911:2002
29.	Potassium	mg/l	-		BAS EN ISO 14911:2002
30.	Sodium	mg/l	-		BAS EN ISO 14911:2002
31.	Lithium	mg/l	-		BAS EN ISO 14911:2002
32.	Ammonium iodine	mg/l	-		BAS EN ISO 14911:2002
33.	Copper	mg/l	-	0,3	BAS ISO 8288
34.	Cobalt	mg/l	-	0,5	BAS ISO 8288
35.	Nickel	mg/l	-	0,01	BAS ISO 8288
36.	Lead	mg/l	<0,01	0,01	BAS ISO 8288
37.	Zinc	mg/l	0,08	1	BAS ISO 8288
38.	Cadmium	mg/l	0,01	0,01	BAS ISO 8288
39.	Chromium	mg/l	-	0,1	BAS EN 1233
40.	HPK*	mg/l	364,27	125	JUS ISO 6060

Waste water coming from the landfill dam body are precipitation water from the landfill that are collected in catch pit under the landfill dam and further they empty into Glogovac brook.

Temperature of water that leaves the landfill is under 30 ^{0}C, in all three samples it amounts to 20 ^{0}C so it can be released into natural water flows, when it comes to the temperature.

The measured colour value in all three samples, as well as turbidity is quite high, because the colour value is over 60 ^{0}Co-Pt scale, and turbidity is above 50 NTU.

pH value was 7,43, in all three samples, which is within permitted level, because it is practically neutral environment, and the permitted range of pH value of waste water that can be released into natural water flows is between 6,5 – 9,0.

The total evaporation residue has very small value of more than 2400 mg/l, which brings us to conclusion that the water samples contain a lot of dissolved and suspended substances, and the permitted value for release into natural water flows is 3500 mg/l.

Consumption of $KMnO_4$ is quite big for the water taken at the main sewer under the landfill, because the measured values exceed 280 in first sample and, 340 mg/l in other two, which are quite big values and a direct indicator that the samples contain a lot dissolved organic substance.

Concentrations of dissolved oxygen in samples from the landfill main sewer are 0.8, 0.2 and 0.4 mg/l, retrospective, while the bottom limit for the fourth class of natural water flows is 3.0 mg/l.

The concentration of suspended substances by Imhoff range below 0,1 ml/l and the permitted value according to the mentioned Book of Rules 0,5.

Electrical conductance of water from the catch pit in the landfill base is over 4100 μS/cm, which is a quite high value comparing to natural water flows, because the limit for the fourth class of natural water flows is 1500 μS/cm, and it is caused by dissolution of various ion compounds in water when passing through the landfill body.

Biological oxygen consumptions after five days for all three samples are 24, 27 and 25 mg/l, retrospectively, and the permitted value for release into natural water flows is 25 mg/l.
Alkalinity of all three water samples taken at the main sewer is above 1700 mg/l $CaCO_3$, which is quite high concentration taking in consideration it exceeds permitted concentrations for release into natural water flows.

The values of acidity of all three samples taken from the landfill main sewer are above permitted value of 127,47 mg/l $CaCO_3$.

Ammonia values in all three samples from the landfill main sewer are quite high, and the ammonia concentration in the first was 63,09 mg/l, which is significantly above the permitted value comparing to measured concentrations in other water samples.

Concentration of nitrite is quite increased comparing to other samples and amounts to over 5 mg/l, and concentration of nitrate is also above 60 mg/l.

Concentration of chloride of 400 mg/l, and concentration of sulphate of over 120 mg/l are significantly increased, but concentration of sulphate are below maximal permitted 200 mg/l, while the concentration of chloride is above maximal permitted 250 mg/l, which is a direct indicator of water pollution.

Concentration of ortho-phosphate is quite high comparing to natural water flows and generally to other water samples.

Concentration of iron in water samples taken from the landfill main sewer are significantly above maximal permitted concentration for release into natural water flows as they amount to over 5 mg/l and the permitted value is 2 mg/l.

Concentration of manganese is in water samples taken from the landfill main sewer are significantly above maximal permitted concentration for release into natural water flows as they amount to over 3,75 mg/l in the last two samples, and the permitted value is 0,5 mg/l.

Concentration of lead in water samples taken from the landfill main sewer are significantly above maximal permitted concentration for release into natural water flows as they amount to over 0,012 mg/l in first two samples, and the permitted value is less than 0,01 mg/l.

Concentration of Zink in water samples taken from the landfill main sewer are significantly above maximal permitted concentration for release into natural water flows as they amount to over 0,08 mg/l in the last two samples, and the permitted value is 1,0 mg/l.

Concentration of cadmium in the first water sample taken at the landfill main sewer is six time higher than maximal permitted concentration for release into natural water flows as it amounted to 0,06 mg/l, and the permitted value is 0,01 mg/l. Concentration value in other sample was 0.015 mg/l, and concentration in the last sample was maximal permitted for release into natural water flows. Values of chemical consumption of oxygen in the water samples taken at the landfill main sewer are quite high and amount to over 530 mg/l O_2, in first sample, and the permitted value is 125 mg/l O_2, which is a clear indicator of water pollution.

According to the Book of Rules on release of waste water into surface water flows (Official Gazette RS no. 44/01) Article 10. „effluent quality, i.e. concentration of all quality parameters of waste water treatment plants effluents have to be below the values given in this BoR", and if this condition is not met it is considered that the conditions for release into surface water flows are not satisfied.

Date of sampling: 12 September 2006

Table no. 15a Physical-chemical parameters of water quality

No	Method	Findings	Method code
1.	Total number of aerobic mesophilic bacteria in 1ml on 37° C	6100	BAS ISO 6222
2.	Total number of aerobic heterotrophic psychrophile bacteria in 1ml on 22° C	>20000	BAS ISO 6222
3.	Total coliform bacteria	16100	BAS ISO 9308-1
4.	Total coliform bacteria of faces origin	Present	BAS ISO 9308-1
5.	Sulphide-reducing Clostride	29	BAS EN 26461-2
6.	Pseudomonas aeruginosa	Present	BAS EN 12780
7.	Intestine enterococcus	Present	BAS ISO 7899-2
8.	Salmonella	None	ISO 6340 : 1995

Date of sampling: 22 September 2006

Table no. 16a Microbiological water parameters

No	Method	Findings	Method code
1.	Total number of aerobic mesophilic bacteria in 1ml on 37° C	7600	BAS ISO 6222
2.	Total number of aerobic heterotrophic psychrophile bacteria in 1ml on 22° C	10600	BAS ISO 6222
3.	Total coliform bacteria	16100	BAS ISO 9308-1
4.	Total coliform bacteria of faces origin	Present	BAS ISO 9308-1
5.	Sulphide-reducing Clostride	96	BAS EN 26461-2
6.	Pseudomonas aeruginosa	Present	BAS EN 12780
7.	Intestine enterococcus	Present	BAS ISO 7899-2
8.	Salmonella	None	ISO 6340 : 1995

Date of sampling: 25 September 2006

Table no. 16a Microbiological water parameters

No	Method	Findings	Method code
1.	Total number of aerobic mesophilic bacteria in 1ml on 37° C	11100	BAS ISO 6222
2.	Total number of aerobic heterotrophic psychrophile bacteria in 1ml on 22° C	9200	BAS ISO 6222
3.	Total coliform bacteria	16100	BAS ISO 9308-1
4.	Total coliform bacteria of faces origin	Present	BAS ISO 9308-1
5.	Sulphide-reducing Clostride	Present	BAS EN 26461-2
6.	Pseudomonas aeruginosa	Present	BAS EN 12780
7.	Intestine enterococcus	Present	BAS ISO 7899-2
8.	Salmonella	None	ISO 6340 : 1995

Microbiological indicators of water pollution were determined in taken water samples.

Complete water testing was performed with »Tatic« laboratory certified for water analysis, Osjecani, Doboj, while the results are synthesized and presented in the enclosed Tables 15a, 16a and 17a.

Total number of aerobic mesophilic bacteria in 1ml on 37º C in the water samples taken from the main sewer of the landfill were quite high, and in the first sample they amounted to 6100, in the second 7600 and in the third they increased all up to 111100.

Total number of aerobic heterotrophic psychrophile bacteria in 1ml on 22º C in the water samples taken from the main sewer of the landfill were quite high and in the first sample they were 20000, in the second they decreased to 10600 and in the third the total number amounted to 9200.

Total number of coliform bacteria was constantly high in all samples and it amounted to over 16000.

Total number of coliform bacteria of faces origin was very high so that it wasn't possible to determine their exact number and therefore we only made a conclusion stating that they were present.

Total number of sulphide - reducing clostride in water samples taken from the main sewer were high and in the first sample they amounted to 29, in the second 96, in the third the number of clostride was so high that it was hard to determine the exact number, so we only made a conclusion stating that they were present.

The same thing happened to the number of bacteria Pseudomonas aeruginosa and Intestine enterococcus which number was not possible to determine and therefore a conclusion was made and that they were present.

During the bacteria analysis, Salmonella was not proven to exist.

By observing the results of physical-chemical and microbiological analyses of samples of water taken from the main sewer on September 12, September 22 and September 25, 2006 a conclusion is made that those waters are very polluted with non-organic, organic substitutes as well as microbiologically and that they can not be discharged into natural water courses, in any case.

2.2.5.2.2. LOCATION: The Glogovac Brook, 300 meters downstream from the landfill dam, nearby „Unis“ factory

Date of sampling: September 12, 2006.

Table no. 18 Physical-chemical parameters of water quality

No	PARAMETER		Result (± pl. of uncertainty)	MDK Waste water	Method code
1.	Temperature	°C	17,5	30	JUS H.Z1.106:1970; EPA 170.1
2.	Colour	°Co-Pt scale	>60		BAS ISO 7887:2002; EPA 110.2
3.	Turbidity	NTU	28,0		BAS ISO 7027:2002; EPA 180.1
4.	pH		8,11	6,50 – 9,00	BAS ISO 10523:2002; EPA 150.1
5.	Consumption of $KMnO_4$	mg/l	229,86		BAS ISO 8467:2002
6.	Residue evaporation-total	mg/l	2264		EPA 160.3:1971
7.	Residue -non-filter	mg/l	-	35	BAS EN 872:2002; EPA 160.2
8.	Residue -filter	mg/l	-		EPA 160.1:1971
9.	Suspended substance according to Imhoff	ml/l	<0,1	0,5	EPA 160.5
10.	Electric conductance/20°C	µS/cm	3640		BAS EN 27888:2002; EPA 120.1
11.	Dissolved oxygen	mg/l	2,6		BAS EN 25814:2000; EPA 360.1
		% of saturation	28,6	Up to 50	BAS EN 25814:2000; EPA 360.1
12.	Biological consumption of oxygen after 5 days (BPK_5)	mg/l	19	25	BAS ISO 5851-1 BAS ISO 5851-2
13.	Residual chlorine	mg/l	-		BAS ISO 7393-2:2003
14.	Hardness of water	°dH	-		BAS ISO 6059:2000; EPA 130.2
15.	Alkalinity	mg/l $CaCO_3$	1496,8	1705,91	BAS ISO 9963-1:2000;EPA 310.1
16	Acidity	mg/l $CaCO_3$	23,24	127,47	BAS ISO 9963-1:2000;EPA 305.1
17.	Ammonia	mg/l	14,96		BAS ISO 6778:2002; EPA 350.3
18.	Nitrite	mg/l	0,73		BAS EN ISO 10304-1:2002
19.	Nitrate	mg/l	28,17		BAS EN ISO 10304-1:2002
20.	Chloride	mg/l	290,92	250	BAS EN ISO 10304-1:2002
21.	Sulphate	mg/l	104,49	200	BAS EN ISO 10304-1:2002
22.	Ortho-phosphate	mg/l	37,49		BAS EN ISO 10304-1:2002
23.	Fluoride	mg/l	-	2	BAS EN ISO 10304-1:2002
24.	Bromide	mg/l	-		BAS EN ISO 10304-1:2002
25.	Iron	mg/l	3,82	2	BAS ISO 6332:2000
26.	Manganese	mg/l	0,65	0,5	BAS ISO 6333:2003
27.	Calcium	mg/l	-		BAS EN ISO 14911:2002
28.	Magnesium	mg/l	-		BAS EN ISO 14911:2002
29.	Potassium	mg/l	-		BAS EN ISO 14911:2002
30.	Sodium	mg/l	-		BAS EN ISO 14911:2002
31.	Lithium	mg/l	-		BAS EN ISO 14911:2002
32.	Ammonium iodine	mg/l	-		BAS EN ISO 14911:2002
33.	Copper	mg/l	-	0,3	BAS ISO 8288
34.	Cobalt	mg/l	-	0,5	BAS ISO 8288
35.	Nickel	mg/l	-	0,01	BAS ISO 8288
36.	Lead	mg/l	<0,012	0,01	BAS ISO 8288
37.	Zinc	mg/l	0,027	1	BAS ISO 8288
38.	Cadmium	mg/l	0,048	0,01	BAS ISO 8288
39.	Chromium	mg/l	-	0,1	BAS EN 1233
40.	HPK*	mg/l	389,7	125	JUS ISO 6060

Water of the Glogovac brook is the water which ‘’has its headwaters’’ in the landfill dam due to existence of a spring with low capacity in the very trunk of the existing waste disposal. These are seepage waters from landfill which are

gathered in the seepage compartment under the landfill dam, from where then they are emptied into the water of the brook, canal, Glogovac, which is then emptied into the Dragocaj river, which is then emptied into the Vrbas river. One water sampling from the canal of the Glogovac brook, 300 m downstream from the place of its appearance, was performed by a skilled team of experts from ‘’Tatić“ laboratory on September 12, 2006.
After performed physical-chemical measurements, the following comments of the results could be given.

Water temperature in the canal of the Glogovac brook is below 30 ^{0}C, and it was 17,5 ^{0}C, so that, when taking into consideration the temperature, it can be discharged into natural water courses.

Measured colour values, as with turbidity are still quite high, because the value of the colour is over 60 ^{0}Co-Pt of the scale, while the value of turbidity is somewhat lower than the one of the water from the main sewer and it amounts to 28 NTU.

pH value amounted to 8,11, which is within the allowed limits, because the allowed range of pH value of waste waters, which can be released into the natural water currents, is 6,5 – 9,0.

Total residue of evaporation has very high value amounting over 2200 mg/l, which brings us to the conclusion that in the taken water sample is dissolved and suspended large quantities of substance, while the allowed value to discharge water into surface water course is 3500 mg/L.

Consumption of $KMnO_4$ is very high because the measured value is, 229,86 mg/l, and those are very high values and direct indicators that in the taken samples of water are dissolved great quantities of organic substance.

Concentration of dissolved oxygen is pretty higher when compared to the water samples taken from the main sewer of the landfill and it amounts to 2,6 mg/l, while for the forth class of natural water currents the lower limit is 3.0 mg/l and the subject water current falls into the fifth class of water currents in compliance with Regulation on classification and categorization of water currents (Official Gazette of Republic of Srpska, no 42/01).

Concentration of suspended substances according to Imhoff ranges under 0,1 ml/l while the allowed value according to the mentioned Regulation is 0,5.

Electric conductance of the water sample from the catch pit in the base of the dam is over 3640 μS/cm, which represents high value when compared to natural water currents because the limit for the forth class of natural water currents is up to 1500 μS/cm, and all that in compliance with the Regulation on classification and categorization of the water currents (Official Gazette of Republic of Srpska, no 42/01), and it is a result of dissolving different ionic compounds in the water.

Biological consumption of oxygen after five days amounts to 19 mg/l, while the allowed value for discharging into surface courses is 25 mg/l.

Alkalinity of the water in the canal of the Glogovac brook, taken 300 m from the main sewer under the landfill dam is over 1496 mg/l $CaCO_3$, representing high concentration, but being under allowed concentration for releasing into natural waters.

Value of acidity is 23,24, which is under allowed value of 127,47 mg/l $CaCO_3$.
Ammonia value is 14,96 mg/l, which is somewhat above allowed value of 10 mg/l of ammonia nitrogen.

Nitrite concentration is pretty low and it amounts to 0,73 mg/l, which is under the allowed value of 1 mg of nitrite nitrogen per litre.

Value of nitrate concentration is 28,17 mg/l, which is somewhat above allowed value of 10 mg of nitrate nitrogen per litre.

In the taken water sample from the canal of the Glogovac brook, Chloride concentration amounting over 290 mg/l, and sulphate concentration amounting to 104 mg/l, are pretty high, while sulphate concentrations are under maximum allowed 200 mg/l, while chloride concentrations are over maximum allowed 250 mg/l.

Ortho-phosphate concentration is quite high when compared to natural water currents and generally when compared to other samples of water.

Iron concentrations are quite over maximum allowed concentration for release into natural water courses, because they are amounting to 3,82 mg/l while the allowed value for discharging into water courses is 2 mg/l.

Manganese concentrations are somewhat above maximum allowed concentration for release into natural water courses, because they amount to 0,65 mg/l, while the allowed value for release into natural water currents are 0,5 mg/l.

Lead concentration is slightly over maximum allowed concentration for discharging into natural water currents because it amounts to 0,012 mg/l, while the allowed value for discharging into natural water courses is lower than 0,01 mg/l.

Zinc concentration is lower than maximum allowed concentration for discharging into natural water courses because they amount to 0,027 mg/l, while the allowed value for discharging into natural water currents amounts to 1,0 mg/l.

Cadmium concentration is pretty higher then maximum allowed concentration for discharging into natural water currents because it amounts to 0,048 mg/l, while the allowed value for discharging into natural water currents is 0,01 mg/l.

Value of chemical oxygen consumption is quite high and it amounts over 380 mg/l O_2, while the allowed value for discharging into natural water courses is 125 mg/l O_2, which is clear indicator of water pollution.

According to the Book of Rules on conditions for release of waste water into surface courses (Official Gazette of Republic of Srpska no.44/01) article 10, ''quality of effluent, i.e. concentration of all parameters of waste-water quality or effluent of the Plant for water treatment must be lower than the value given in this regulation'', if this condition is not fulfilled it is considered that conditions of discharging into surface courses have not been fulfilled.

Date of sampling: September 12, 2006

Table no. 18a Microbiological parameters of water quality

No	Method	Findings	Code of the method
1.	Total number of aerobic mesophilic bacteria in 1ml on 37º C	5900	BAS ISO 6222
2.	Total number of aerobic heterotrophic psychrophile bacteria in 1ml on 22º C	>20000	BAS ISO 6222
3.	Total coliform bacteria	16100	BAS ISO 9308-1
4.	Total coliform bacteria of faces origin	present	BAS ISO 9308-1
5.	Sulphide-reducing clostride	11	BAS EN 26461-2
6.	Pseudomonas aeruginosa	present	BAS EN 12780
7.	Intestine enterococcus	present	BAS ISO 7899-2
8.	Salmonella	none	ISO 6340 : 1995

Microbiological indicators of water pollution were also determined in the water samples taken from the Glogovac brook canal.

On the basis of these analyses the following conclusions could be made.

Total number of aerobic mesophilic bacteria in 1ml on 37º C in the water sample taken from the canal of the Glogovac brook is quite high and it amounts to 5900.

Total number of aerobic heterotrophic psychrophile bacteria in 1ml on 22º C in the water sample taken from the canal of the Glogovac brook was quite high and it amounted to over 20000.

Total number of coliform bacteria was constantly high in all samples and it amounted to over 16000.

Total coliform bacteria of faces origin is very high, so that it was impossible to determine their exact number and therefore a conclusion has been drawn that they are present.

Total number of Sulphide-reducing clostride in the water sample taken from the canal of the Glogovac brook is low and it amounts to 11.

Total number of bacteria Pseudomonas aeruginosa and Intestine enterococcus was so high and therefore it was impossible to determine their exact number and therefore a conclusion has been drawn that they are only present.

During the bacteria analysis the existence of Salmonella has not been proven.

2.2.5.2.3. LOCATION : The Dragocaj River, before the mouth of the Glogovac brook

Date of sampling: September 12, 2006

Table no. 19 Physical-chemical parameters of water quality

No	PARAMETER		Result (± pl. of uncertainty)	Method code
1.	Temperature	°C	15,5	JUS H.Z1.106:1970; EPA 170.1
2.	Colour	°Co-Pt scale	7	BAS ISO 7887:2002; EPA 110.2
3.	Turbidity	NTU	0,10	BAS ISO 7027:2002; EPA 180.1
4.	pH		7,53	BAS ISO 10523:2002; EPA 150.1
5.	Consumption of $KMnO_4$	mg/l	5,57	BAS ISO 8467:2002
6.	Residue evaporation-total	mg/l	196	EPA 160.3:1971
7.	Residue -non-filter	mg/l	-	BAS EN 872:2002; EPA 160.2
8.	Residue -filter	mg/l	-	EPA 160.1:1971
9.	Suspended substance according to Imhoff	ml/l	<0,1	EPA 160.5
10.	Electric conductance/20°C	µS/cm	282	BAS EN 27888:2002; EPA 120.1
11.	Dissolved oxygen	mg/l	5,0	BAS EN 25814:2000; EPA 360.1
		% of saturation	55	BAS EN 25814:2000; EPA 360.1
12.	Biological consumption of oxygen after 5 days (BPK_5)	mg/l	3	BAS ISO 5851-1 BAS ISO 5851-2
13.	Residual chlorine	mg/l	-	BAS ISO 7393-2:2003
14.	Hardness of water	°dH	-	BAS ISO 6059:2000; EPA 130.2
15.	Alkalinity	mg/l $CaCO_3$	139,04	BAS ISO 9963-1:2000;EPA 310.1
16	Acidity	mg/l $CaCO_3$	7,14	BAS ISO 9963-1:2000;EPA 305.1
17.	Ammonia	mg/l	<0,1	BAS ISO 6778:2002; EPA 350.3
18.	Nitrite	mg/l	0,98	BAS EN ISO 10304-1:2002
19.	Nitrate	mg/l	0	BAS EN ISO 10304-1:2002
20.	Chloride	mg/l	5,36	BAS EN ISO 10304-1:2002
21.	Sulphate	mg/l	8,17	BAS EN ISO 10304-1:2002
22.	Ortho-phosphate	mg/l	4,13	BAS EN ISO 10304-1:2002
23.	Fluoride	mg/l	-	BAS EN ISO 10304-1:2002
24.	Bromide	mg/l	-	BAS EN ISO 10304-1:2002
25.	Iron	mg/l	0,41	BAS ISO 6332:2000
26.	Manganese	mg/l	0,08	BAS ISO 6333:2003
27.	Calcium	mg/l	-	BAS EN ISO 14911:2002
28.	Magnesium	mg/l	-	BAS EN ISO 14911:2002
29.	Potassium	mg/l	-	BAS EN ISO 14911:2002
30.	Sodium	mg/l	-	BAS EN ISO 14911:2002
31.	Lithium	mg/l	-	BAS EN ISO 14911:2002
32.	Ammonium iodine	mg/l	-	BAS EN ISO 14911:2002
33.	Copper	mg/l	-	BAS ISO 8288
34.	Cobalt	mg/l	-	BAS ISO 8288
35.	Nickel	mg/l	-	BAS ISO 8288
36.	Lead	mg/l	<0,012	BAS ISO 8288
37.	Zinc	mg/l	0,024	BAS ISO 8288
38.	Cadmium	mg/l	<0,0006	BAS ISO 8288
39.	Chromium	mg/l	-	BAS EN 1233
40.	HPK*	mg/l	35,2	JUS ISO 6060

Date of sampling: September 22, 2006

Table no. 20 Physical-chemical parameters of water quality

No	PARAMETER		Result (± pl. of uncertainty)	Method code
1.	Temperature	°C	16	JUS H.Z1.106:1970; EPA 170.1
2.	Colour	°Co-Pt scale	10	BAS ISO 7887:2002; EPA 110.2
3.	Turbidity	NTU	7,42	BAS ISO 7027:2002; EPA 180.1
4.	pH		7,83	BAS ISO 10523:2002; EPA 150.1
5.	Consumption of $KMnO_4$	mg/l	5,556	BAS ISO 8467:2002
6.	Residue evaporation-total	mg/l	116	EPA 160.3:1971
7.	Residue -non-filter	mg/l	-	BAS EN 872:2002; EPA 160.2
8.	Residue -filter	mg/l	-	EPA 160.1:1971
9.	Suspended substance according to Imhoff	ml/l	<0,1	EPA 160.5
10.	Electric conductance/20°C	µS/cm	224	BAS EN 27888:2002; EPA 120.1
11.	Dissolved oxygen	mg/l	8,1	BAS EN 25814:2000; EPA 360.1
		% of saturation	89,1	BAS EN 25814:2000; EPA 360.1
12.	Biological consumption of oxygen after 5 days (BPK_5)	mg/l	3	BAS ISO 5851-1 BAS ISO 5851-2
13.	Residual chlorine	mg/l	-	BAS ISO 7393-2:2003
14.	Hardness of water	°dH	-	BAS ISO 6059:2000; EPA 130.2
15.	Alkalinity	mg/l $CaCO_3$	116,49	BAS ISO 9963-1:2000;EPA 310.1
16	Acidity	mg/l $CaCO_3$	3,96	BAS ISO 9963-1:2000;EPA 305.1
17.	Ammonia	mg/l	<0,1	BAS ISO 6778:2002; EPA 350.3
18.	Nitrite	mg/l	0	BAS EN ISO 10304-1:2002
19.	Nitrate	mg/l	3,78	BAS EN ISO 10304-1:2002
20.	Chloride	mg/l	4,98	BAS EN ISO 10304-1:2002
21.	Sulphate	mg/l	10,36	BAS EN ISO 10304-1:2002
22.	Ortho-phosphate	mg/l	6,47	BAS EN ISO 10304-1:2002
23.	Fluoride	mg/l	-	BAS EN ISO 10304-1:2002
24.	Bromide	mg/l	-	BAS EN ISO 10304-1:2002
25.	Iron	mg/l	0,08	BAS ISO 6332:2000
26.	Manganese	mg/l	0,06	BAS ISO 6333:2003
27.	Calcium	mg/l	-	BAS EN ISO 14911:2002
28.	Magnesium	mg/l	-	BAS EN ISO 14911:2002
29.	Potassium	mg/l	-	BAS EN ISO 14911:2002
30.	Sodium	mg/l	-	BAS EN ISO 14911:2002
31.	Lithium	mg/l	-	BAS EN ISO 14911:2002
32.	Ammonium iodine	mg/l	-	BAS EN ISO 14911:2002
33.	Copper	mg/l	-	BAS ISO 8288
34.	Cobalt	mg/l	-	BAS ISO 8288
35.	Nickel	mg/l	-	BAS ISO 8288
36.	Lead	mg/l	<0,01	BAS ISO 8288
37.	Zinc	mg/l	0,04	BAS ISO 8288
38.	Cadmium	mg/l	0,007	BAS ISO 8288
39.	Chromium	mg/l	-	BAS EN 1233
40.	HPK*	mg/l	27,64	JUS ISO 6060

Date of sampling: September 25, 2006

Table no. 21 Physical-chemical parameters of water quality

No	PARAMETER		Result (± pl. of uncertainty)	Method code
1.	Temperature	°C	20	JUS H.Z1.106:1970; EPA 170.1
2.	Colour	°Co-Pt scale	10	BAS ISO 7887:2002; EPA 110.2
3.	Turbidity	NTU	5,72	BAS ISO 7027:2002; EPA 180.1
4.	pH		7,80	BAS ISO 10523:2002; EPA 150.1
5.	Consumption of $KMnO_4$	mg/l	5,749	BAS ISO 8467:2002
6.	Residue evaporation-total	mg/l	142	EPA 160.3:1971
7.	Residue -non-filter	mg/l	-	BAS EN 872:2002; EPA 160.2
8.	Residue -filter	mg/l	-	EPA 160.1:1971
9.	Suspended substance according to Imhoff	ml/l	<0,1	EPA 160.5
10.	Electric conductance/20°C	µS/cm	276	BAS EN 27888:2002; EPA 120.1
11.	Dissolved oxygen	mg/l	7,7	BAS EN 25814:2000; EPA 360.1
		% of saturation	84,7	BAS EN 25814:2000; EPA 360.1
12.	Biological consumption of oxygen after 5 days (BPK_5)	mg/l	5	BAS ISO 5851-1 BAS ISO 5851-2
13.	Residual chlorine	mg/l	-	BAS ISO 7393-2:2003
14.	Hardness of water	°dH	-	BAS ISO 6059:2000; EPA 130.2
15.	Alkalinity	mg/l $CaCO_3$	121,73	BAS ISO 9963-1:2000;EPA 310.1
16	Acidity	mg/l $CaCO_3$	4,17	BAS ISO 9963-1:2000;EPA 305.1
17.	Ammonia	mg/l	<0,1	BAS ISO 6778:2002; EPA 350.3
18.	Nitrite	mg/l	0,01	BAS EN ISO 10304-1:2002
19.	Nitrate	mg/l	2,79	BAS EN ISO 10304-1:2002
20.	Chloride	mg/l	6,57	BAS EN ISO 10304-1:2002
21.	Sulphate	mg/l	9,72	BAS EN ISO 10304-1:2002
22.	Ortho-phosphate	mg/l	6,25	BAS EN ISO 10304-1:2002
23.	Fluoride	mg/l	-	BAS EN ISO 10304-1:2002
24.	Bromide	mg/l	-	BAS EN ISO 10304-1:2002
25.	Iron	mg/l	0,10	BAS ISO 6332:2000
26.	Manganese	mg/l	0,05	BAS ISO 6333:2003
27.	Calcium	mg/l	-	BAS EN ISO 14911:2002
28.	Magnesium	mg/l	-	BAS EN ISO 14911:2002
29.	Potassium	mg/l	-	BAS EN ISO 14911:2002
30.	Sodium	mg/l	-	BAS EN ISO 14911:2002
31.	Lithium	mg/l	-	BAS EN ISO 14911:2002
32.	Ammonium iodine	mg/l	-	BAS EN ISO 14911:2002
33.	Copper	mg/l	-	BAS ISO 8288
34.	Cobalt	mg/l	-	BAS ISO 8288
35.	Nickel	mg/l	-	BAS ISO 8288
36.	Lead	mg/l	<0,01	BAS ISO 8288
37.	Zinc	mg/l	0,04	BAS ISO 8288
38.	Cadmium	mg/l	0,008	BAS ISO 8288
39.	Chromium	mg/l	-	BAS EN 1233
40.	HPK*	mg/l	22,17	JUS ISO 6060

The Landfill is located on the hill above Dragocaj water course. This river empties into Vrbas River about 5 km downstream. Main course is about 6 km long and it consists of right tributary called Dragocaj which length is about 9,5 km and left tributary called Ivastanka which length is about 11 km. An average specific flowing off towards the river Vrbas basin, where the landfill is located, is 19,90 l/s/km2. Maximum discharge of Dragocaj river on the mouth of the brook Glogovac is 230 m^3/s.

Characteristic discharges of the river Vrbas on the mouth of the river Dragocaj are:

Q_{min} = 18 m^3/s , Q_{sr}= 112 m^3/s, $Q_{max, 1/100}$= 1765 m^3/s.

Water sampling from Dragocaj river before the mouth of Glogovac brook, was performed by the skilled team of experts from ‘’Tatic“ laboratory on September 12, September 22 and September 25, 2006.

After performed physical-chemical measuring, the following commentary is given on the results in compliance with the Regulation on classification and categorization of water courses (Official Gazette of Republic of Srpska, no. 42/01).

Water temperature in Dragocaj River, of all three samples was 15.5, 16 and 20 ^{0}C, respectively.

Measured colour values, as well as turbidity are pretty lower when compared to the water from the main sewer of the landfill and the water of the brook Glogovac and their values are 7, 10 and 10 ^{0}Co-Pt scale, and the turbidity is 0.10, 7.42 and 5.72 NTU.

pH value was 7.53, 7.83 and 7.80, which is within the allowed limits of natural water courses.

Total residue of evaporation has the value of 196, 116 and 142 mg/l, which is quite less than the previously taken samples.

Consumptions of $KMnO_4$ are 5.57, 5.556 and 5.749 mg/l, which are pretty low values than those registered into the samples of water from the landfill and the canal of the brook Glogovac.

Concentration of dissolved oxygen is 5.0, 8.1 and 7.7 mg/l, which, on the basis of the last two samples, classifies the subject water course into the first class of water courses in compliance with the Regulation on classification and categorization of water course (Official Gazette of Republic of Srpska, no 42/01), while on the basis of the first sample performed on September 12, into the third class.

Concentration of suspended substances according to Imhoff ranges under 0,1 ml/l, which classifies the subject water course, before the mouth of the water of the brook Glogovac, into the first class of water course, in compliance with the Regulation on classification and categorization of water course (Official Gazette of Republic of Srpska, no 42/01).

Electric conductance of the Dragocaj river sample before the mouth of the Glogovac brook water is under 280 μS/cm, which classifies the subject water course, before the mouth of the water of the brook Glogovac, into the first class of the water courses in compliance with the Regulation on classification and

categorization of water course (Official Gazette of Republic of Srpska, no 42/01).

Biological consumption of oxygen after five days amounts to 3, 3 and 5 mg/l, which on the basis of the first two samples classifies the subject water course into the second class, while on the basis of the third in the third class of water courses.

Alkalinity of water samples of the river Dragocaj before the mouth of the brook water amount to 121.73, 116,49 and 139,04 mg/l $CaCO_3$, which classifies the subject water course, before the mouth of the water of the brook Glogovac, into the third class of water courses in compliance with the Regulation on classification and categorization of water course (Official Gazette of Republic of Srpska, no 42/01).

Ammonia value is lower than 0,1mg/l, which classifies the subject water course, before the mouth of the water of the brook Glogovac , into the first class of the water courses in compliance with the Regulation on classification and categorization of water course (Official Gazette of Republic of Srpska, no 42/01).

Based on nitrite concentration in the first two samples, the subject water course, before the mouth of the brook Glogovac, belongs to the first class of water courses, in compliance with the Regulation on classification and categorization of water course (Official Gazette of Republic of Srpska, no 42/01), while on the basis of the third sample it does not even belongs to the fifth class, but probably that is only temporary pollution.

Based on nitrate concentration the subject water course, before the Glogovac brook mouth, belongs to the third class of water course in compliance with the Regulation on classification and categorization of water course (Official Gazette of Republic of Srpska, no 42/01).

Based on determined concentration of chloride and sulphate, the subject water course, before the Glogovac brook mouth, belongs to the first class of water courses in compliance with the Regulation on classification and categorization of water courses (Official Gazette of the Republic of Srpska, no 42/01).

Ortho-phosphate concentration is quite high when compared to natural water courses, but significantly lower than in the water from the landfill and the brook Glogovac.

According to iron concentration in the last two samples the subject water course, before the Glogovac brook mouth, belongs to the first class of water courses in compliance with the Regulation on classification and categorization of water course (Official Gazette of the Republic of Srpska, no 42/01), while according to the first sample it belongs to the third class.

On the basis of manganese concentration the subject water course, before the Glogovac brook mouth, belongs to the second class of water courses in compliance with the Regulation on classification and categorization of water course (Official Gazette of Republic of Srpska, no 42/01).

Lead concentrations are quite higher than usual lead concentrations in natural water courses.

On the basis of zinc concentration the subject water course, before the Glogovac brook mouth, belongs to the first class of water courses in compliance with the Regulation on classification and categorization of water course (Official Gazette of Republic of Srpska, no 42/01).

On the basis of cadmium concentration the subject water course, before the Glogovac brook mouth, belongs to the fifth class of water courses in compliance with the Regulation on classification and categorization of water course (Official Gazette of Republic of Srpska, no 42/01), as well as in lead concentration which is raised at the subject water course.

Value of chemical oxygen consumption ranges from 22.17 to 35,2 mg/l O_2, which classifies the subject water course into the third class of water courses in compliance with the Regulation on classification and categorization of water course (Official Gazette of Republic of Srpska, no 42/01).

Date of sampling: September 12, 2006

Table no. 19a Microbiological parameters of water quality

No	Method	Findings	Method code
1.	Total number of aerobic mesophilic bacteria in 1ml on 37° C	3600	BAS ISO 6222
2.	Total number of aerobic heterotrophic psychrophile bacteria in 1ml on 22° C	5900	BAS ISO 6222
3.	Total coliform bacteria	16100	BAS ISO 9308-1
4.	Total coliform bacteria of faces origin	present	BAS ISO 9308-1
5.	Sulphide-reducing Clostride	6	BAS EN 26461-2
6.	Pseudomonas aeruginosa	none	BAS EN 12780
7.	Intestine enterococcus	present	BAS ISO 7899-2
8.	Salmonella	none	ISO 6340 : 1995

Date of sampling: September 22, 2006.

Table no. 20a Microbiological parameters of water quality

No	Method	Findings	Method code
1.	Total number of aerobic mesophilic bacteria in 1ml on 37° C	3100	BAS ISO 6222
2.	Total number of aerobic heterotrophic psychrophile bacteria in 1ml on 22° C	5600	BAS ISO 6222
3.	Total coliform bacteria	16100	BAS ISO 9308-1
4.	Total coliform bacteria of faces origin	present	BAS ISO 9308-1
5.	Sulphide-reducing Clostride	5	BAS EN 26461-2
6.	Pseudomonas aeruginosa	none	BAS EN 12780
7.	Intestine enterococcus	present	BAS ISO 7899-2
8.	Salmonella	none	ISO 6340 : 1995

Date of sampling: September 25, 2006

Table no. 21a Microbiological parameters of water quality

No	Method	Findings	Method code
1.	Total number of aerobic mesophilic bacteria in 1ml on 37° C	2700	BAS ISO 6222
2.	Total number of aerobic heterotrophic psychrophile bacteria in 1ml on 22° C	4900	BAS ISO 6222
3.	Total coliform bacteria	16100	BAS ISO 9308-1
4.	Total coliform bacteria of faces origin	present	BAS ISO 9308-1
5.	Sulphide-reducing Clostride	7	BAS EN 26461-2
6.	Pseudomonas aeruginosa	none	BAS EN 12780
7.	Intestine enterococcus	present	BAS ISO 7899-2
8.	Salmonella	none	ISO 6340 : 1995

Microbiological indicators of water pollution are determined in the taken water samples.

Complete water testing was performed in the »Tatić« laboratory certified for water analysis, Osjecani, Doboj, and the results were synthesized and presented in the enclosed tables 19a, 20a and 21a.

Total number of aerobic mesophilic bacteria in 1ml on 37º C in the water samples taken from the Dragocaj, before the Glogovac brook water mouth, was in the first sample 3600, in the second 3100 and in the third 2700, which classifies the subject water course, before the Glogovac brook water mouth, into the second class of water courses in compliance with the Regulation on classification and categorization of water course (Official Gazette of Republic of Srpska, no 42/01).

Total number of aerobic heterotrophic psychrophile bacteria in 1ml on 22º C in the first sample amounted to 5900, in the second 5600 and in the third the total number amounted to 4900.

Total number of coliform bacteria was constantly high in all samples and it amounted to over 16000, which classifies the subject water course, before the Glogovac brook water mouth, into the third class of water courses in compliance with the Regulation on classification and categorization of water course (Official Gazette of Republic of Srpska, no 42/01).

Total number of coliform bacteria of faces origin is very high so that it was not possible to determine their exact number and therefore a conclusion was brought that they are only present.

Total number of Sulphide-reducing Clostride in the first sample was 6, in the second 5, and in the third 7.

During the microbiological analysis, it was not proved that bacteria Pseudomonas aeruginosa, Salmonella and intestine enterococcus existed.

Observing the results of physical- chemical and microbiological analysis of water samples taken from the river Dragocaj, before the Glogovac brook water mouth, on September 12, September 22 and September 25, 2006, and comparing them to the Regulation on classification and categorization of water course (Official Gazette of Republic of Srpska, no 42/01). A conclusion can be drawn that the river Dragocaj, upstream from the Glogovac brook water mouth belongs to the first class of waters although some parameters of the quality deviate from the parameters for the first class of waters and therefore it is classified from the first to the third class.

Lead and cadmium are higher than permitted for natural water courses.

2.2.5.2.4. LOCATION: Dragocaj River, after the Glogovac brook water mouth

Date of sampling: September 12, 2006

Table no. 22 Physical-chemical parameters of water quality

No	PARAMETERS		Result (± meas. uncertainty)	Method Code
1.	Temperature	°C	15,5	JUS H.Z1.106:1970; EPA 170.1
2.	Colour	°Co-Pt scale	>60	BAS ISO 7887:2002; EPA 110.2
3.	Turbidity	NTU	7,26	BAS ISO 7027:2002; EPA 180.1
4.	pH		7,90	BAS ISO 10523:2002; EPA 150.1
5.	Consumption of $KMnO_4$	mg/l	68,52	BAS ISO 8467:2002
6.	Residue evaporation-total	mg/l	1144	EPA 160.3:1971
7.	Residue -non-filter	mg/l	-	BAS EN 872:2002; EPA 160.2
8.	Residue -filter	mg/l	-	EPA 160.1:1971
9.	Suspended substance according to Imhoff	ml/l	<0,1	EPA 160.5
10.	Electric conductance/20°C	µS/cm	1714	BAS EN 27888:2002; EPA 120.1
11.	Dissolved oxygen	mg/l	3,2	BAS EN 25814:2000; EPA 360.1
		% of saturation	35,20	BAS EN 25814:2000; EPA 360.1
12.	Biological consumption of oxygen after 5 days (BPK_5)	mg/l	12	BAS ISO 5851-1 BAS ISO 5851-2
13.	Residual chlorine	mg/l	-	BAS ISO 7393-2:2003
14.	Hardness of water	°dH	-	BAS ISO 6059:2000; EPA 130.2
15.	Alkalinity	mg/l $CaCO_3$	1108,48	BAS ISO 9963-1:2000;EPA 310.1
16	Acidity	mg/l $CaCO_3$	8,18	BAS ISO 9963-1:2000;EPA 305.1
17.	Ammonia	mg/l	5,01	BAS ISO 6778:2002; EPA 350.3
18.	Nitrite	mg/l	0,50	BAS EN ISO 10304-1:2002
19.	Nitrate	mg/l	7,32	BAS EN ISO 10304-1:2002
20.	Chloride	mg/l	132,02	BAS EN ISO 10304-1:2002
21.	Sulphate	mg/l	51,09	BAS EN ISO 10304-1:2002
22.	Ortho-phosphate	mg/l	19,93	BAS EN ISO 10304-1:2002
23.	Fluoride	mg/l	-	BAS EN ISO 10304-1:2002
24.	Bromide	mg/l	-	BAS EN ISO 10304-1:2002
25.	Iron	mg/l	1,11	BAS ISO 6332:2000
26.	Manganese	mg/l	0,125	BAS ISO 6333:2003
27.	Calcium	mg/l	-	BAS EN ISO 14911:2002
28.	Magnesium	mg/l	-	BAS EN ISO 14911:2002
29.	Potassium	mg/l	-	BAS EN ISO 14911:2002
30.	Sodium	mg/l	-	BAS EN ISO 14911:2002
31.	Lithium	mg/l	-	BAS EN ISO 14911:2002
32.	Ammonium iodine	mg/l	-	BAS EN ISO 14911:2002
33.	Copper	mg/l	-	BAS ISO 8288
34.	Cobalt	mg/l	-	BAS ISO 8288
35.	Nickel	mg/l	-	BAS ISO 8288
36.	Lead	mg/l	<0,012	BAS ISO 8288
37.	Zinc	mg/l	0,007	BAS ISO 8288
38.	Cadmium	mg/l	<0,006	BAS ISO 8288
39.	Chromium	mg/l	-	BAS EN 1233
40.	HPK*	mg/l	189,2	JUS ISO 6060

Date of sampling: September 22 September 2006

Table no. 23 Physical-chemical parameters of water quality

No	PARAMETERS		Result (± measur. uncertainty)	Method Code
1.	Temperature	°C	16	JUS H.Z1.106:1970; EPA 170.1
2.	Colour	°Co-Pt scale	>60	BAS ISO 7887:2002; EPA 110.2
3.	Turbidity	NTU	26,5	BAS ISO 7027:2002; EPA 180.1
4.	pH		7,73	BAS ISO 10523:2002; EPA 150.1
5.	Consumption of $KMnO_4$	mg/l	189,87	BAS ISO 8467:2002
6.	Residue evaporation-total	mg/l	692	EPA 160.3:1971
7.	Residue -non-filter	mg/l	-	BAS EN 872:2002; EPA 160.2
8.	Residue -filter	mg/l	-	EPA 160.1:1971
9.	Suspended substance according to Imhoff	ml/l	<0,1	EPA 160.5
10.	Electric conductance/20°C	μS/cm	1558	BAS EN 27888:2002; EPA 120.1
11.	Dissolved oxygen	mg/l	7,2	BAS EN 25814:2000; EPA 360.1
		% of saturation	79,2	BAS EN 25814:2000; EPA 360.1
12.	Biological consumption of oxygen after 5 days (BPK_5)	mg/l	20	BAS ISO 5851-1 BAS ISO 5851-2
13.	Residual chlorine	mg/l	-	BAS ISO 7393-2:2003
14.	Hardness of water	°dH	-	BAS ISO 6059:2000; EPA 130.2
15.	Alkalinity	mg/l $CaCO_3$	531,67	BAS ISO 9963-1:2000;EPA 310.1
16	Acidity	mg/l $CaCO_3$	34,54	BAS ISO 9963-1:2000;EPA 305.1
17.	Ammonia	mg/l	6,30	BAS ISO 6778:2002; EPA 350.3
18.	Nitrite	mg/l	0,53	BAS EN ISO 10304-1:2002
19.	Nitrate	mg/l	46,53	BAS EN ISO 10304-1:2002
20.	Chloride	mg/l	128,13	BAS EN ISO 10304-1:2002
21.	Sulphate	mg/l	39,73	BAS EN ISO 10304-1:2002
22.	Ortho-phosphate	mg/l	14,48	BAS EN ISO 10304-1:2002
23.	Fluoride	mg/l	-	BAS EN ISO 10304-1:2002
24.	Bromide	mg/l	-	BAS EN ISO 10304-1:2002
25.	Iron	mg/l	1,75	BAS ISO 6332:2000
26.	Manganese	mg/l	0,81	BAS ISO 6333:2003
27.	Calcium	mg/l	-	BAS EN ISO 14911:2002
28.	Magnesium	mg/l	-	BAS EN ISO 14911:2002
29.	Potassium	mg/l	-	BAS EN ISO 14911:2002
30.	Sodium	mg/l	-	BAS EN ISO 14911:2002
31.	Lithium	mg/l	-	BAS EN ISO 14911:2002
32.	Ammonium iodine	mg/l	-	BAS EN ISO 14911:2002
33.	Copper	mg/l	-	BAS ISO 8288
34.	Cobalt	mg/l	-	BAS ISO 8288
35.	Nickel	mg/l	-	BAS ISO 8288
36.	Lead	mg/l	<0,012	BAS ISO 8288
37.	Zinc	mg/l	0,05	BAS ISO 8288
38.	Cadmium	mg/l	0,01	BAS ISO 8288
39.	Chromium	mg/l	-	BAS EN 1233
40.	HPK*	mg/l	43,44	JUS ISO 6060

Date of sampling: September 25, 2006

Table no. 24 Physical-chemical parameters of water quality

No	PARAMETERS		Result (± measur. uncertainty)	Method Code
1.	Temperature	°C	16	JUS H.Z1.106:1970; EPA 170.1
2.	Colour	°Co-Pt scale	>60	BAS ISO 7887:2002; EPA 110.2
3.	Turbidity	NTU	22,6	BAS ISO 7027:2002; EPA 180.1
4.	pH		7,81	BAS ISO 10523:2002; EPA 150.1
5.	Consumption of $KMnO_4$	mg/l	163,30	BAS ISO 8467:2002
6.	Residue evaporation-total	mg/l	711	EPA 160.3:1971
7.	Residue -non-filter	mg/l	-	BAS EN 872:2002; EPA 160.2
8.	Residue -filter	mg/l	-	EPA 160.1:1971
9.	Suspended substance according to Imhoff	ml/l	<0,1	EPA 160.5
10.	Electric conductance/20°C	µS/cm	1473	BAS EN 27888:2002; EPA 120.1
11.	Dissolved oxygen	mg/l	6,7	BAS EN 25814:2000; EPA 360.1
		% of saturation	73,7	BAS EN 25814:2000; EPA 360.1
12.	Biological consumption of oxygen after 5 days (BPK_5)	mg/l	16	BAS ISO 5851-1 BAS ISO 5851-2
13.	Residual chlorine	mg/l	-	BAS ISO 7393-2:2003
14.	Hardness of water	°dH	-	BAS ISO 6059:2000; EPA 130.2
15.	Alkalinity	mg/l $CaCO_3$	672,16	BAS ISO 9963-1:2000;EPA 310.1
16	Acidity	mg/l $CaCO_3$	39,90	BAS ISO 9963-1:2000;EPA 305.1
17.	Ammonia	mg/l	8,41	BAS ISO 6778:2002; EPA 350.3
18.	Nitrite	mg/l	0,49	BAS EN ISO 10304-1:2002
19.	Nitrate	mg/l	36,87	BAS EN ISO 10304-1:2002
20.	Chloride	mg/l	121,42	BAS EN ISO 10304-1:2002
21.	Sulphate	mg/l	37,82	BAS EN ISO 10304-1:2002
22.	Ortho-phosphate	mg/l	11,56	BAS EN ISO 10304-1:2002
23.	Fluoride	mg/l	-	BAS EN ISO 10304-1:2002
24.	Bromide	mg/l	-	BAS EN ISO 10304-1:2002
25.	Iron	mg/l	1,65	BAS ISO 6332:2000
26.	Manganese	mg/l	0,790	BAS ISO 6333:2003
27.	Calcium	mg/l	-	BAS EN ISO 14911:2002
28.	Magnesium	mg/l	-	BAS EN ISO 14911:2002
29.	Potassium	mg/l	-	BAS EN ISO 14911:2002
30.	Sodium	mg/l	-	BAS EN ISO 14911:2002
31.	Lithium	mg/l	-	BAS EN ISO 14911:2002
32.	Ammonium iodine	mg/l	-	BAS EN ISO 14911:2002
33.	Copper	mg/l	-	BAS ISO 8288
34.	Cobalt	mg/l	-	BAS ISO 8288
35.	Nickel	mg/l	-	BAS ISO 8288
36.	Lead	mg/l	<0,012	BAS ISO 8288
37.	Zinc	mg/l	0,05	BAS ISO 8288
38.	Cadmium	mg/l	0,009	BAS ISO 8288
39.	Chromium	mg/l	-	BAS EN 1233
40.	HPK*	mg/l	51,47	JUS ISO 6060

The landfill is located on a hill above the water course Dragocaj. This river empties into the river Vrbas about 5 km downstream. Main course is about 6 km long. The brook Glogovac empties into the river Dragocaj. Maximum discharge of the river Dragocaj on the mouth of the brook Glogovac is 230 m^3/s.

Water sampling from the river Dragocaj after the Glogovac brook water mouth was performed by the skilled team of experts from ‘’Tatić“ laboratory on September 12, September 22 and September 25, 2006.

After performed physical-chemical measurements the following commentary on the results could be given in compliance with the Regulation on classification and categorization of water courses (Official Gazette of Republic of Srpska, no. 42/01).

Water temperature in the river Dragočaj, after the Glogovac brook water mouth in all three samples was 15.5, 16 and 16 ^{0}C, respectively. Observing the sample of the water of the river Dragocaj as of September 25, with the temperature of 20 ^{0}C, we can draw a conclusion that the Glogovac brook water mouth the temperature of the river Dragocaj is reducing.

Measured colour values, as well as turbidity are quite higher when compared to the water of the river Dragocaj before the Glogovac brook water mouth and its value is over 60 ^{0}Co-Pt of the scale, while the turbidity is over 26 NTU.

There haven’t been significant changes of pH values after the Glogovac brook water mouth and it usually has a value which is characteristic for natural water courses.

After the Glogovac brook water mouth there has been increase of value of total residue of evaporation which means that with the water of the brook Glogovac, into the river Dragocaj, also empties the great amount of dissolved substances.

Also the consumption of $KMnO_4$ grows the Glogovac brook water mouth into the river Dragocaj, meaning that with the water of the brook into the river comes as well the great quantity of organic substances.

Concentration of dissolved oxygen is 3.2, 7.2 and 6.7 mg/l, which, on the basis of the first sample, classifies the subject water course, after the Glogovac brook water mouth into the fourth class of water courses in compliance with the Regulation on classification and categorization of water course (Official Gazette of Republic of Srpska, no 42/01), while on the basis of the second, i.e. third sample into the first i.e. second class.

Concentration of suspended substances according to Imhoff ranges under 0,1 ml/l, which classifies the subject water course, after the Glogovac brook water mouth into the first class of water courses, in compliance with the Regulation on classification and categorization of water course (Official Gazette of Republic of Srpska, no 42/01).

Electric conductance of the samples of the river Dragocaj after the Glogovac brook water mouth significantly grows and in compliance with the Regulation on classification and categorization of water course (Official Gazette of Republic of Srpska, no 42/01) the water of the river Dragocaj after the water of the brook Glogovac belongs to the fifth class of the water course.

Biological consumption of oxygen after five days in the river Dragocaj after the Glogovac brook water mouth significantly grows and in compliance with the Regulation on classification and categorization of water course (Official Gazette of Republic of Srpska, no 42/01) it belongs to the fifth class of water courses.

Alkalinity of water samples of the river Dragocaj after the Glogovac brook water mouth grows.

Ammonia value after the Glogovac brook water mouth significantly grows, which makes the subject water course to be outclassed regarding the quality.

Nitrite, nitrate, chloride, sulphate and ortho-phosphate concentration, after the Glogovac brook water mouth into the river Dragocaj significantly grow, which is caused by weak discharge of the river Dragocaj at the time of measuring and great concentration of the pollutant in the water of the brook Glogovac.

Also after the Glogovac brook water mouth into the river Dragocaj, concentration of iron and manganese is growing.

Lead and cadmium concentration, even if they are quite high in the river Dragocaj, after the Glogovac brook water mouth are not increasing, from where we can draw a conclusion that high concentration of lead and cadmium in the water of the river Dragocaj are not the consequence of the landfill, i.e. the waters from the landfill.

After the Glogovac brook water mouth there is slight increase of concentration of zinc in the water of the river Dragocaj.

Value of chemical consumption of oxygen of the river Dragocaj is increasing after the Glogovac brook water mouth, by which also increases the class of the water course in compliance with the Regulation on classification and categorization of water course (Official Gazette of Republic of Srpska, no 42/01).

Date of sampling: September 12, 2006

Table no. 22a Physical-chemical parameters of water quality

No	Method	Findings	Method code
1.	Total number of aerobic mesophilic bacteria in 1ml on 37° C	8200	BAS ISO 6222
2.	Total number of aerobic heterotrophic psychrophile bacteria in 1ml on 22° C	6500	BAS ISO 6222
3.	Total coliform bacteria	16100	BAS ISO 9308-1
4.	Total coliform bacteria of faces origin	present	BAS ISO 9308-1
5.	Sulphide-reducing Clostride	present	BAS EN 26461-2
6.	Pseudomonas aeruginosa	none	BAS EN 12780
7.	Intestine enterococcus	present	BAS ISO 7899-2
8.	Salmonella	none	ISO 6340 : 1995

Date of sampling: September 22, 2006

Table no. 23a Microbiological parameters of water quality

No	Method	Findings	Method code
1.	Total number of aerobic mesophilic bacteria in 1ml on 37° C	9000	BAS ISO 6222
2.	Total number of aerobic heterotrophic psychrophile bacteria in 1ml on 22° C	8600	BAS ISO 6222
3.	Total coliform bacteria	16100	BAS ISO 9308-1
4.	Total coliform bacteria of faces origin	present	BAS ISO 9308-1
5.	Sulphide-reducing Clostride	present	BAS EN 26461-2
6.	Pseudomonas aeruginosa	none	BAS EN 12780
7.	Intestine enterococcus	present	BAS ISO 7899-2
8.	Salmonella	none	ISO 6340 : 1995

Date of sampling: September 25, 2006

Table no. 24a Microbiological parameters of water quality

No	Method	Findings	Method code
1.	Total number of aerobic mesophilic bacteria in 1ml on 37° C	8700	BAS ISO 6222
2.	Total number of aerobic heterotrophic psychrophile bacteria in 1ml on 22° C	7900	BAS ISO 6222
3.	Total coliform bacteria	16100	BAS ISO 9308-1
4.	Total coliform bacteria of faces origin	present	BAS ISO 9308-1
5.	Sulphide-reducing Clostride	present	BAS EN 26461-2
6.	Pseudomonas aeruginosa	none	BAS EN 12780
7.	Intestine enterococcus	present	BAS ISO 7899-2
8.	Salmonella	none	ISO 6340 : 1995

Microbiological indicators of water pollution are determined in the taken water samples.

Complete water testing was performed in »Tatić« laboratory certified for water analysis, Osjecani, Doboj, and the results were synthesized and presented in the enclosed tables 22a, 23a and 24a.

Total number of aerobic mesophilic bacteria in 1ml on 37º C in the water samples taken from the river Dragocaj, after the Glogovac brook water mouth significantly grows and in the first sample amounts to 8200, in the second 9000 and in the third 8700, which classifies the subject water course, after the Glogovac brook water mouth, into the second class of water courses in compliance with the Regulation on classification and categorization of water course (Official Gazette of Republic of Srpska, no 42/01).

Total number of aerobic heterotrophic psychrophile bacteria in 1ml on 22º C in the first sample amounted to 6500, in the second 8600 and in the third the total number amounted to 7900.

Total number of coliform bacteria was constantly high in all samples and it amounted over 16000, which classifies the subject water course, before the Glogovac brook water mouth, into the third class of water courses in compliance with the Regulation on classification and categorization of water course (Official Gazette of Republic of Srpska, no 42/01).

Total number of coliform bacteria of faces origin is very high so that it was not possible to determine their exact number and therefore a conclusion was brought that they were only present.

Total number of Sulphide-reducing Clostride was very high, and therefore a conclusion was brought that they were only present.

During the microbiological analysis, it was not proved that bacteria Pseudomonas aeruginosa and Salmonella existed, while Intestine enterococcus existed, and earlier before the mouth didn't exist, so that a conclusion can be drawn that they are brought into the river Dragocaj with the water of the brook Glogovac.

Observing the results of physical-chemical and microbiological analysis of water samples taken from the river Dragocaj, after the Glogovac brook water mouth on September 12, September 22 and September 25, 2006, and comparing them to the results obtained by the sample analysis taken simultaneously from the river Dragocaj only above the mouth and to the Regulation on classification and categorization of water course (Official Gazette of Republic of Srpska, no 42/01), a conclusion can be drawn that the quality of the river Dragocaj, downstream from the mouth of the water of the brook Glogovac decreases, i.e. that the water of the brook Glogovac violates the water quality of the river Dragocaj.

2.2.6. LEVEL OF UNDERGROUND WATERS, THEIR DIRECTION AND QUALITY

Detailed aimed hydro-geological testing were carried out for the subject location in order to define the level of water tightness of the landfill basement, in order to define possible pollution of underground and surface water. The subject testing was carried out by company "INDUSTROPROJEKT" from Zagreb in 1974, and the Client was Communal Company "Čistoća" – Banja Luka, which was, at that time, a company in charge for waste collection and deposition.

Besides these investigations, there were investigations for determination of coal reserves in 1973, carried out by Institute for mining and chemical-technological research in Tuzla for the Ramići coal deposits.

These investigations determined that the underground water appears at peak elevation of 150 to 200 m in the landfill area, which is about 30 m below the landfill basement, and this eliminated the danger of possible underground water at the landfill.
The underground water direction is east – west, i.e. upper to lower part of the landfill, as well as surface courses.

2.2.7. LAND FERTILITY AND PURPOSE OF USE AND CONTENT OF HARMFUL AND WASTE COMPOUND IN LAND

In order to define the state of the soil quality in the surroundings and at the landfill itself, the authors of the Impact Study on September 13, 2006 performed the sampling of 10 soil samples from the surroundings and from the public waste disposal.

In order to define ‘’zero’’ soil state at the very landfill location, the sampling was performed by dividing the total surface into five parcels, and on each was taken a surface compound sample and a deep compound sample.

The samples were taken at the following locations:

1. Sample 1, (surface) and sample 2, (deep) on the eastern meadow, below the landfill dam,
2. Sample 3, (surface) and sample 4, (deep) on the northern meadow,
3. Sample 5, (surface) and sample 6, (deep) on the western meadow,
4. Sample 7, (surface) and sample 8, (deep) on the southern meadow,
5. Sample 9, (surface) and sample 10, (deep) on the landfill, green area behind the scale.

Sampling was performed in the following manner:

- Necessary equipment was provided: shovel, knife, pail, lead pencil, slip of papers and plastic bags;
- The remaining of plant materials, mineral fertilizer, lime material, etc. were removed;

- A hole was dug with the depth of 25 - 30 cm;

- Head-on side was levelled and across the entire depth was notched a soil layer with the depth of 2 - 5 cm;
- Notched soil layer was taken out on the working part of the shovel;

- With knife we cut off the surplus of the soil on the both sides of the working part of the shovel;

- The middle part of the soil was thrown into a pail. This quantity of the soil represents average sample;
- Total quantity of the soil in the pail was properly mixed and dirt was removed (plant material);
- From the chopped, mixed quantity we took 1-2 kg of soil (which is enough for analysis) and put it into a clean bag;

- In the described way, we walked in a zigzag line across the parcel and we took 9 more average samples of the soil from the subject location.

Picture no. 28 Sampling of soil on and in the surroundings of the Landfill in Ramići

Physical-chemical characteristics, analyses of microelements and heavy metals in the soil were determined in the taken soil samples

Complete soil testing is performed at the Agricultural Institute of Republic of Srpska, Banja Luka in the laboratory for pedology, and the results were synthesized and presented in the enclosed tables 25, 26, 27, 28, 29, 30, 31, 32, 33 and 34.

Synthesized and presented results of physical-chemical, analysis of microelements and heavy metals in the soil represent *solvency* of the soil of the subject location.

Table no. 25 Physical-chemical, analyses of microelements in the soil of the sample 1 surface, the eastern meadow, under the landfill dam

SAMPLE 1. surface		
PHYSICAL CHARACTERISTICS		
No	**Determination parameters**	**Analysis results**
1.	Particle of sand %	5,63
2.	Particle of dust %	52,41
3.	Particle of clay %	41,96
4.	Classification according to triangle Ehwald	Powdery clay
CHEMICAL ANALYSIS OF THE SOIL		
No	**Determination parameters**	**Analysis results**
5.	pH H_2O	8,3
6.	pH KCl	7,3
7.	Humus %	2,9
8.	P_2O_5 mg/100g	1,7
9.	K_2O mg/100g	10,2
ANALYSIS OF MICROELEMENTS AND HEAVY METALS IN THE SOIL		
	Determination parameters	**Analysis results**
10.	Zn mg/kg	50
11.	Cu mg/kg	36
12.	Mn mg/kg	969
13.	Pb mg/kg	18
14.	Cd mg/kg	1

Table no. 26 Physical-chemical, analyses of microelements in the soil of the sample 2 deep, the eastern meadow, under the dam of the landfill

SAMPLE 2. deep		
PHYSICAL CHARACTERISTICS		
No	**Determination parameters**	**Analysis results**
1.	Particle of sand %	2,29
2.	Particle of dust %	58,26
3.	Particle of clay %	39,45
4.	Classification according to triangle Ehwald	Powdery clay
CHEMICAL ANALYSIS OF THE SOIL		
No	**Determination parameters**	**Analysis results**
5.	pH H_2O	8,4
6.	pH KCl	7,4
7.	Humus %	2,7
8.	P_2O_5 mg/100g	1,1
9.	K_2O mg/100g	11,0
ANALYSIS OF MICROELEMENTS AND HEAVY METALS IN THE SOIL		
No	**Determination parameters**	**Analysis results**
10.	Zn mg/kg	53
11.	Cu mg/kg	38
12.	Mn mg/kg	867
13.	Pb mg/kg	23
14.	Cd mg/kg	3

Table no. 27 Physical-chemical, analyses of microelements in the soil of the sample 3 surface, the northern meadow

SAMPLE 3. surface		
PHYSICAL CHARACTERISTICS		
No	**Determination parameters**	**Analysis results**
1.	Particle of sand %	4,35
2.	Particle of dust %	46,62
3.	Particle of clay %	49,03
4.	Classification according to triangle Ehwald	Clay
CHEMICAL ANALYSIS OF THE SOIL		
No	**Determination parameters**	**Analysis results**
5.	pH H_2O	8,4
6.	pH KCl	7,9
7.	Humus %	4,4
8.	P_2O_5 mg/100g	3,7
9.	K_2O mg/100g	23,0
ANALYSIS OF MICROELEMENTS AND HEAVY METALS IN THE SOIL		
No	**Determination parameters**	**Analysis results**
10.	Zn mg/kg	75
11.	Cu mg/kg	48
12.	Mn mg/kg	215
13.	Pb mg/kg	30
14.	Cd mg/kg	1

Table no. 28 Physical-chemical, analyses of microelements and heavy elements in the soil of the sample 4 deep, the northern meadow

SAMPLE 4. deep		
PHYSICAL CHARACTERISTICS		
No	**Determination parameters**	**Analysis results**
1.	Particle of sand %	2,51
2.	Particle of dust %	44,70
3.	Particle of clay %	52,79
4.	Classification according to triangle Ehwald	Clay
CHEMICAL ANALYSIS OF THE SOIL		
No	**Determination parameters**	**Analysis results**
5.	pH H_2O	8,2
6.	pH KCl	7,2
7.	Humus %	3,1
8.	P_2O_5 mg/100g	0,3
9.	K_2O mg/100g	12,3
ANALYSIS OF MICROELEMENTS AND HEAVY METALS IN THE SOIL		
No	**Determination parameters**	**Analysis results**
10.	Zn mg/kg	78
11.	Cu mg/kg	43
12.	Mn mg/kg	1545
13.	Pb mg/kg	3
14.	Cd mg/kg	0

Table no. 29 Physical-chemical, analyses of microelements and heavy elements in the soil of the sample 5 surface, the western meadow

SAMPLE 5. surface		
PHYSICAL CHARACTERISTICS		
No	**Determination parameters**	**Analysis results**
1.	Particle of sand %	4,79
2.	Particle of dust %	52,58
3.	Particle of clay %	42,63
4.	Classification according to triangle Ehwald	Powdery clay
CHEMICAL ANALYSIS OF THE SOIL		
No	**Determination parameters**	**Analysis results**
5.	pH H_2O	8,2
6.	pH KCl	7,1
7.	Humus %	2,5
8.	P_2O_5 mg/100g	0,2
9.	K_2O mg/100g	12,5
ANALYSIS OF MICROELEMENTS AND HEAVY METALS IN THE SOIL		
No	**Determination parameters**	**Analysis results**
10.	Zn mg/kg	79
11.	Cu mg/kg	46
12.	Mn mg/kg	1385
13.	Pb mg/kg	23
14.	Cd mg/kg	2

Table no. 30 Physical-chemical, analyses of microelements and heavy elements in the soil of the sample 6 deep, the western meadow

SAMPLE 6. deep		
PHYSICAL CHARACTERISTICS		
No	**Determination parameters**	**Analysis results**
1.	Particle of sand %	3,61
2.	Particle of dust %	50,79
3.	Particle of clay %	45,60
4.	Classification according to triangle Ehwald	Clay
CHEMICAL ANALYSIS OF THE SOIL		
No	**Determination parameters**	**Analysis results**
5.	pH H_2O	8,1
6.	pH KCl	7,2
7.	Humus %	2,9
8.	P_2O_5 mg/100g	0,3
9.	K_2O mg/100g	13,9
ANALYSIS OF MICROELEMENTS AND HEAVY METALS IN THE SOIL		
No	**Determination parameters**	**Analysis results**
10.	Zn mg/kg	85
11.	Cu mg/kg	49
12.	Mn mg/kg	1655
13.	Pb mg/kg	3
14.	Cd mg/kg	0

Table no. 31 Physical-chemical, analyses of microelements and heavy elements in the soil of the sample7 surface, the southern meadow

SAMPLE 7. surface		
PHYSICAL CHARACTERISTICS		
No	**Determination parameters**	**Analysis results**
1.	Particle of sand %	2,22
2.	Particle of dust %	40,64
3.	Particle of clay %	57,14
4.	Classification according to triangle Ehwald	Clay
CHEMICAL ANALYSIS OF THE SOIL		
No	**Determination parameters**	**Analysis results**
5.	pH H_2O	8,3
6.	pH KCl	7,5
7.	Humus %	1,8
8.	P_2O_5 mg/100g	0,1
9.	K_2O mg/100g	13
ANALYSIS OF MICROELEMENTS AND HEAVY METALS IN THE SOIL		
No	**Determination parameters**	**Analysis results**
10.	Zn mg/kg	82
11.	Cu mg/kg	52
12.	Mn mg/kg	1170
13.	Pb mg/kg	0
14.	Cd mg/kg	1

Table no. 32 Physical-chemical, analyses of microelements and heavy elements in the soil of the sample 8 deep, the southern meadow

SAMPLE 8. deep		
PHYSICAL CHARACTERISTICS		
No	**Determination parameters**	**Analysis results**
1.	Particle of sand %	1,66
2.	Particle of dust %	60,35
3.	Particle of clay %	37,99
4.	Classification according to triangle Ehwald	Powdery clay
CHEMICAL ANALYSIS OF THE SOIL		
No	**Determination parameters**	**Analysis results**
5.	pH H_2O	8,2
6.	pH KCl	7,2
7.	Humus %	0,5
8.	P_2O_5 mg/100g	1,1
9.	K_2O mg/100g	9,0
ANALYSIS OF MICROELEMENTS AND HEAVY METALS IN THE SOIL		
No	**Determination parameters**	**Analysis results**
10.	Zn mg/kg	73
11.	Cu mg/kg	52
12.	Mn mg/kg	800
13.	Pb mg/kg	0
14.	Cd mg/kg	2

Table no. 33 Physical-chemical, analyses of microelements and heavy elements in the soil of the sample 9 surface, from the landfill, green area from scale

SAMPLE 9. surface		
PHYSICAL CHARACTERISTICS		
No	**Determination parameters**	**Analysis results**
1.	Particle of sand %	6,92
2.	Particle of dust %	32,66
3.	Particle of clay %	60,42
4.	Classification according to triangle Ehwald	Clay
CHEMICAL ANALYSIS OF THE SOIL		
No	**Determination parameters**	**Analysis results**
5.	pH H_2O	8,2
6.	pH KCl	7,3
7.	Humus %	1,5
8.	P_2O_5 mg/100g	0,5
9.	K_2O mg/100g	17,3
A ANALYSIS OF MICROELEMENTS AND HEAVY METALS IN THE SOIL		
No	**Determination parameters**	**Analysis results**
10.	Zn mg/kg	85
11.	Cu mg/kg	50
12.	Mn mg/kg	1885
13.	Pb mg/kg	0
14.	Cd mg/kg	5

Table no. 34 Physical-chemical, analyses of microelements and heavy elements in the soil of the sample 10 deep, from the landfill, green area from scale

SAMPLE 10. deep		
PHYSICAL CHARACTERISTICS		
No	**Determination parameters**	**Analysis results**
1.	Particle of sand %	3,25
2.	Particle of dust %	56,64
3.	Particle of clay %	40,11
4.	Classification according to triangle Ehwald	Powdery clay
CHEMICAL ANALYSIS OF THE SOIL		
No	**Determination parameters**	**Analysis results**
5.	pH H_2O	8,0
6.	pH KCl	7,1
7.	Humus %	2,1
8.	P_2O_5 mg/100g	0,3
9.	K_2O mg/100g	14,8
ANALYSIS OF MICROELEMENTS AND HEAVY METALS IN THE SOIL		
No	**Determination parameters**	**Analysis results**
10.	Zn mg/kg	79
11.	Cu mg/kg	43
12.	Mn mg/kg	1349
13.	Pb mg/kg	0
14.	Cd mg/kg	2

Bosnia and Herzegovina has no legal regulation that could be used for comparation of the analysis results of concentration values of certain harmful substances in the sampled soil.

Republic of Montenegro has passed *Book of Rules on permitted values of dangerous and harmful substances in soil and methods fop testing* (Official Gazette of R. Montenegro, no. 18/97).

According to this Book of Rules the Maximal Permitted Value (MPV) of dangerous and harmful substance in soil for:

- Cadmium, Cd amounts to 2 mg/kg of soil,
- Lead, Pb amounts to 50 mg/kg of soil,
- Zink, Zn amounts to 300 mg/kg of soil,

- Copper, Cu amounts to 100 mg/kg of soil.

Concentration of these dangerous and harmful substances in all soil samples are below Maximal Permitted Values according to the mentioned BoR, apart for samples: 2. – deep, 5. – surface, 8. – deep, 9. – surface and 10. deep in which the concentration of Cadmium, Cd, is slightly above or equal to Maximal Permitted Value (MPV).

In the subject samples, concretely speaking in soil sample 9. – surface analysis found cadmium concentration, Cd, of 5 mg/kg of soil, and maximal permitted value is 2 mg/kg of soil in accordance with the mention Book of Rules, and deep analysis on soil sample 2. revealed Cadmium concentration Cd, of 3 mg/kg of soil.

In soil samples 5. – surface, 8. – deep and 10. deep, the analysis found cadmium concentration, Cd, of 2 mg/kg of soil, and the maximal permitted value is 2 mg/kg of soil according to the mentioned Book of Rules.

According to the pedological chart of SFRJ (Section Banja Luka 2) the entire included area is placed on podzol pseudogley terraced soil (terraced brown soil placed on clay). Mechanical structure of B horizon disables flowing off of the surface water so that during the moist part of year it stagnates in the cross section of the soil. Natural draining is weak and incomplete. Chemical features of the soil are also bad. Soil reaction is acid, humus is poor and base content is low. There's deficit of phosphorus and potassium. Having in mind natural conditions and the purpose of the area it can be concluded that, first of all, due to pedosphere pollution, at the stake are extreme conditions for the development of forest vegetation.

2.3. PROJECT DESCRIPTION, INCLUDING ITS PURPOSE AND SIZE

2.3.1. DESCRIPTION OF PHYSICAL CHARACTERISTICS OF THE ENTIRE PROJECT AND LAND USE CONDITIONS IN THE COURSE OF CONSTRUCTION AND WORK OF PLANTS FORESEEN BY THE PROJECT

The existing Regional Landfill covers the area of 29 ha. Design for rehabilitation and expansion foresees expansion to 44 ha to the space bordering with the existing landfill.

According to Conceptual design for rehabilitation and expansion of the existing Landfill in Ramici made by consortium of the companies „GWCC“ Vienna, HIDROTEHNIKA Limited liability company Banja Luka and „DVOKUT PRO“ Sarajevo the following necessary operations will be performed on the existing landfill:.

1. Construction of Eastern Border dam
2. Construction of “Canyon” through old waste compartment
3. Construction of top cover at the old landfill compartment 1 of the old part of the landfill (“low reactivity compartment”)
4. Excavation and “cleaning” of compartments III.2 + IV and refilling in compartments III.1 and II
5. Use of compartment II and III.2 for intermediate phase until new landfill compartment IV is in operation
6. Closure of compartment II and III.2 (covering/cap sheet with the system for gas collection and recirculation system for seepage water)
7. Construction of new landfill compartments IV
8. Construction of storage tank for seepage water, gas incineration unit and recirculation system for seepage water
9. Extension of access and operational road system
10. Extension of entrance area, operational building and construction of storehouse for recycling material

The Landfill parts that will exist after the process of rehabilitation and expansion is finished are as follows:

- Compartment A1 at 2.8 ha,
- Compartment A2 at 2.9 ha,
- Canon K at 2.3 ha, between compartments A1 and A2,
- Compartment B1 at 3.0 ha,
- Compartment B2 at 2.8 ha,
- Compartment C at 8.5 ha,
- The landfill’s part D foreseen for storing and collection of seepage and fire fighting water,
- The landfill’s part E foreseen for seepage water treatment,
- The landfill’s part F foreseen for gas combustion,
- The landfill’s entrance zone and parking space,
- Part of EXPANSION in the first phase to 3.29 ha,
- Part of EXPANSION in the second phase to 1.78 ha,

- Part of EXPANSION foreseen for waste treatment to 0.86 ha
- Part of EXPANSION foreseen for recycling and sorting of waste to 0.45 ha.

Dislocation of all facilities and departments for stockpiling of the existing and future landfill is presented in drawing *Plan of space organization of the Ramići Landfill after rehabilitation and expansion to 44 ha* can be found in Attachments to this Study.

A new border dam will be constructed on the eastern part of the old part of the landfill – as well as on the northern and southern part of the access to the canyon. These parts of the dam will be constructed as earth dams with maximal height of about 2.0 m, inclination of 10% and length of 100 m (southern part) and 140 m (northern part).

Canyon will be constructed through the compartment A, starting from the area of the northern border all to the area for storage of seepage water, in the middle of the landfill location.

This canyon will be constructed in so called ‘’open construction’’ by digging the waste along the planned canyon, starting from the eastern border dam (about 280.000 m³). Excavated waste will be put on the existing waste in the compartment A and it will be used for the compartment molding.

During the construction of the canyon there will be performed interception of the existing spring, which is located in the vicinity. The spring will be dug (and it will be checked if there is any former interception or pipe). After locating the points where the spring is coming to the surface, an interception of the spring as well as the area of the filtering with pebbles will be constructed.

After finalizing, the spring interception will be covered with mineral cover in order to prevent seepage water to penetrate. Spring water will be discharged with gravitational pipes into the main sewer for collection of precipitation water. Connecting points will be equipped with control/measuring chamber.

In order to create area for construction of the location for expansion and in order to reduce the areas of the landfill which do not have sealed surface/floor, the waste which has already been disposed (as well as polluted soil) in the III/3 and IV will be excavated (about 250.000 m³) and disposed in the compartments B1 and B2.

Before that, compartments B1 and B2 will be prepared by the construction of new border dam and by molding of the waste. Further on, these compartments will be used for waste disposal until the construction of the first part of the area of expansion is completed.

When compartments of the landfill are ready for disposal, compartments B1 and B2 will be covered with mineral sealing system, while the well and the recirculation system of seepage water will be constructed. A mineral sealing system in accordance with EU standards CD 1999/31/EC will be constructed for the landfill’s old parts with high reactivity and it will serve as a combined sealer.

New part of the landfill will be constructed for the disposal of non dangerous public waste.

New landfill compartment C will be constructed (in the southern-western part of the existing landfill) in strongboxes, starting with the compartment I. Planned compartments (II – VII) will be developed successively around the compartment I.

Main sewer system for seepage water will secure gravitational drainage of the seepage water and supervision of the pipes for seepage water even after the landfill is closed.

The system for combustion of gas collected from the landfill and the system for seepage water treatment will be constructed under the east dam.

During the landfill expansion, the taken land will also be used during the works execution, so no additional land will be taken for this purpose. After the landfill rehabilitation and expansion this area will be used for basic landfill function – waste deposition and all auxiliary activities (waste receive, unloading, sorting, stockpiling, covering, vehicles washing,…).

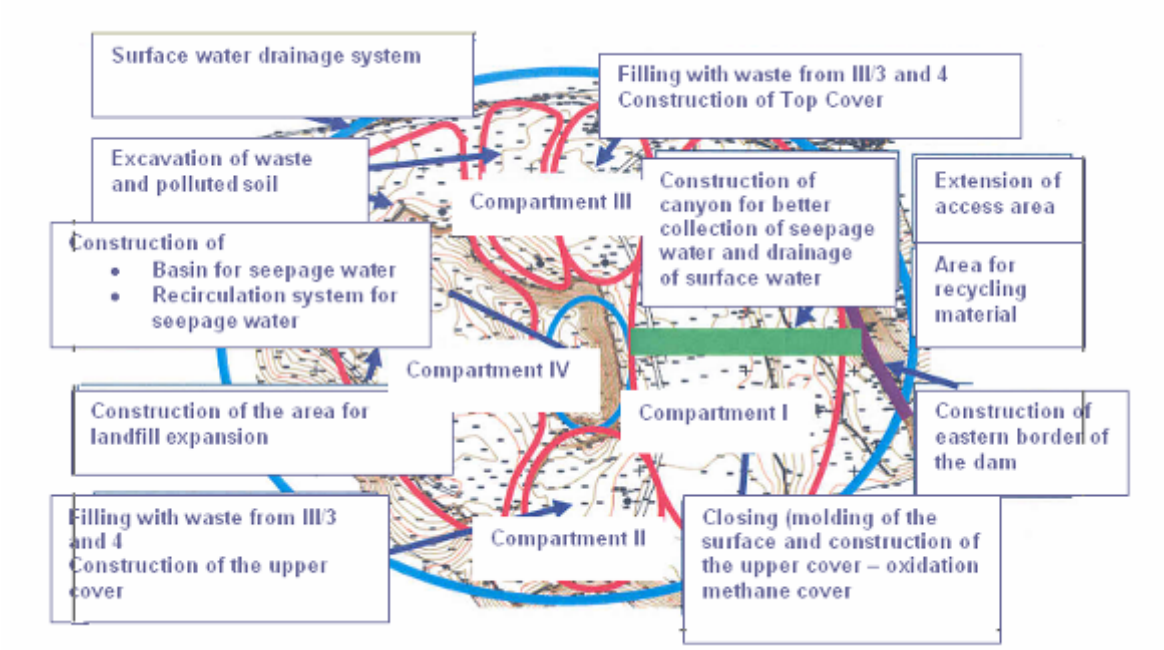
2.3.2. DESCRIPTION OF PROJECT, PLANNED PRODUCTION PROCESS, TECHNOLOGICAL AND OTHER CHARACTERISTICS

Conceptual design of rehabilitation and expansion of the existing landfill in Ramici was made by consortium of the companies „GWCC“ Vienna, HIDROTEHNIKA Limited liability company Banja Luka and „DVOKUT PRO“ Sarajevo.

According to that conceptual design the following necessary operations will be performed on the existing landfill:

1. Construction of Eastern Border dam
2. Construction of “Canyon” through old waste compartment
3. Construction of top cover at the old landfill compartment 1 of the old part of the landfill (“low reactivity compartment”)
4. Excavation and “cleaning” of compartments III.2 + IV and refilling in compartments III.1 and II
5. Use of compartment II and III.2 for intermediate phase until new landfill compartment IV is in operation
6. Closure of compartment II and III.2 (covering/cap sheet with the system for gas collection and recirculation system for seepage water)
7. Construction of new landfill compartments IV
8. Construction of storage tank for seepage water, gas incineration unit and recirculation system for seepage water
9. Extension of access and operational road system

10. Extension of entrance area, operational building and construction of storehouse for recycling material



Picture no. 29 scheme of operations which are to be performed on the already existing landfill
Source: „Conceptual design of rehabilitation and expansion of the landfill in Ramici, consortium: GWCC-Hidrotehnika-Dvokut.

2.3.2.1. Construction of eastern border dam

- A new border dam will be constructed on the eastern part of the old part of the landfill – as well as on the northern and southern part of the access to the canyon

These parts of the dam will be constructed as earthen dams with the maximum height of about 2.0 m, slope of 10 % and it will be 100 m long (southern part) and 140 m (northern part).

Behind this dam, next to the bottom of the dam, both on the northern and southern parts of the dam, will be constructed drainage system for seepage water which will collect eventual appearances of seepage waters from the old part of the landfill, as well as stop pressure of the fluids on the dam. These pipes will be connected with the chamber for collection of seepage waters from where seepage water shall be discharged into the inter-reservoir.

2.3.2.2. Construction of canyon through Compartment A

Canyon will be constructed through the compartment A, starting from the area of the northern border all to the area for storage of seepage water, in the middle

of the landfill location.

This canyon will be constructed in so called ‘’open construction’’ by digging the waste along the planned canyon, starting from the eastern border dam (about 280.000 m³). Excavated waste will be put on the existing waste in the compartment A and it will be used for the compartment molding.

Along the bottom of the canyon will be installed pumps for seepage and precipitation water, from the area for seepage water and all through to the place of discharging into the brook Glogovac, as well as to the return recirculation pipe of seepage water back to the new landfill.

2.3.2.3. Spring interception

Interception of the existing spring, which is located in the vicinity, will be performed during the construction of the canyon.

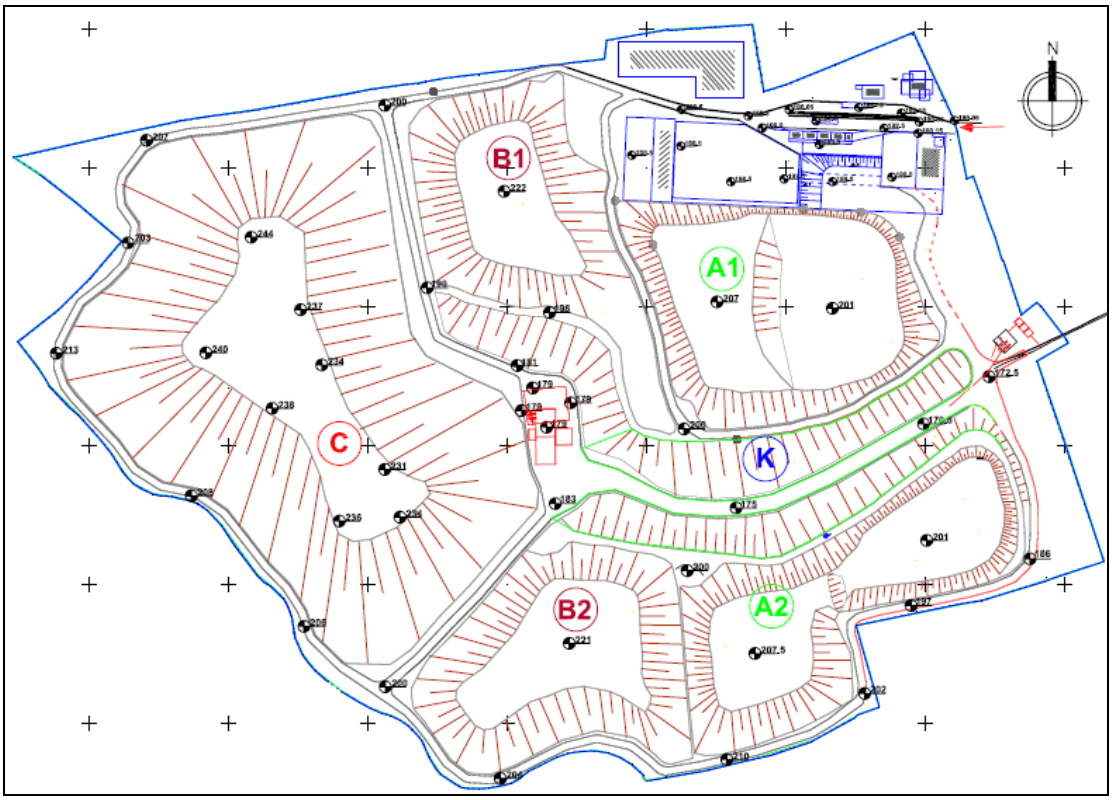
The spring will be dug (and it will be checked if there is any former interception or pipe). After locating the points where the spring is coming to the surface, an interception of the spring as well as the area of the filtering with pebbles will be constructed.

After finalizing, the spring interception will be covered with mineral cover in order to prevent seepage water to penetrate. Spring water will be discharged with gravitational pipes into the main sewer for collection of precipitation water. Connecting points will be equipped with control/measuring chamber

2.3.2.4. Excavation and cleaning of compartments III/3 and IV and refilling of compartments B1 and B2

In order to create area for construction of the location for expansion and in order to reduce the areas of the landfill which do not have sealed surface/floor, the waste which has already been disposed (as well as polluted soil) in the III/3 and IV will be excavated (about 250.000 m³) and disposed in the compartments B1 and B2.

Before that, compartments B1 and B2 will be prepared by the construction of new border dam and by molding of the waste. Further on, these compartments will be used for waste disposal until the construction of the first part of the area of expansion is completed.



Picture 30. Areas on the landfill planned for waste disposal

The excavated waste will be tested, while the dangerous substances from the waste will be separated and disposed in the appropriate plants for treatment. Storehouse for inter-disposal will be provided for such substances.

It is suggested that the transport of the waste in the compartments B1 and B2 is to be organized with the help of the stripped transport.

When compartments of the landfill are ready for disposal, compartments B1 and B2 will be covered with mineral sealing system, while the well and the recirculation system of seepage water will be constructed.

2.3.2.5. Extension area (compartment C)

New part of the landfill will be constructed for the disposal of non dangerous public waste.

New landfill compartment C will be constructed (in the southern-western part of the existing landfill) in strongboxes, starting with the compartment I. Planned compartments (II – VII) will be developed successively around the compartment I.

Compartments are further divided into 19 operating phases (with temporary covers in the phases when disposal is not performed in order to reduce production of seepage water in the area of the current disposal. Seepage water will be collected and discharged with the help of collection system.

2.3.2.5.1. Landfill adaptation concept

After excavation, the landfill base is ready for the bottom sealing system.

Following the results of the first phase of geotechnical exploration, the underground is suitable for the landfill base taking into consideration geotechnical stability and low permeability. If this material can be used as mineral sealer, then it must be tested in additional set of research, so that the Final Design could be made.

2.3.2.5.2. Main sewer

The main sewer shall have the following functions:

1. collection and drainage of the seepage water into the storage tank,
2. discharge of precipitation water from the western surrounding area and from unused parts of the landfill which are without waste,
3. discharge of precipitation from the compartments of the landfill which are still not in function.

All seepage water will be drained into closed collection pumps on the both sides of the main sewer.

Unpolluted precipitation water shall be discharged into opened trenches at the bottom of the main sewer.

Main sewer shall be equipped with aeration system which is obligatory to be used before the access of all persons who are responsible for the maintenance of the main sewer. The main sewer shall be closed on the both sides with security doors.

2.3.2.5.3. Concept of the landfill filling

Filling shall be performed only in the areas which are predicted for disposal inside the compartment C.

Size of the area for disposal during the period of the operation is limited in order to reduce the quantity of seepage water. However, this area must be quite big in order to satisfy operating demands.

Waste is compacted in such way that it makes layers of about 2 – 3 m. Inter-cover shall be placed on each 3 – 4 m.

2.3.2.5.4. Phase concept

The filling will be performed in phases.

Phase 1: Adaptation of the landfill bottom
Phase 2: Active operations of filling
Phase 3: Taking care of the inter-cover and temporary system of recirculation of seepage water on some parts of the landfill
Phase 4: Execution of the cover of the landfill with gas collection and recirculation of seepage water

2.3.2.6. Infrastructure facilities at the landfill

2.3.2.6.1. Access area

Access area will contain the following:

- Main gate,
- 2 bridges/scales,
- Administrative facility,
- Operating facility with garage and workshops,
- Facility for weight control,
- Garages and eaves for heavy mechanization,
- Facility for recycling the material,
- Gas station,
- Facility for cleaning and disinfection,
- Parking lot.

2.3.2.6.2. Internal traffic system

Internal traffic system consists of 2 operating road systems. Main operating road leads from the access area to new part of the landfill and further to the area for collection of seepage water. This road will be used for waste delivering to the new landfill part.

In addition, alternative road system shall lead:

- Around new part of the landfill,
- Across the landfill,
- From access area to the area for seepage water treatment.

These roads shall be used for the maintenance of the plant and they will be open only to be used internally by the landfill employees.

Primary operating roads will be strengthened and paved with asphalt.

Access road from the main road to the operating area of disposal area is secured by temporary internal roads. Locations of these roads will be adopted

in compliance with the location and height of the disposal area. Surface of these roads will be strengthened with pebbly material.

On the closed parts of the landfill shall be secured and present operating roads which will be used for the maintenance of the landfill. These roads shall be made as green earthen/covered roads.

2.3.2.6.3. Fence

Entire disposal area, together with the zone of reception and forwarding of the waste, is fenced with 2.0 m high metal fence.

2.3.2.6.4. Collection of precipitation water

Appearance of surface water in the area of the landfill intake shall be collected by the canal system along the border of the dam.

All collected surface waters shall be or drained through main sewers or they will drain out directly into the pipeline which goes along the canyon towards the brook Glogovac.

In the middle of the area of the landfill one precipitation canal shall be discharged into smaller fire protected basin (400 m³). Level of the water in this fire protected basin shall be constant; surplus of water will be drained towards the pipeline system which is placed along the canyon.

2.3.2.6.5. The landfill sealing system

- **Bottom sealing system**

Projected sealing system shall be constructed for the new part of the landfill in compliance with EU standards CD 1999/31/EC as combined sealing and it consists of (from the top to the bottom):

- Drainage layer 50 cm (drainage pebble 16/32) with drainage pipes DN 200,
- Cover (geotextile 1.200 g/m²),
- Plastic cover 2 mm (HDPE – thermal sealing),
- Mineral layer 3 x 25 cm (kf < 10-9 m/s),
- Layer of geotextile,
- Layer for levelling (E > 15 MN/m²).

- **Cover sealing system**

Designed cover for the landfill for

- The new part of the landfill and

- For the parts of the old part of the landfill with high reactivity will be constructed in compliance with EU standards CD 1999/31/EC as combined sealer and it consists of (from the top to the bottom):
- Upper layer of the soil 100 cm
- Layer for separation-geotextile
- Drainage layer 50 cm (pebble 2/40)
- Cover (geotextile 1.200 g/m²)•
- Plastic cover 2 mm (HDPE – thermal sealing)
- Mineral layer 2 x 25 cm (kf < 10-9 m/s)
- Layer for separation-geotextile
- Gas drainage layer 30 cm (pebble 2/40)
- Layer for levelling 50 cm
- Waste

2.3.2.6.6. The landfill gas control system

Quantity of gas from the landfill depends on several factors, and especially on:

- Quantity of waste,
- Waste quality,
- Age of waste,
- Water management,
- temperature (atmosphere, waste),
- air inflow,
- chemical and microbiological conditions on the body of the landfill having the influence on the biological degradations.

Main characteristic of all systems for gas collection is to produce under-pressure which is distributed inside the landfill and which attracts entire gas from the landfill into the pipeline.

Projected system for gas collection consists of net of vertical wells for gas release and horizontal pipes for gas drainage, connected with horizontal pipes which collect produced gas and conduct it into gas burner.

Plant for gas treatment contains collection units with condensation eliminator and gas burner.

There is automatic system of control which secures that all technical and environmental standards are fulfilled.

2.3.2.6.7. Precipitation water collection system

Technical solutions which are used for seepage water management must fulfil several goals, including:

- Decrease of quantity of seepage water which is to be processed,
- Optimal quantity of humidity for chemical reaction in the landfill in order to produce enough and equal quantity of landfill gas,
- Prevention of environment pollution.

System of collection of seepage water starts with the system of the landfill bottom sealing, which will prevent penetration into natural underground under the landfill, further on into underground waters.

Seepage water, which flows through disposed waste, will be collected on the bottom of the landfill with drainage layer – pebble 16/32, d = 50 cm – and it will be drained with drainage pipe DN 200 with the distance of about 50 m and with the slope of 2,5 % through pipes for seepage, into the main sewer.

Pipeline for seepage water collection is discharged into the basin for seepage water storage.

Necessary quantity of the storehouse will be placed between two separate basins (with the size of 2.000 m³), in compliance with management, maintenance and checking of the activity of the plant.

Seepage water from the storehouse will be recirculated back to the landfill by using pumps and pipeline under pressure. For connecting the distributive system will be secured special hydrant.

Old part of the landfill will be equipped with partial system of seepage water collection (as long as it is technically feasible).

In all phases of construction/management, treated effluents will be discharged into potential water of the brook Glogovac.
Concentrate will be recirculated. Plant for treatment will be located on the eastern part of the location near the brook of Glogovac.

2.3.2.6.8. Recirculation of seepage water

Recirculation of seepage water helps to reduce cost price of the seepage water treatment, to equalize gas production from the landfill and to decrease pollution on a long term basis. In essence, the landfill is transformed into active in-site bioreactor where the values of anaerobic microbes are high, speeding up the process of seepage water processing as well as the process of organic stabilization on the very landfill.

Advantages:

- Waste stabilization
- Increase of gas production
- Decrease of disposal price
- Speeding up the waste settling.

Seepage water is pumped from the storehouse basin to the discharge points and/or horizontal injection wells.

On this area where the surface of the landfill is sealed with interlayer, seepage water can be directed by the seepage holes into waste (2 x 2 x 3 m, filling with rough concrete leftovers) by using flexible system of pumps from the point of discharge in order to fill these holes properly with seepage water.

In the area where sealing cover of the landfill is placed, distribution of seepage water is performed by underground irrigation system. Irrigation plums are placed into pebble layer under the sealing cover and injection plums start from injection wells.

2.3.2.6.9. Seepage water treatment

By the estimate, quantity of seepage water, which appears on the old part of the landfill, ranges on the average about 15 m³/day, while for the new part of the landfill it is predicted that the quantity would be ranging between 14 and 150 m³/day.

Real quality of seepage water after revitalization and reconstruction can not be estimated at the moment (especially after separation of precipitation water from spring water).

Due to that, the decision on treatment solution has to take into consideration high flexibility in treatment quantity as well as in qualitative capacity of the treatment.

Taking into consideration the requested standards for seepage water for discharge into the brook Glogovac, the following phases of plant construction were suggested for seepage water treatment:

Pilot phase: two-step reserve osmosis (construction of container) including anti-scaling dosage and acid dosage or other technology/process of seepage water processing, which satisfies the Regulation on the condition of discharge of water into surface waters, Official Gazette of Republic of Srpska 44/01).

In all phases of construction/management, treated effluent will de discharged into reception water of the brook Glogovac. Concentrate will be recirculating. Plant for treatment will be located on the eastern side of the location near the brook Glogovac.

2.3.3. SUMMARY OF TYPES AND AMOUNTS OF REQUIRED ENERGY, WATER, RAW MATERIAL FOR CONSTRUCTION ETC.

The most used energy for the landfill rehabilitation and expansion will be diesel fuel as it is necessary for operation of construction mechanization (dredges, payloaders, trucks, compacters). The amounts of used fuel will depend on the site organization and construction mechanization order. The used mechanization has to be technically in function and adapted to European standards, EURO, for internal combustion engines.

Another important emergent used in the course of the landfill rehabilitation and expansion will be electric power. Consumption of electric power will be quite low, because it will be used only to start belt conveyor during transportation of excavated waste to the new landfill, to start water pump for vehicles washing, to start fuel pump and for illumination.

In the course of regular landfill exploitation, electric power will be more used to start waste water treatment system, waste water recirculation system and landfill watering, to start landfill gas exhausting system, to start water pump for vehicles washing, fuel pump and illumination.

Water will not be used for the landfill rehabilitation and expansion process, apart for periodical washing of construction mechanization. In the course of the landfill regular exploitation, water will be used as sanitary water, for the landfill watering and for vehicles washing. The water used for the landfill watering will be waste recirculation precipitation water from the landfill bottom and therefore there will not be need to take any fresh water for this purpose whatsoever. Treated waste water will be used for washing of vehicles and the landfill manipulating area and therefore there will not be need to take any fresh water. Water for sanitary – hygienic needs will be used from the town water supply system.

Many raw materials will be used during the landfill rehabilitation and expansion, and the most important that will be used as structural elements are as follows:

- Earth, required for construction of earth dam with maximal height of 2.0 m, inclination of 10 % and length of 100 m (southern part) and 140m (northern part);
- Gravel 16/32, d = 50 cm required for drainage layer and drainage pipes DN 200 for collection system for precipitation waste water and transmission to the main sewer;
- Pipes for seepage and precipitation water, from seepage storage area for seepage water treatment plant and discharge location into the Glogovac Brook, as well as to recirculation line of seepage water back to the new landfill;
- Material required for construction of the landfill bottom sealing system that consists of the following elements:

- Cover (geotextile 1.200 g/m²),
- Plastic cover 2 mm (HDPE – thermal sealing),
- Mineral layer 3 x 25 cm (kf < 10-9 m/s),
- Geotextile layer,
- Layer for levelling (E > 15 MN/m²).

- Material required for construction of the landfill cover sealing system that consists of the following elements:
  - Upper layer of soil 100 cm
  - Layer for separation-geotextile
  - Drainage layer 50 cm (pebble 2/40)
  - Cover (geotextile 1.200 g/m²)•
  - Plastic cover 2 mm (HDPE – thermal sealing)
  - Mineral layer 2 x 25 cm (kf < 10-9 m/s)
  - Layer for separation-geotextile
  - Gas drainage layer 30 cm (pebble 2/40)
  - Layer for levelling 50 cm

- Material and equipment required for construction of the landfill degassing system and landfill gas combustion;
- Concrete required for construction of collection tanks for waste water and construction of other required auxiliary facilities on the landfill:

  - 1 bridge/scale,
  - Administrative facility,
  - Operating facility with garage and workshops,
  - Garages and eaves for heavy mechanization,
  - Facility for material recycling.

2.3.4. SUMMARY OF TYPES AND AMOUNTS OF EXHAUSTED GASES, WATER AND OTHER LIQUID AND GASEOUS WASTE MATERIALS

During the old landfill rehabilitation, old deposited waste will be excavated and transferred to the other part of the landfill. In this process we are expecting emissions of big amount of landfill gasses (methane, complex carbon-hydrogen, mercaptanes, other sulphur compounds, suspended particles) and emission of internal combustion engines products coming from heavy construction mechanization.

Emission of heat into the environment will happen during excavation of deposited waste. The heat origins from began process of deposited waste composition.

Uncontrolled emissions of waste water during the old landfill rehabilitation are possible only before excavation of improperly tapped Jazovac spring, which is located in the landfill body. When the spring is tapped and channelled into the Glogovac Brook, there will not be any waste water emission apart from seepage

water from the old landfill parts and when the collection system is built this water will be channelled into a closed tank and be used for the landfill watering or will go to the water treatment plant.

Fuel and lubricants could leak from the construction mechanization used in the process of the landfill rehabilitation. This has to be prevented by proper handling of construction mechanization, use of technically functioning machines, refuelling only in areas foreseen for that (the landfill pump station).

In the process of the Ramići Regional Landfill rehabilitation and expansion there will not be any ionizing or non-ionizing radiation.

2.3.5. IDENTIFICATION OF TYPES AND ASSESSMENT OF AMOUNTS OF POSSIBLE WASTE, PRESENTATION OF TREATMENT TECHNOLOGY (PROCESSING, RECYCLING, DEPOSITINON) OF ALL KINDS OF WASTE SUBSTANCES

In the process of the landfill rehabilitation previously deposited waste will be excavated. During this process monitoring of the excavated waste will be organized in case that dangerous waste appears which would be separated to a place dedicated for this purpose. This possible separated dangerous waste would be treated in accordance with special program (it would be sent to refining or destruction in facilities specialized for this purpose in the country or abroad). The amounts of this kind of waste can not be predicted at all, as in the past there were no records on types and amounts of the deposited waste.

During the rehabilitation, all excavated waste (undangerous) will be deposited at the existing landfill parts, additionally organized for this purpose, amount of about 250.000 m^3. After the excavation of all waste from the landfill parts, the ground where this waste was deposited will be tested and depending on the pollution depth, this ground layer will be removed and deposited with the excavated waste at the existing landfill.

Some small amounts of construction waste could appear during the construction works execution on rehabilitation and construction of new parts of the landfill. By proper calculations, appropriate works execution and responsible handling of construction material these amounts would be brought to minimum and in that case it could be again used as construction material.

In the course of the landfill normal work it is expected to start the process of waste selection and secondary raw material separation, which would be purchased by companies registered for trade and processing of secondary raw material. There is space on the landfill defined for construction of the facility for waste selection and recycling yards for temporary deposition of selected secondary raw material. The waste that wouldn't be used as secondary raw material will be deposited in departments constructed in the compartment C of the rehabilitated and expanded new landfill.

2.4. DESCRIPTION OF POSSIBLE PROJECT IMPACTS TO LIVING ENVIRONMENT

Basic natural elements quality degradation can be created as a result of natural or anthropogenic processes. The specific location with all its natural elements is under anthropogenic degradation which lasts for long time period of time, thus presently has a cumulative character.

The existing degradation is reflected mainly through:

1. Water (surface and underground) pollution,
2. Accumulation of solid waste,
3. Atmosphere pollution,
4. Noise appearance etc.

Area defined by this plan was used as a waste landfill in previous period, but even though it was planned as sanitary landfill, the waste was not disposed in sanitary way.

Rehabilitation, expansion and exploitation of specific landfill in determined situations can, regardless of all technical-technological solutions, namely working operations and equipment usage, present hazard for workers also as source of living environment pollution. The success of each solution in the working and living environment protection area implies versatile consideration and definition of all possible impacts.

Living environment impact during rehabilitation and expansion of existing landfill in Ramići can be expected in two phases:

- Living environment impacts which will occur during the phase of works on the old part rehabilitation and construction of landfill enlargement area and
- Living environment impacts which will occur during landfill exploitation phase.

The most significant living environment impacts of rehabilitation works on the existing waste landfill are the impacts that can occur as a result of location preparation, as well as works during rehabilitation and landfill expansion process, namely realization of works per phases.

2.4.1. WATER QUALITY IMPACTS

Releasing of waste ingredients from landfills into environment is a very complex process which significantly differs for different substances, and depends on waste composition and its decomposition phase. It is known that waste landfills even to hundred years of age can release determined harmful substances to the environment. Filtrated water is created when precipitations fall to open disposed waste body and passing through the waste they dissolve soluble waste components. Disposed waste composition directly conditions type and level of filtered water pollution.

Present impact of „Ramići“ waste landfill to water quality is a result of different harmful substances release from the waste and creation of polluted filtered waters, which come in contact with Jazovac well waters, respectively with surface waters of Glogovac stream and underground (underground waters). Proposed collection and drainage system of precipitation and leachate water from landfill body is partially done, but not adequately maintained. At the location, as a result, neither gravity neither drainage system is functioning. Due to that filtered waters from waste landfill are extremely polluted (ammonia, organic substance, oil and grease, sulphides, total nitrogen, heavy metals, microbiological indicators). Filtered waters which form two shallow “lakes” in landfill “depression” are extremely polluted, as well as waters which flow out under the dam by outgoing pipe of 600 mm diameter. Waters are filtered through the dam on more locations, and are also polluted. They significantly contribute to total pollution load expressed through PE (population equivalent), of the stream formed out of outcoming waters from the pipe and other filtered waters (the stream has 20-30 % bigger pollution load than the out coming pipe). All waters are extremely microbiologically polluted, significantly more than it is normal for sewage waters. High pathogenic micro organisms’ concentrations are present in filtered waters. Downstream from the landfill the stream is a watercourse out of category according to all criteria and presents hazard for human and animal health downstream from the landfill. The hazard is significantly bigger if there are water supply objects – wells downstream of the landfill or the agricultural area irrigation is being done and the waters is drank by cattle.

Because of that reason the collected filtered waters from bottom sealing system of the new surface will be drained by special drainage network to filtered waters collection pool and be brought back by filtered waters recirculation system to disposed waste – surface in work (about 25% of treated filtered water). If throughout the year there is an amount which can not be brought back to the landfill it will be stored in mobile units for filtered waters treatment (75% of the water) and drained downstream of the landfill body in receiving pit where it will be treated in treatment plant by the reverse osmosis system up to purity level which is in concordance with the standards for outflow in the river and only after positive quality analysis those waters will be let into Glogovac stream.

Precipitation waters from arranged surfaces (areas for vehicle washing and disinfection and asphalted surfaces (parking and manipulative surfaces)) will not be in contact with any other waste type. From mentioned surfaces it will be collected in the precipitation drainage canals and let into the recipient.

Polluted water from the vehicle cleaning and disinfection area and asphalted surfaces (parking and manipulative surfaces) will be treated on the oil and grease separator – sedimentation tank and be re-used for tire cleaning or green areas watering and the rest will be let into the recipient.

By rehabilitation preliminary design it is planned to accept gravity surface waters as well as Jazovac well waters and bring them outside of the landfill with closed collector which will prevent their pollution from landfill infiltrates.

Absence of maintenance and regular emptying and cleaning of the impermeable septic tank content can cause negative water impact.

2.4.2. AIR QUALITY IMPCTS

Landfill air quality impact depends on numerous factors. Basic factors are meteorological circumstances, especially air temperature, pressure, relative air humidity, precipitation types and amount and wind direction and speed. Waste content and landfill age is also very important, as well as correct application of the technology predicted for waste management.

Air impact has different causes:

- Impact from landfill gases,
- Impact of emission gases and flying particles from mechanization at the landfill and transport,
- Impact of air pollution by flying particles from the landfill.

2.4.2.1. Gases impacts

2.4.2.1.1. Landfill gases impacts

Gases which release from disposed waste, product of aerobic and anaerobic organic substance decomposition are mainly carbon dioxide (CO_2) and methane (CH_4), while there are hydrogen sulphide (H_2S), ammonia (NH_3), nitrogen (N_2), various aldehides, mercaptanes, gas lower hydrocarbons, and hexane, heptanes, octane and other in smaller amounts. Theoretically, the composition of landfill gas is methane (CH_4) 45-55%, carbon dioxide (CO_2) 40-45% and other gases 10%. Quantity of gases which are created is in direct connection with waste decomposition level, and the quantity that can be collected depends on the way of landfill sealing and applied system for gas pulling.

The biggest carbon dioxide amount is created at the landfill by biochemical processes during aerobic phase, while passing to anaerobic conditions its amount reduces considerably. Carbon dioxide is heavier than air and falls to the landfill bottom, where it is dissolved in the water, and increases corrosion and acidity of filtered water. As well as methane, carbon dioxide in plant root area can cause plant mortality due to oxygen decrease.

By biochemical processes which happen in anaerobic conditions in landfill body methane is created with help of methanogenic bacteria, even 20 years after organic waste disposal cease. Methane is a gas which can be inflamed, and even explosive in determined ratio with air. It is easier than air and that is why it migrates easily. Its movement within landfill body depends on pressure and diffusion to the surrounding area. Only 5 – 15 % of the methane makes an explosive mixture with air, so it is important to apply all measures of preventing explosion and fire possibility at the landfills. Methane amount in determined plant root zone results with their mortality due to oxygen lack. That kind of impact can be created after reclamation of covering layer, if landfill gas pulling was not made well. Apart from that, the methane emission can transform into

positive impact as well, namely energy resource, if sufficient amount is freed and burnt on the flare.

Both carbon dioxide and methane belong to greenhouse gases which enter the atmosphere as a result of human operations (anthropogenic greenhouse gases). Time necessary to exit the atmosphere is 200-450 years for carbon dioxide and global warming effects is defined as 1, while methane needs 12-15 years to exit the atmosphere, and for the global warming effect is defined as 22, namely is 22 times more hazardous than carbon dioxide. Data of other greenhouse gases is given for the comparison. Nitric dioxide needs 120 years to exit the atmosphere, and global warming effect is defined as 310, CFC-12 Freon type needs 2 years to exit the atmosphere and global warming effect is defined between 6200 and 7100 and to HCFC-22 type chlorofluorocarbon needs 121 years to exit the atmosphere, and global warming effect is defined between 1300 and 1400.

As a result of waste organic parts anaerobic decomposition is a release of unpleasant odours. Namely, sulphur conjunctions (from organic component) are converting to sulphides (S^{2-}) which form hydrogen sulphide (H_2S) in combination with hydrogen. It is a carrier of unpleasant odours (rotten eggs smell) and can be noted at the distance up to 400 m from the landfill. Unpleasant landfill odours carriers are also various aldehides, mercaptanes and others.

Disposed waste is mainly inertized, but it is to be expected that waste will be disposed with determined biological component portion which will cause further creation of big landfill gases amounts during landfill functioning continuation. It is planned to construct the well for gas pulling during landfill construction, by which both well capture and gas pulling from individual landfill layers will be achieved.

Gas emission calculation from communal waste landfill

Gas emission calculation from communal waste landfill is made in concordance with recommendations of EPA (www.epa.gov/ttn/chief/ap42/ch2/final/c02s04.pdf). Calculation results are presented in table 35.

Input data for emission calculation:

- Disposal begun 30 years ago.
- Waste is still being disposed.
- Yearly average precipitation amount is 1054,1 L/m^2 .
- Waste amount being disposed is 81000 tons per year.
- In one year per 1 ton of waste, 91 m^3 of methane is created.
- Methane takes part with 55 vol. % in waste landfill gas composition.
- CO_2 takes part with 40 vol. % in waste landfill gas composition.
- Gas temperature at the landfill is 25 °C.

Table 35. Calculated gas amount which will be created at the landfill during one year

Pollutant name	Quantity, m^3/year
Methane	5150621
Carbon dioxide	3745906
Nitrogen	468238
Acetone	65,7
Carbon monoxide	1321,8
Ethan	8333,6
Ethanol	255,0
Ethyl benzene	43,2
Hydrogen Sulphide	332,8
Xylene	113,4
2-propanol (isopropyl alcohol)	469,6
Methyl mercaptane	23,3
Ethyl mercaptane	21,4

Table. 36. Calculated yearly methane amounts which will be created at the waste landfill „Ramići“ during next 20 years

Year	Methane amount, m^3
2006	5150621
2007	5237675
2008	5321315
2009	5401676
2010	5478887
2011	5553070
2012	5624345
2013	5692825
2014	5758621
2015	5821836
2016	5882574
2017	5940930
2018	5996998
2019	6050868
2020	6102626
2021	6152354
2022	6200133
2023	6246039
2024	6290145
2025	6332522

On the basis of predicted waste disposal solutions, further management technology and meteorological circumstances existing at the landfill area it can be presumed that a more intensive landfill odour will be felt only right next to the working space of waste disposal. Taking into account the wind rose, landscape attributes and technology application, the possibility that the unpleasant odours reach close settlements – Ramići village, is very small.

2.4.2.1.2. Impact of emission gases and suspended particles of the landfill mechanization and transport

According to the expected waste amounts which will be over 6750 tons per month, namely app. 360 transport vehicles per month. During intensified traffic and trucks and other transport vehicles work air pollution can occur by emission gases and dust.

Daily waste amount brought to the landfill is 250 t (maximally 300 tons in spring town-cleaning period) which responds to carriage of 75 trucks per day in one direction (150 trucks in both directions).

The emissions of gases, dust for internal and external truck transport and mechanization have been calculated at the landfill and close to landfill using EPA emission tables (EPA 42.; section 11.9 and ALOHA program (25 and 27).

Input data for emissions calculations:
Vehicles number per day in both directions: 30
Road length at the landfill: 2 km
Fuel consumption: 35 l/100 km
Number of days: 310

Table. 37 Emission of gas and truck motor harmful substances calculation

Pollutant name	Emission factor (kg/l)	Emission amount, (kg/day)	Total emission amount (kg/year)
NOx	0,04597	9,6537	2990
SO2	0,00046	0,0966	30
Total suspended particles	0,00092	0,1932	60
CO	0,01202	2,5242	780
CO2	2,740	575,4	178370
HC	0,00149	0,3129	100

**the sulphur content is implied to 0,03 % in diesel*

Input data for emissions calculations:
Mechanization number: 6
Path length at the landfill: 0,5 km
Fuel consumption: 45 l/100 km
Number of days: 310

Table. 38 Calculation of emission of gas and harmful substances created due to the work of 6 working machines (3 diggers and 3 loaders)

Pollutant name	Emission factor (kg/l)	Emission amount, (kg/day)	Total emission amount (kg/year)
NOx	0,04597	0,0620595	19
SO2	0,00046	0,000621	0
Total suspended particles	0,00092	0,001242	0
CO	0,01202	0,016227	5
CO2	2,740	3,699	1147
HC	0,00149	0,0020115	1

**the sulphur content is implied to 0,03 % in diesel*

Calculation of emission of gas and dust from M4 Banja Luka – Prijedor main road was made in table 39 only for comparison. This road is situated at the distance of app. 150 m from Ramići landfill.

Table. 39 Calculation of emission of gas and dust from M4 Banja Luka – Prijedor highway.

Vehicle number per day in one direction: 10000
Highway length: 48 km
Average fuel consumption: 15 l/100 km
Number of days: 365

Pollutant name	Emission factor (kg/l)	Estimated emission (kg/day)	Emission amount EM, (kg)
NOx	0,04597	3309,84	1208092
SO2	0,00046	33,12	12089
Total suspended particles	0,00092	66,24	24178
CO	0,01202	865,44	315886
CO2	2,740	197280	72007200
HC	0,00149	107,28	39157

**the sulphur content is implied to 0,03 % in diesel*

Comment
According to calculations, emission of gas and dust created due to the work of transport means and mechanization **does not have significant impact to air pollution**. **Much more significant impact will have M4 Banja Luka – Prijedor main road** to air pollution by emission gases.

2.4.2.2. Suspended particles impact

In conditions of dry and warm weather (during the summer) and during windy weather, air pollution by flying particles (dust) is possible due to trucks movement and mechanization work at the landfill, respectively due to dust drift from big landfill area.

2.4.2.2.1. Dust emission calculation from unpaved roads

Calculation of dust emission from unpaved roads is made in concordance to the recommendations of EPA : (www.epa.gov/ttn/chief/ap42/ch13/final/c13s0202.pdf). The calculation has been made for the cases without rain (**table 40**) and with rain (precipitation higher than 0,254 mm, 157,5 days of the year, **table 41**).

Input data for dust emission calculation:

- Average vehicle mass: 15 tons
- Dust at the road surface (silt loading): 6,4 g/m^2
- Number of days per year with precipitation: 157,5
- Average vehicle speed: 30 km/h
- Humidity content in road layer: 2%

Table 40 Calculation of dust emission from unpaved roads, without rain

Flying particle size	Dust emission, g/km passed of a vehicle
< 2,5 μm	75,9728
< 10 μm	495,4749
< 30 μm	1.835,3833

Table 41 Calculation of dust emission from unpaved roads, with rain

Flying particle size	Dust emission, g/km passed of a vehicle
< 2.5 μm	44.7511
< 10 μm	291.8551
< 30 μm	1081.1162

Comment
According to the calculation of dust emission from unpaved roads (with and without rain) due to mechanization work at the landfill, minimal mechanization at the landfill **does not have significant impact to air pollution.**

2.4.2.2.2. Calculation of dust emission from opened areas

The most significant dust impact to the air of the existing waste landfill rehabilitation works are impacts which can occur as a result of location preparation, as well as works during rehabilitation and landfill expansion process itself, respectively realization of the works per phases when the dust elevation from the area of app. 15 ha is possible.

Calculations of dust from open areas during rehabilitation and exploitation are specially made in continuation.

Calculation of dust emission from open areas during rehabilitation

Calculation of dust emission from open areas only during the rehabilitation was made in concordance with recommendations of EPA (www.epa.gov/ttn/chief/ap42/ch13/final/c13s02-5.pdf).

The calculation regards the area of 150000 m^2.
The area is uniformly covered with material (NO bevel form).

Distance from emission resource: 500 m
Source and location height above sea level difference (res.-loc.): 0 m
Distance from the axis: 0 m
Sedimentation speed: 0,1 cm/s
Outflow height: 0 m

Atmosphere types (after Pasquill) are characterized by temperature gradients. Those are expressed by temperature changes (dT) per height (dz) on 100 meters of height difference.

A atmosphere type: dT/dz < -1.9
B atmosphere type: -1.9 < dT/dz < -1.7
C atmosphere type: -1.7 < dT/dz < -1.5
D atmosphere type: -1.5 < dT/dz < -0.5
E atmosphere type: -0.5 < dT/dz < 1.5
F atmosphere type: 1.5 < dT/dz < 4.0
G atmosphere type: 4.0 < dT/dz

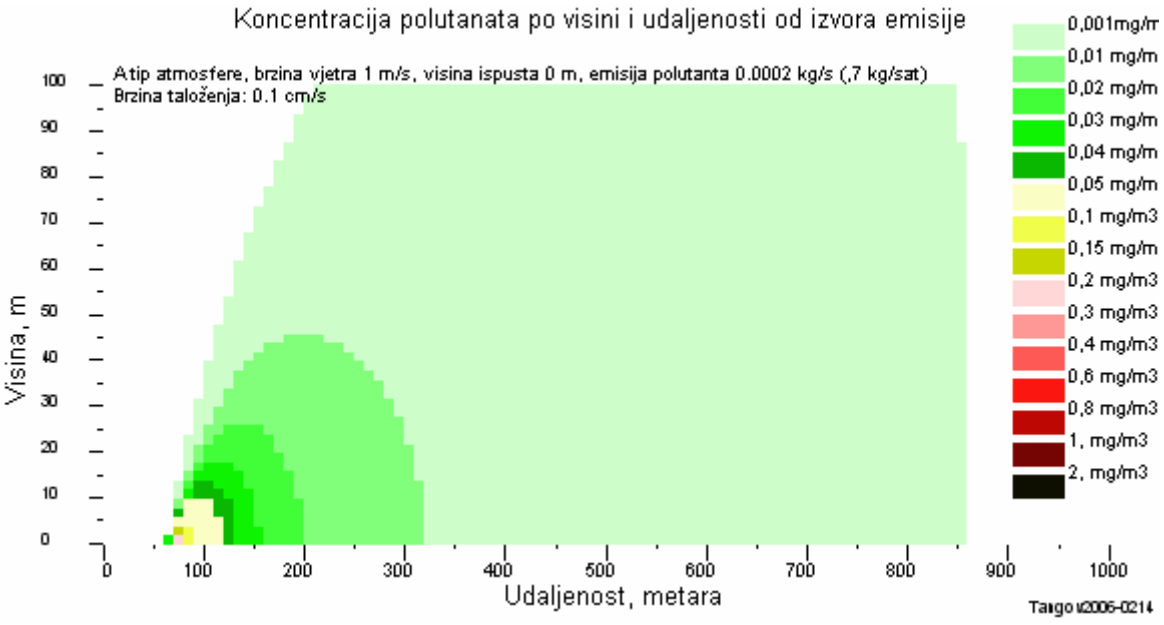
Pollutant concentration in the air

Wind speed	0.5	1	2	3	5	10	(m/s)
A atmosphere type	9	4	2	1	0	0	(ug/m3)
B atmosphere type	30	15	7	5	3	1	(ug/m3)
C atmosphere type	49	25	12	8	5	2	(ug/m3)
D atmosphere type	114	58	29	19	11	5	(ug/m3)
E atmosphere type	224	114	57	38	23	11	(ug/m3)
F atmosphere type	664	348	178	120	72	36	(ug/m3)

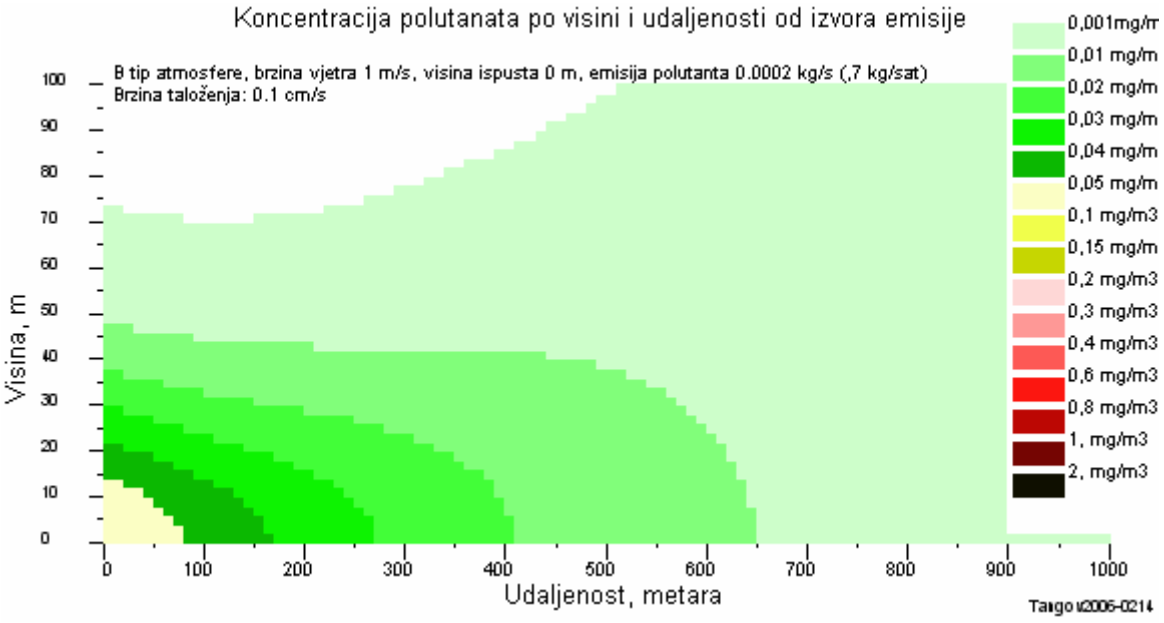
Pollutant concentration in the sediment

Wind speed	0.5	1	2	3	5	10	(m/s)
A atmosphere type	0	0	0	0	0	0	(mg/m2/dn)
B atmosphere type	0	0	0	0	0	0	(mg/m2/dn)
C atmosphere type	1	0	0	0	0	0	(mg/m2/dn)
D atmosphere type	3	1	0	0	0	0	(mg/m2/dn)
E atmosphere type	6	3	1	1	0	0	(mg/m2/dn)
F atmosphere type	19	10	5	3	2	1	(mg/m2/dn)

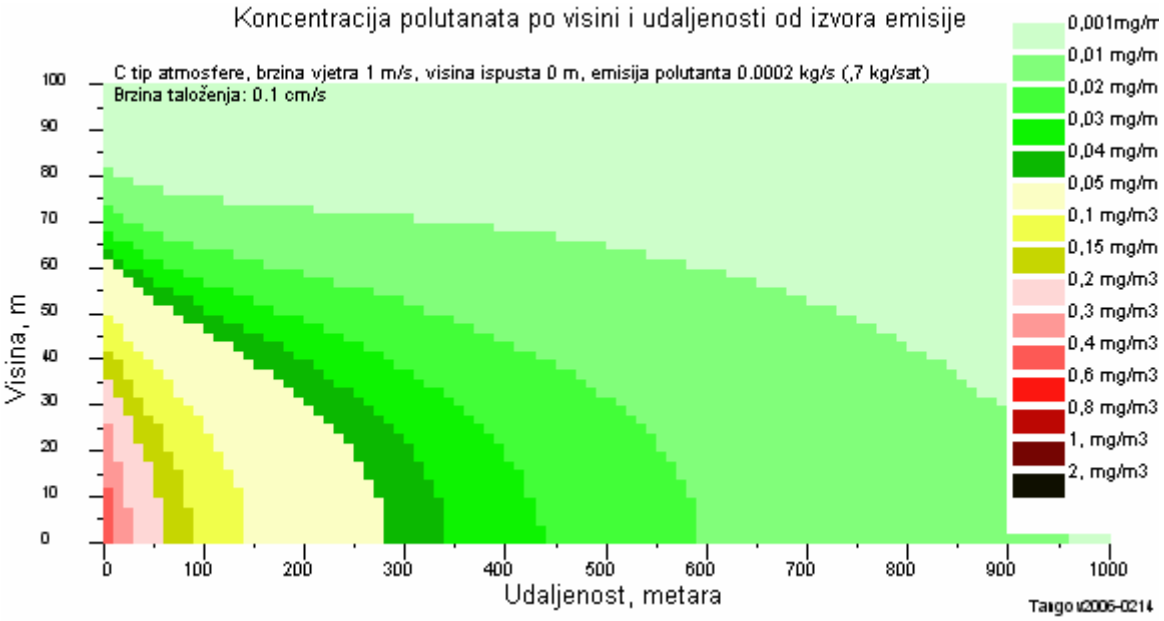
Remark:
The calculation is made presuming that during monitored 24 hours the wind will blow from pollutant source direction for 4 hours, and during that time the dust emission from the source will be 0,7 kg/hour.



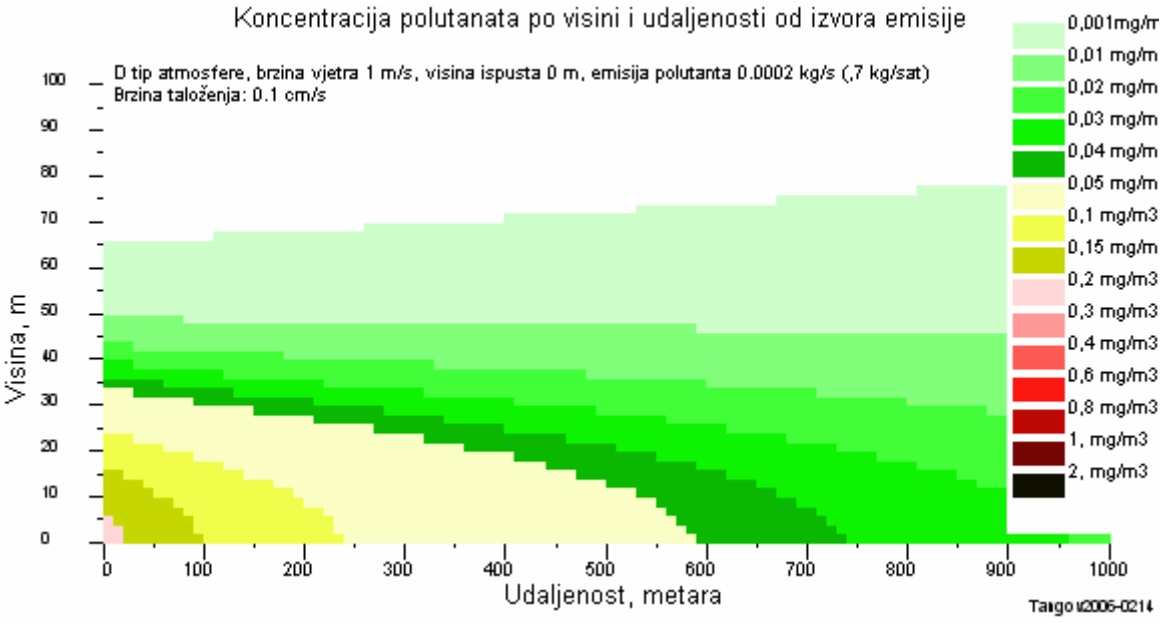
Picture no. 31 Pollutant concentration per height and distance from emission source, A atmosphere type



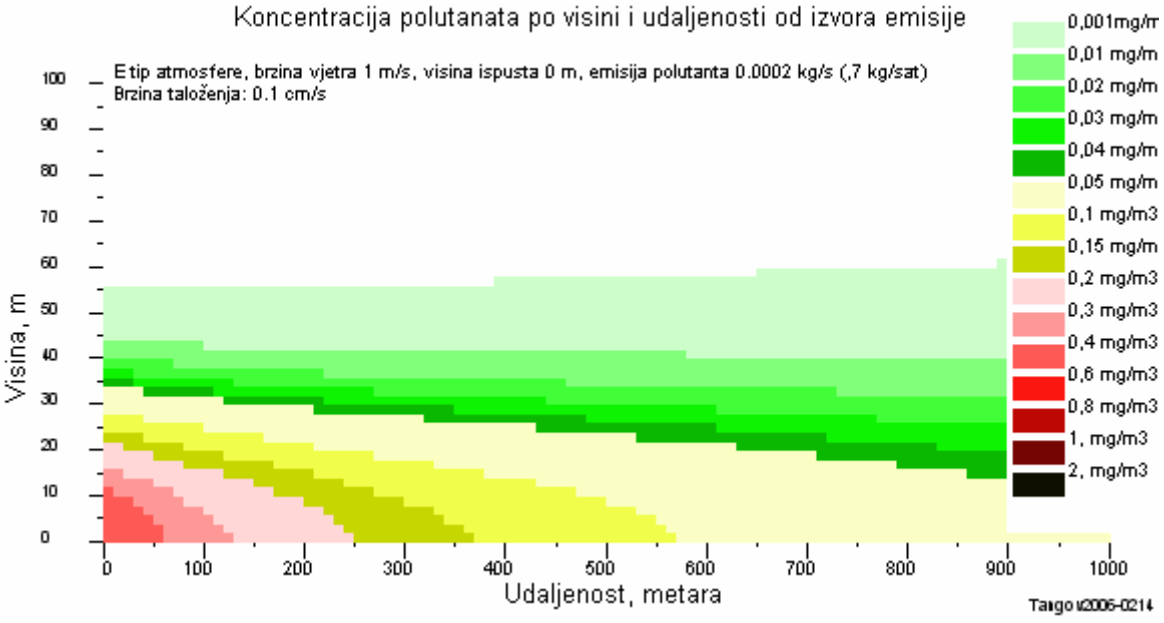
Picture 32 Pollutant concentration per height and distance from emission source, B atmosphere type



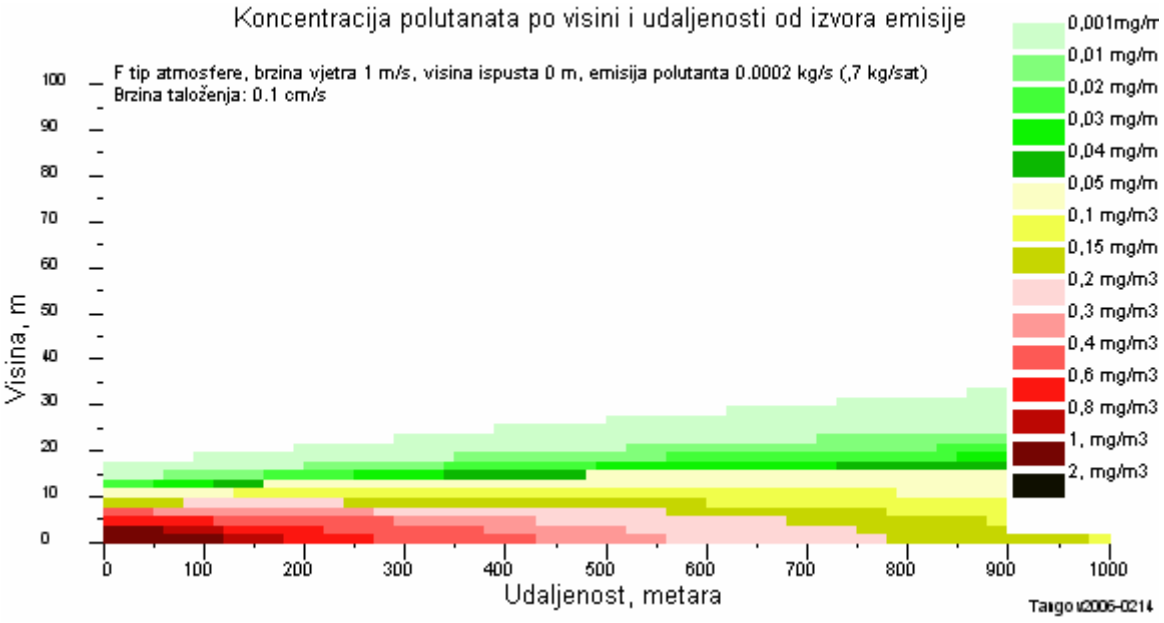
Picture no. 33 Pollutant concentration per height and distance from emission source, C atmosphere type



Picture no. 34 Pollutant concentration per height and distance from emission source, D atmosphere type



Picture no. 35 Pollutant concentration per height and distance from emission source, E atmosphere type



Picture no. 36 Pollutant concentration per height and distance from emission source, F atmosphere type

Calculated dust concentration which will be created during existing landfill rehabilitation (along with protection measures application) will be under average year values in concordance with Regulations on limit values of air quality (Official Gazette of Republic of Srpska, No. 39/05).

2.4.2.2.3. Calculation of dust concentration from open areas during exploitation

After finishing the rehabilitation dust emission will be multiply reduced because the open landfill area will be reduced so the dust emission will be possible only from sanitary (new) disposal area (area of app. 8,5 ha) and only from the segment which will momentary be filled by waste – area of app. 1-2 ha. A special dust emission calculation will not be made for this because it is predicted that the waste is regularly poured with inert material after working hours.

Calculation of dust emission from open areas during the exploitation was made in concordance with recommendations of EPA (www.epa.gov/ttn/chief/ap42/ch13/final/c13s02-5.pdf).

The calculation regards the area of 10000 m^2.
The area is uniformly covered with material (NO bevel form).

Distance from emission resource: 500 m
Source and location height above sea level difference (res.-loc.): 0 m
Distance from the axis: 0 m
Sedimentation speed: 0,1 cm/s
Outflow height: 0 m

Atmosphere types (after Pasquill) are characterized by temperature gradients. Those are expressed by temperature changes (dT) per height (dz) on 100 meters of height difference.

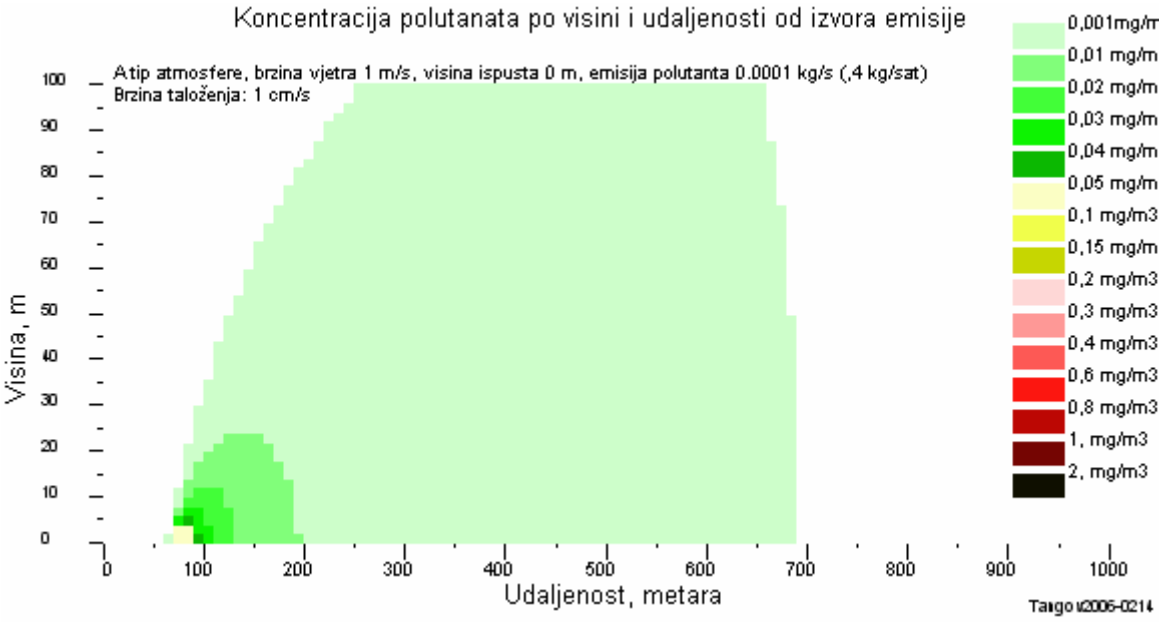
A atmosphere type: dT/dz < -1.9
B atmosphere type: -1.9 < dT/dz < -1.7
C atmosphere type: -1.7 < dT/dz < -1.5
D atmosphere type: -1.5 < dT/dz < -0.5
E atmosphere type: -0.5 < dT/dz < 1.5
F atmosphere type: 1.5 < dT/dz < 4.0
G atmosphere type: 4.0 < dT/dz

Pollutant concentration in the air

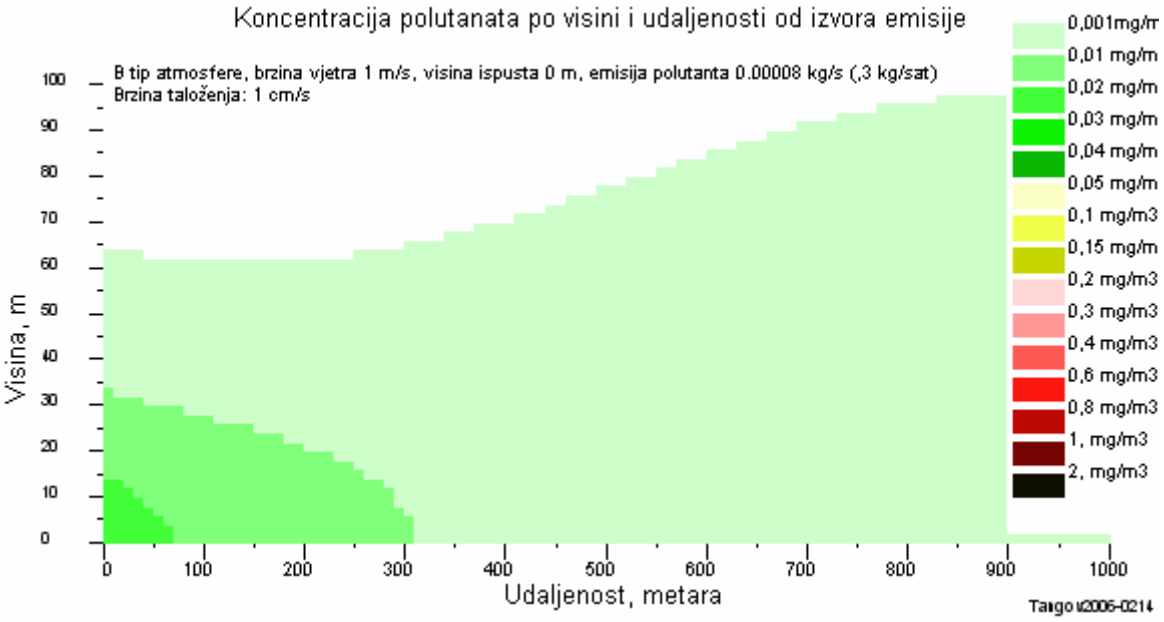
Wind speed	0.5	1	2	3	5	10	(m/s)
A atmosphere type	3	1	0	0	0	0	(ug/m3)
B atmosphere type	10	5	2	2	1	0	(ug/m3)
C atmosphere type	17	9	4	3	1	1	(ug/m3)
D atmosphere type	34	20	10	7	4	2	(ug/m3)
E atmosphere type	61	37	21	14	8	4	(ug/m3)
F atmosphere type	110	89	57	41	26	13	(ug/m3)
G atmosphere type	169	176	126	95	63	34	(ug/m3)

Pollutant concentration in the sediment

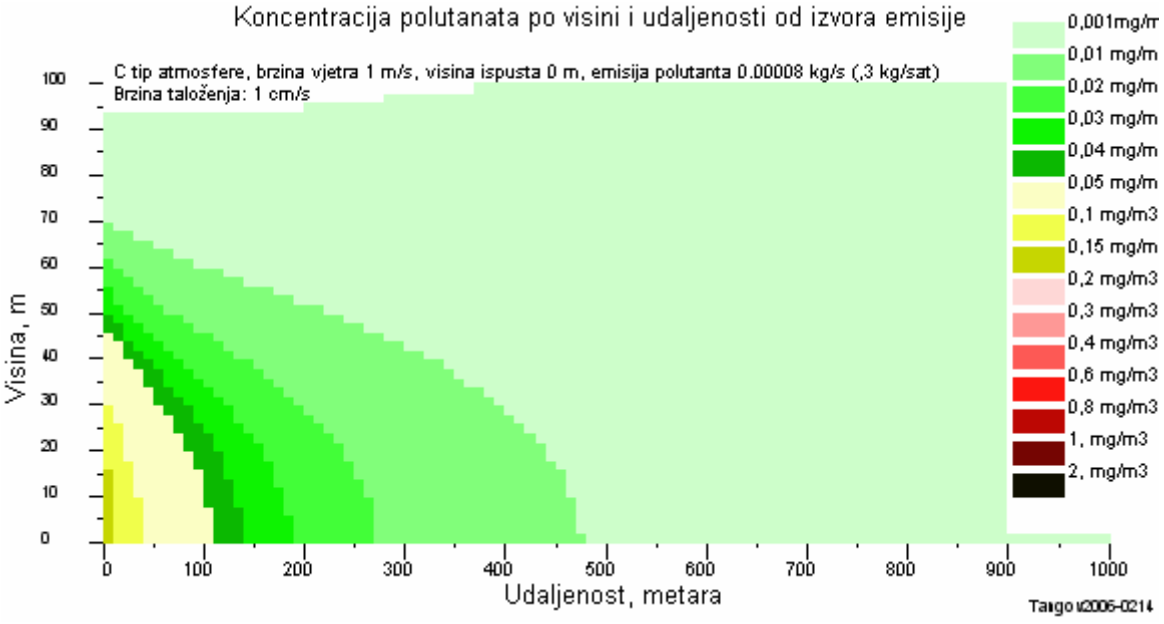
Wind speed	0.5	1	2	3	5	10	(m/s)
A atmosphere type	1	0	0	0	0	0	(mg/m2/dn)
B atmosphere type	2	1	0	0	0	0	(mg/m2/dn)
C atmosphere type	4	2	1	0	0	0	(mg/m2/dn)
D atmosphere type	9	5	3	2	1	0	(mg/m2/dn)
E atmosphere type	17	10	6	4	2	1	(mg/m2/dn)
F atmosphere type	31	25	16	11	7	4	(mg/m2/dn)
G atmosphere type	48	50	36	27	18	9	(mg/m2/dn)



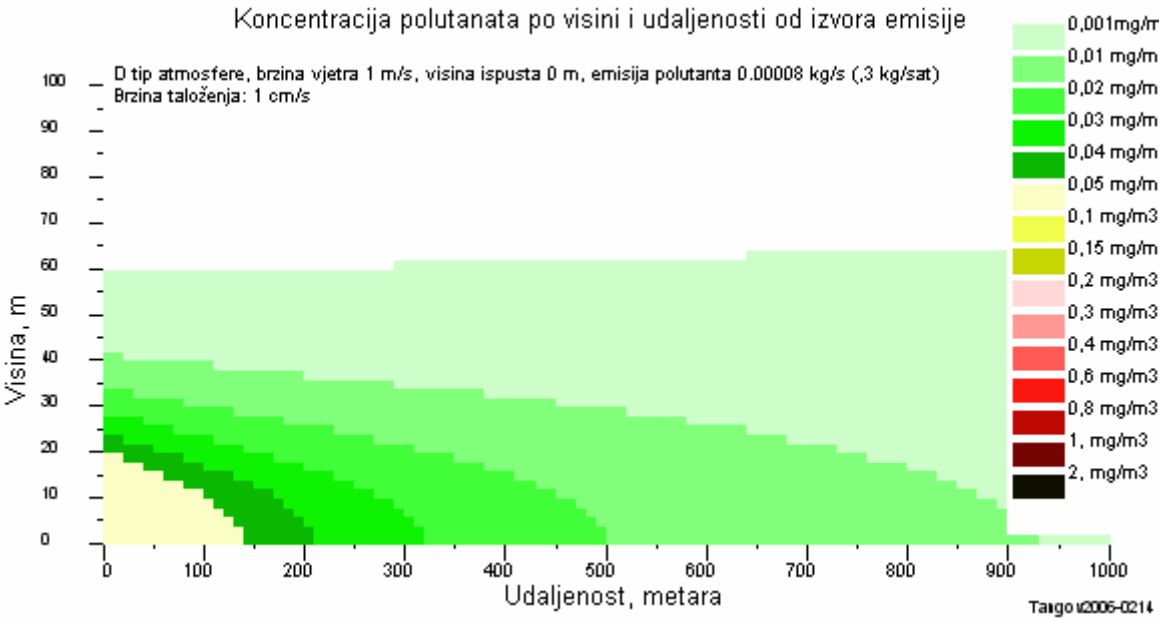
Picture no. 37 Pollutant concentration per height and distance from emission source, A atmosphere type



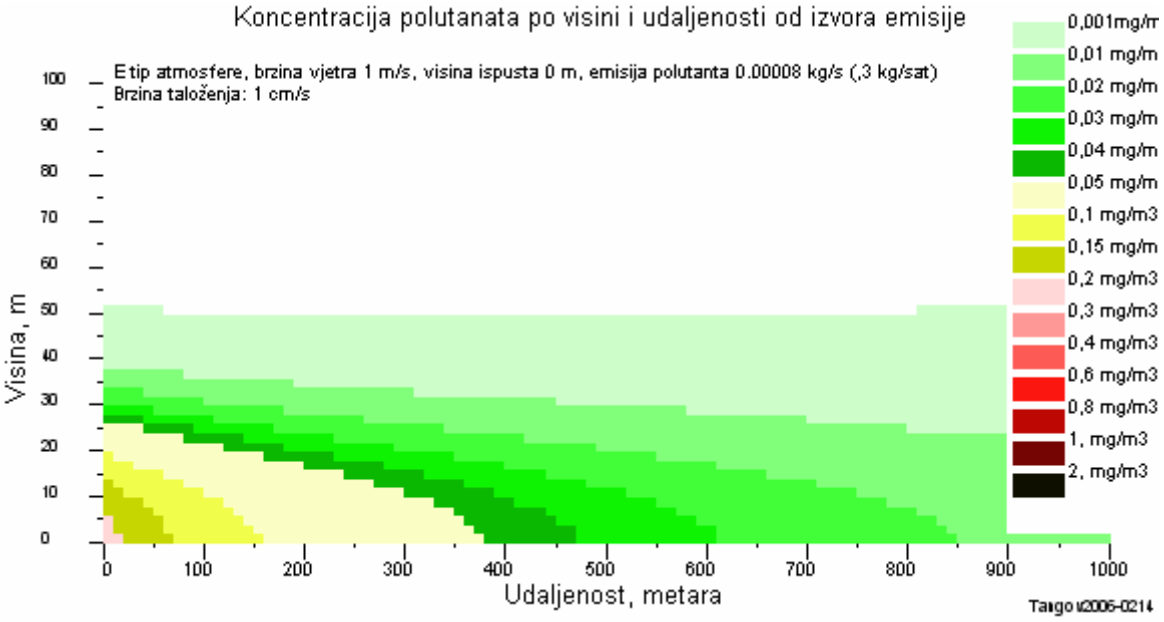
Picture no. 38 Pollutant concentration per height and distance from emission source, B atmosphere type



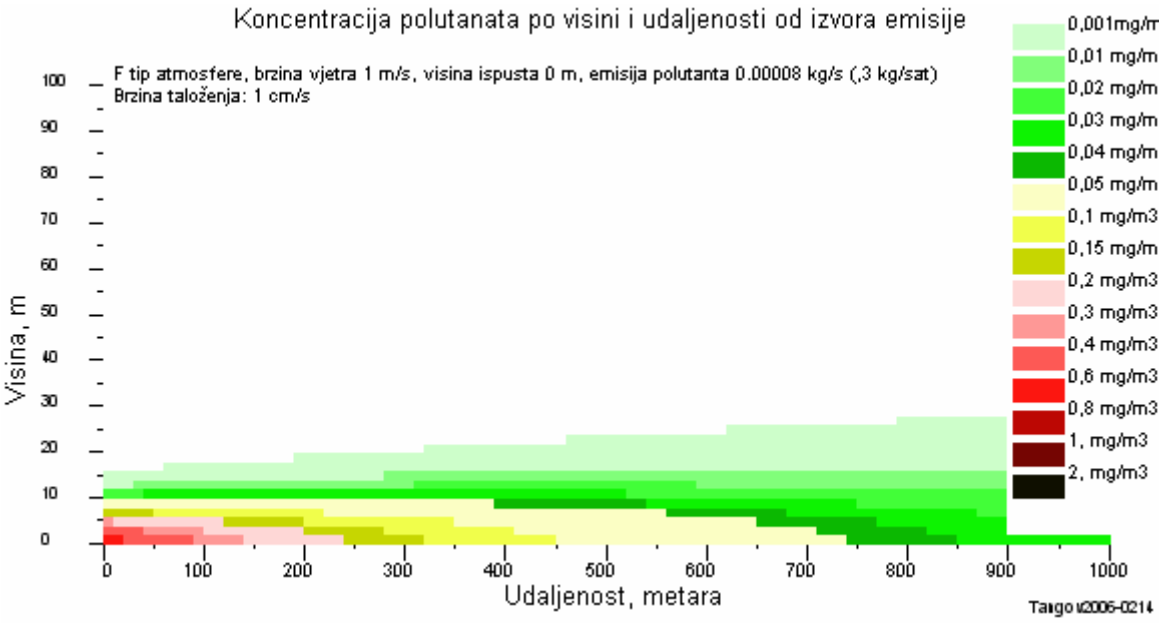
Picture no. 39 Pollutant concentration per height and distance from emission source, C atmosphere type



Picture no. 40 Pollutant concentration per height and distance from emission source, D atmosphere type



Picture no. 41 Pollutant concentration per height and distance from emission source, E atmosphere type



Picture no. 42 Pollutant concentration per height and distance from emission source, F atmosphere type

Calculated dust concentration which will be created during existing landfill exploitation (along with protection measures application) will be under average year values in concordance with Regulations on limit values of air quality (Official Gazette of Republic of Srpska, No. 39/05).

2.4.3. SOIL QUALITY IMPACT

Due to **wind spreading** of dust, steam and aerosol (from disposed waste) it is possible that they deposit on soil in the landfill surrounding. This impact mostly depends on the size of **working area, speed and wind rose**. During rehabilitation realization **additional soil pollution** will occur due to the dust which will rise during excavation and waste loading as well as mechanization work.

If **untreated waste landfill surface and filtered waters are being let into the ground,** indirectly there can be an impact to surrounding soil.

By rehabilitation and landfill closure the negative soil and agricultural land impact will be brought to a minimum.

2.4.4. TOTAL NOISE LEVEL IMPACT

2.4.4.1. Impact during rehabilitation

Taking into account the waste landfill rehabilitation way and time foreseen, the waste landfill „Ramići“ will be active **only during 6 working days, only during day time**.

Dominant noise sources at the landfill will be transport vehicles and working machines: 5 trucks-dumpers for material transport, 5 diggers and 5 loaders.

Material transport trucks

Trucks owned by the third parties will be used for waste transport. They appear as noise resource during movements by arrival and departure. During the time waiting to be loaded the vehicle motors are turned off. The maximum frequency of 5 vehicles is expected, and the vehicle speed within the landfill is limited to 10 km/h. In those conditions the load vehicles noise is negligible compared to working machines noise.

Working machines

Taking into account that the investor does not have data on type and model of the working machines, data on noise force are given for the corresponding mechanization of Fuchs producer and are 102 dB(A) for the digger and 103 dB(A) for the loader.

Noise imission critical points

The closest residential houses will be the most threatened ones by landfill noise. Those are situated app. 500 m on east and northeast from the area where rehabilitation will be done (point MM1).

Noise calculation

Noise level is calculated in continuation which will appear at critical imission points as a result of diggers and loaders work at the landfill. The calculation is done by computer program for critical case when diggers and loaders are closest to residential object.

The following data has been used in calculation:

- Digger:

Noise force: Lw = 102 dB(A)
Calculation height 2 m above surface level

- Loader

Noise force: Lw = 103 dB(A)
Calculation height 2 m above surface level

- Calculation height of noise imission points: 4 m (1st floor height).
- Imission point MM1distance from noise resource: 500 m.

Noise level at critical imission point MM1 is 46,5 dB(A). Calculated noise level **is lower than the permitted for day time**.

2.4.4.2. Impact during exploitation

Taking into account the waste landfill functioning way and time expected, the waste landfill „Ramići“ will be active **only during 6 working days, only during day time**.

Dominant noise sources at the landfill will be transport vehicles and working machines: 15 trucks for waste carriage, 1 compactor, 2 bulldozers and 1 loader.

Trucks for waste carriage

Trucks owned by the third parties will be used for waste carriage. They appear as noise resource during movements by arrival and departure. During the time waiting to be loaded the vehicle motors are turned off. The maximum frequency of 15 vehicles is expected, and the vehicle speed within the landfill is limited to 10 km/h. In those conditions the load vehicles noise is negligible compared to working machines noise.

Working machines

Taking into account that the investor does not have data on type and model of the working machines, data on noise force are given for the corresponding mechanization of Fuchs producer and are 102 dB(A) for the bulldogger and 103 dB(A) for the loader. For the compactor assumed noise is 102 dB(A).

Noise imission critical points

The closest **residential houses** will be the most threatened ones by landfill noise. Those are situated app. 500 m on east and northeast from the area where rehabilitation will be done (point MM1).

Noise calculation

Noise level is calculated in continuation which will appear at critical imission points as a result of diggers and loaders work at the landfill. The calculation is done by computer program for critical case when diggers and loaders are closest to residential object.

The following data has been used in calculation:

- Digger:

Noise force: Lw = 102 dB(A)
Calculation height 2 m above surface level

- Compactor:

Noise force: Lw = 102 dB(A)
Calculation height 2 m above surface level

- Loader

Noise force: Lw = 103 dB(A)
Calculation height 2 m above surface level

- Calculation height of noise imission points: 4 m (1st floor height).
- Imission point MM1distance from noise resource: 800 m.

Noise level at critical imission point MM1 is 38,2 dB(A). Calculated noise level **is lower than the permitted for day time**.

2.4.5. IMPACTS OVER VIBRATIONS AND RADIATION INTENSITY

In the course of works execution on rehabilitation and expansion the following works are foreseen: excavation works and redeposition of waste, as well as construction of auxiliary facilities by classic construction works. During the works execution no mine-explosive means or any other means that can cause increase of the existing vibration level emitted into environment will be used. Later during the normal operation and during the rehabilitation and expansion, the only vibrations that will be emitted into environment are vibrations of mechanization used for these operation which level is minor.

Namely, the level of vibrations caused by the foreseen mechanization for the subject works has to be below the standards of vibrations harmful for health of workers handling this mechanization.

There will not be any ionizing or non-ionizing emissions in the course of works execution on the landfill rehabilitation and expansion.

2.4.6. FLORA AND FAUNA QUALITY IMPACTS

Waste landfill presents special ecosystem due to its specific characteristics (air, animal feed resource, shelter for smaller mammals – rodents and insects, etc.). There are plant and animal species specific for that area existing at the landfill. The existing landfill rehabilitation and disposal continuation will not cause any

significant changes at the micro location of landfill ecosystem, respectively, smaller mammals-rodents, birds and insects will continue to find feed and shelter at the landfill. The only negative impact is that ecosystem will be devastated (soil, plants, animals) in the area, respectively, surfaces predicted for landfill expansion. That negative impact to the ecosystem though has to be considered from the aspect of future profit from the intervention after landfill rehabilitation.

So, by the existing landfill rehabilitation and expansion the existing ecosystem will be maintained and there will not be any significant changes in its equilibrium.

By rehabilitation works plant species on the predicted surfaces for temporal and permanent waste disposal will be devastated. In the intervention area there are no endangered, rare and protected plant species so they will not be endangered by the landfill rehabilitation.

Even before the rehabilitation itself, the animal approach to the landfill is prevented by setting up an iron fence around the landfill so the number and diversity of determined animal species which are usually at the landfill has been partially reduced because feed resource is not approachable. By predicted protection measures uncontrolled animal reproduction will be prevented of the species which are usually at the landfill and are potential carriers of contagious diseases. The biggest negative impact to other fauna members during the rehabilitation will be the noise. That impact will be very weak to determined animal species due to the fact that the most animal species will be maintained at the broader intervention area.

Conditions for determined habitat renovation will be created by final landfill rehabilitation which will positively impact further flora and fauna development and contribute to landscape diversity.

2.4.7. IMPACT ON THE POPULLATION HEALTH

During the rehabilitation works the most impacted workers will be those who will be realizing physical landfill rehabilitation. Namely, at every landfill there are rodents who find their feed in waste and can reproduce in big number (rats mainly), then insects (flies, wasps) and birds (sparrows, gulls and similar) so during rehabilitation works **there is a possibility** of contagious diseases transfer from animals to workers working at the landfill if they will not stick to the work protection measures (Law on work protection, Official Gazette of Republic of Srpska No. 44/94). **There is a danger** for workers during rehabilitation work of rodents and insects bite, cuts from waste disposed and inhaling of the dust created during the works.

The risk from the aspect of workers health during the rehabilitation and reclamation **will be minimal** if the prescribed personal protection measures are obeyed.

The project of the landfill rehabilitation and expansion should not have any impact over the health of local population.

2.4.8. IMPACTS ON METEOROLOGICAL PARAMETERS AND CLIMATE CHARACTERISTICS

Waste landfill impact to climate changes is not provable, but would probably be felt only at the area which is occupied by waste landfill and more on the part where new waste will be disposed, which will be manifested through the increase of air temperature due to increased temperatures in landfill body. The consequences of these microclimatic changes will be manifested in a little bit more intensive evaporation and evapotranspiration processes, and a little bit quicker snow melting processes in landfill area.

2.4.9. ECOSYSTEM QUALITY IMPACT

The goal of the project execution for the landfill rehabilitation and expansion is to decrease current landfill impacts to ecosystem.

Namely, the landfill in the current condition has a lot of impact over the local ecosystem, mostly to water, soil and air.

The rehabilitation project of the regional landfill foresees rehabilitation of all impacts on local water streams by construction of collection system for all seepage, precipitation and sanitary water and their treatment up to the quality that can be discharged into natural water streams.

The construction of collection system for all waste water from the landfill will enable recirculation of waste water, i.e. repeated return of waste water to the landfill, and only small surplus will be treated and discharged into natural water streams.

All landfill gases will be collected by the landfill gases collection system and we be combusted in the combustion plant, and will not be spread around as it is today.

According to the landfill rehabilitation project, a protection watertight layer will be constructed in the landfill basement as well as bottom sealing system so the land will be protected.

2.4.10. IMPACTS OVER INHABITATION, CONCENTRATION AND MIGRATION OF POPULLATION

Rehabilitation and expansion of the Ramići Regional Landfill shall have no impact over inhabitation, concentration and migration of population in the surrounding area.

2.4.11. IMPACT OVER QUALITY, PURPOSE AND USE OF AREAS (CONSTRUCTED AND UNCONSTRUTED AREAS, USE OF AGRICULTURAL LAND)

Rehabilitation and expansion of the Ramići Regional Landfill shall have no impact over constructed or unconstructed areas, or agricultural land use, because the rehabilitation will take place on surfaces that were long ago foreseen for waste deposition, and the expansion will be to the bordering surfaces that are not being used as agricultural land.

After the process of waste deposition to the subject landfill is finished, it will be necessary to carry out reclamation of filled landfill, i.e. the surface will require rehabilitation and adaptation to other purpose.

2.4.12. COMMUNAL INFRASTRUCTURE IMPACTS

Rehabilitation and expansion of the Ramići Regional Landfill shall have no impact over the existing communal infrastructure of the surrounding area.

2.4.13. IMPACTS OVER NATURAL HERITAGE OF SPECIAL VALUES, CULTURAL HERITAGE, MATERIAL HERITAGE INCLUDING CULTURAL – HYSTORICAL AND ARCHEOLOGICAL HERITAGE

According to the Ministry of Urbanism, Civil Engineering and Ecology of Republic Srpska Resolution on the obligation for preparation of Environment Impact Assessment, at the area which is an issue of Rehabilitation and expansion project of the landfill in Ramići there are no registered objects of cultural-historical or natural heritage. Due to that, the intervention will not have any impact to cultural and natural heritage.

2.4.14. IMPACTS ON QUALITY OF THE AREA LANDSCAPE CHARACTERISTICS

Any landfill definitely degrades landscape. Waste is a structure which by its colour, texture and shape is not adjusted to characteristics of space in which is situated.

2.4.14.1. Impacts on visual quality of landscape

Visual qualities of landscape are scenery potential of some landscape or its separate parts.

Quality attributes of certain parts of space can be divided into two categories:

- Landscape components of formal artistic line which in scoping area specially refer to agricultural land restructuring (orthogonal system).
- Landscape components of organic artistic line that refer to preservation of natural originality (organic system).

In respect, that area of intervention has already suffered from disturbance of visual values with previous disposal and **additional impacts on landscape will occur** by landfill restructuring during planned utilization period.

Space attributes, which are sensitive about planned intervention, are: micro relief features, vegetation cover, cultural-historical conditions, surface waters, ecological features system etc.

There are no components of cultural landscape or cultural-historical condition in the area of intervention. Therefore the planned activity will have impact on visual qualities due to changes in relief, vegetation devastation, impact on surface waters and anthropogenic predomination.

1. **Micro relief features** – in the area of intervention there aren't any valuable geomorphologic features in micro relief which are perception carriers of organic or natural characteristics which could be endangered with planned activity. Activity of disposing waste causes changes in topography as it makes changes in natural line of terrain. A large quantity of waste has already been disposed on area of intervention therefore topography of terrain is significantly altered.

   During rehabilitation and expansion – execution of the planned activity will cause gradual changes of relief structure on the concerned area with disposal of waste material. Works on rehabilitation and waste disposal will gradually change relief structure of the concerned area. As it was specified in preliminary design, waste will be disposed on several surfaces, which between themselves have deferent shape and size, and they are formed as organic (natural) structures, which is definitely reviewed positively.

   After completed rehabilitation and expansion – a positive impact on relief of concerned area will occur. Namely, planned forming of landfill in final stage is in accordance with topography of surrounding area. As it can be seen from annex final map of surface, landfill is formed as organic structure (sharp lines and geometrical shapes are completely avoided) of soft, but miscellaneous relief characteristics, which distinction of closer area around landfill.

2. **Vegetation cover** – intervention will take place inside the existing landfill borders and won't cause spreading on surrounding area where forest is situated. This means that valuable examples of flora of this area won't be devastated.

   Works in the area of intervention has already devastated flora. Vegetation is a carrier of organic artistic line, which refers on

preservation of natural originality on this area and its devastation changes picture of landscape on concerned area.

During rehabilitation and expansion – Works on expansion will gradually devastate low vegetation on additional surface. However, it is planned that biological reclamation is conducted at the same time as rehabilitation therefore this will reduce negative impacts with devastation of vegetation. After completing phases of each surface for waste disposal, reclamation will be conducted and this will enrich visibility of area.

After completed rehabilitation and expansion – biological rehabilitation will significantly improve picture of the concerned area in comparison with period of disposal. Vegetation texture will be adjusted with organic-natural system in surroundings (forest). After the landfill closure the entire area of the landfill will be covered, and covered land reclaimed with recognizable plant types for this area, which will integrate with vegetation material around it.

3. **Cultural-historical conditions** – on wider area they include traditional way of using land in agricultural purposes. Formal shapes of environmental decoration are indicators of geometrical artistic line that results from formal decoration of space of traditional agricultural activities. On area of intervention, there aren't elements of traditional cultivation of land nor won't traditional building therefore there be negative impacts within this meaning.

4. **Surface waters** – in the area of intervention there is a watercourse Glogovac. It rises in east part of landfill. It does not represent any valuable element when taking into account visual and ambient qualities of concerned area. Rehabilitation and expansion will not cause negative impacts on mentioned canal because its course won't be changed.

5. **Anthropogenic predomination** – in building zones (positioning of necessary mechanization, waste generating, and material disposal) – in the area of intervention there will be mechanization and objects necessary for building present. Structures placed in space significantly affect visual qualities of landscape because it's unadjusted to natural characteristics of space – in the area of intervention there is mechanization and objects present that were placed in this area for the needs of previous disposal.

   During rehabilitation and expansion – landscape anthropogenic will dominate during the entire period of works execution on rehabilitation and expansion.

   After completed rehabilitation and expansion – negative impact of anthropogenic predomination will be considerably reduced.

2.4.14.2. Impact on landscape exposure

Analysis of visual exposure defines exposure of space and its bigger or smaller perceptiveness with most traffic places and places where people stay more often.

Analyses of visual exposure from potential points of visual exposure (mentioned further in text) come up with following conclusion:

1. In the landfill wider surroundings, there are a number of houses for individual living. These houses are situated along margin of the landfill amphitheatric location from southern and western side, around 1000 m away from the landfill. There is one house at the landfill entrance, on the north.

   From direction of the mentioned houses, the landfill exposure degree won't be changed significantly because changes will take place inside the exciting landfill borders.

   In addition, it is important to mention that the works on rehabilitation and expansion will be done in phases that will be separated in spatial and time aspect, therefore in one moment minimum mechanization will be used in the area of intervention. As it was said earlier a number of people who will see the changes will be relatively low. From the mentioned objects direction there will be moderate impact on visual exposure.

2. East from the landfill passes main road Banja Luka – Prijedor with high traffic intensity and represents potential area from which the degree of visual exposure could be high. Along the mentioned road, housing objects and industrial zone with a number of production and service capacities are situated.

   From the mentioned road direction there won't be changes in visibility degree. However, during the period of works on rehabilitation east part of the landfill will become unadjusted with natural characteristics of space, which will increase exposure intensity. Therefore, negative impact will appear on visual exposure taking in consideration that at the moment a part of the landfill overgrown with vegetation is exposed from the mentioned direction.

3. Degree of visual exposure from the direction of access road and facilitates located nearby will not be changed.

   Conclusion – Intervention will be visually exposed from direction of housing objects from surroundings (on margin of amphitheatric location of landfill). However, there will be moderate negative impact on visual exposure because work on rehabilitation and expansion will be conducted in phases which are separated in spatial and time aspect, and at the same time biological re-cultivation will be conducted. Intervention will be visible from direction of highway Banja Luka – Prijedor but in very small angle of visibility. Negative impact on visual exposure will appear from that direction

during work on rehabilitation of east part of landfill. There won't be negative impact from visual exposure on other inhabited parts in surroundings.

2.4.14.3. Impact assessment of landscape intervention in the course of rehabilitation and expansion

Impact assessment of landscape intervention was carried out based on expert method presented in following sources - L. Ortolano, Environmental Regulation and Impact Assessment, J. Douglas Porteus, Environmental Aesthetics. Method is based on decomposing landscape into elements on which the intervention will have impact. Intensity of impact on shown model is reviewed based on results of impact given by visual simulation. Score values of sub elements are chosen to express their experience assessed importance in model.

Each member of reviewers group gives a grade of elements from table. For a result medium value is taken according to scheme from table. Higher result shows higher impact.

Model of impact assessment of landscape intervention during rehabilitation and expansion

VISUAL ELEMENTS	VISUAL SUBELEMENTSI	INDICATORS	SUBELEMENTS SCORING		SCORING RESULTS
LANDSCAPE COMPACTNESS	colour	Significant differences in colour, halftone, values	high	3	3
			moderate	2	
			low	1	
			none	0	
	shape	incompatibility of shape of intervention with surrounding landscape	high	3	
			moderate	2	2
			low	1	
			none	0	
	line	introducing incompatible lines, silhouettes, borders	high	3	
			moderate	2	2
			low	1	
			none	0	
	texture	incompatible texture density, grained, regularity or shape	high	3	3
			moderate	2	
			low	1	
			none	0	
			RESULT		10
CONTRAST	Predominated intervention		high	12	
	One of predominated interventions		moderate	8	8
	Significant intervention		low	4	
	Trivial intervention compared to others close by		none	0	
			RESULT		8
SPATIAL DOMINATION	Background landscape situation	Intervention dominates or is predominant in landscape composition; or prominently place din landscape; or dominates on morphology of terrain	Dominate	12	
			Co-dominant	8	
			Subdominant	4	4
			Without meaning	0	
			RESULT		4
VISUAL EXPOSURE		Degree of exposure to views	Dominate	6	
			Co-dominant	4	
			Subdominant	2	2
			Without meaning	0	
NUMBER OF VISITORS		Number of people who could potentially see the changes	huge	12	
			significant	8	
			small	4	
			trivial	0	0
			RESULT		2

LOCAL SELF GOVERMENT POLITIC	Politic of preserving ecstatic valuables exist	12	0
	Doesn't exist, but it can be important for other activities	8	
	Indifference towards the intervention	4	
	Interested for intervention	0	
		RESULT	0
		TOTAL ASSESED RESULT	**24**

TOTAL ASSESSED IMPACT ON LANDSCAPE DURING REHABILITATION AND EXPANSION

VERY STRONG	from 66 to 47	
SIGNIFICANT	from 46 to 28	
MODERATE	**from 27 to 9**	**24**
VERY WEEK	from 8 to 0	

Given result shows, that intervention (during disposal) belongs to category of interventions with **moderate negative impact.**

Obligatory final forming and re-cultivating of landfill area will improve visual qualities of area. Intervention area will adopt appearance more adjusted to surrounding area **with respect to disposal period** and basic prerequisite for quality integrating in surrounding landscape structures or another allocation of area will be made.

2.4.15. ACCIDENTAL SSITUATIONS IMPACT

In the case of waste landfill **significant accidental situation** is a **fire** at the landfill. The fire can occur **because of the auto-inflammation, human activity, motor vehicles activity as well as a result of natural phenomena.** The fire pollutes the atmosphere by poisonous burning products and presents a hazard due to expansion to surrounding bushes. The fire is a phenomenon characteristically for the landfills, and waste disposal technology (waste covering and compacting) is reducing it to the minimum.

Unpleasant odour expansion and methane explosion are also possible apart from the fire. Unpleasant odour is a result o **hydrogen sulphide, mercaptanes and ammonia traces**, and is neutralized by covering of the waste by soil layer. Methane in quantity of 5 do 15% in combination with an air creates an explosive mass, and negative impact can occur if **landfill work technology is not respected or so to say, if waste is not covered with inertized material and concentration of methane under impermeable surfaces is allowed**.

By regular covering of newly disposed waste and successive set up of gas pulling system as well as filtered water creation reduction and preventing their contact with waters, potential risk of arranged landfill from accidental situation point of view **will be minimal.**

2.4.16. DESCRIPTION OF METHODS FORESEEN FOR ENVIRONMENT IMPACT ASSESMENT

Methods used for environment impact assessment are different depending on the assessment purpose.

Flora and fauna impact was assessed based on the known dust impact to plant and animal species (based on literature), water impact was assessed based on geological and hydro-geological land characteristics, and impact on air, soil and climate factors in accordance with EPA recommendations (www.epa.gov/ttn/chief/ap42/ch13/final/c13s02-5.pdf). Based on that we produced graphic attachment, as well as computer simulations of dust emission into the air.

Impact on material heritage including cultural-historical and archaeological heritage, was assessed based on processed data from Regulation plan for the area of Regional sanitary landfill of solid waste in Ramići, Banja Luka and comments given by *Institute for protection of cultural – historical and natural heritage of RS* stated in Decision no:16-92-81/06 dated 13 June 2006 issued by

the Ministry for spatial planning, civil engineering and ecology of Republic of Srpska.

Impact assessment on landscape was carried out based on expert method represented in the following sources: - L. Ortolano, Environmental Regulation and Impact Assessment, J. Douglas Porteus, Environmental Aesthetics.

The method is based on division of landscape into elements that would be impacted by the landfill. The impact results achieved by impact intensity assessment in accordance with the model presented in table in chapter Landscape impact. Appraisal values of sub-elements were selected in order to express importance in the model.

Population impact was assessed based on calculations of noise and dust emission into the air and the presence on ground.

2.5. DESCRIPTION OF MEASURES FOR PREVENTION, REDUCTION AND MITIGATION OF HARMFUL IMPACT TO ENVIRONMENT

After the analysis of environment impact assessment of the existing landfill in Ramići rehabilitation, expansion and exploitation, the conclusion has been made that taking into account the impacts character and importance certain impact level exists.

When analyzing each of the impacts, the Authors defined measures for prevention, reduction and mitigation of these impacts to environment through definition of measures for space organization, technical – technological, sanitary – hygienic, biological, organizational, legal and other measures.

2.5.1. SPACE ORGANIZATION MEASURES

Measures for space organization will be implemented during the works execution on rehabilitation and expansion of the landfill through strict obeying of the conditions stated in Town planning – Technical documentation and within Regulation plan for the area of the Ramići Regional Sanitary Landfill in Banja Luka.

During the old landfill rehabilitation and its expansion the Investor and Contractors will have to carry out all activities within the works frame defined in the above stated Town Planning documentation.

2.5.2. ORGANIZATIONAL PROTECTION MEASURES

Organizational measures in the phase of the landfill rehabilitation and expansion refer to organization of companies executing the works. W e recommend the companies that will execute the works to introduce elements into their organization that will contribute to reduction of negative impacts to environment. It is very important to appoint a responsible person for execution of environment protection measures.

- Construction works at the landfill have in been in a phase that enables normal commencement and undisturbed works. All living and working environment protection regulations have to obey.
- Installation and assembly of devices have been carried out in accordance with the manufacturer's instruction, attached drawings and technical description of the facility.
- All used material has to be of good quality and correspondent to valid regulations and standards. If a need appears for deviations from the final Design, every change has to be approved by Supervisor in written.
- Civil engineering works have to be carried out in such a way that does not damage surfaces and natural contents outside the project (due to carelessness or unprofessional work) and in a way that will not cause

unnecessary dusting, earth spreading, garbage throwing etc. All construction waste has to be immediately collected and stockpiled in space defined and organized for this purpose.

- It is necessary to carry out detailed inspection of complete electrical installation at the site from the aspect of protection at work and during the inspection pay attention to proper earthling all metal mass in the facility, automatic disconnection in case of need and other protection measures stated in electric installation design.
- All foreseen mechanical equipment and installations have to be in accordance with valid quality standards and norms. All installed equipment and installations have to be protected with appropriate coatings, and test runs for isolation pressure and tightness (tested by appropriate tension).
- It is necessary to take measures for prevention of material spilling on access roads (from vehicles transporting building material), and if spilling happens, the material has to be removed.
- During the subject facility exploitation it is necessary to perform control of the required environment protection measures by the authors of this Study or other certified institution.
- Extensive prevention measures for fire protection have to be taken in accordance with valid standards, it is necessary to provide the required number of initial fire extinguishers and train workers for professional and safe handling of these devices.

In case of fire it is necessary to start sound alarm and inform police and fire fighting unit, extinguish fire until firemen come and participate in fire fighting with all available men and means.

2.5.3. LEGAL PROTECTION MEASURES

Complex of legal protection measures encompasses a number of activities in sense of legal regulation of certain occurrences, which if not regulated, could case negative consequences. These protection measures include the following activities:

- In the phase of technical documentation preparation, and before the works commencement, it is necessary to sanction possible individual construction in the landfill immediate vicinity by administrative-legal measures. This is the way to prevent negative impact to which these objects would be exposed and subsequent requests for protection measures.

- Provide instruments within the approval issued by competent town and republic institution (competent ministries), in that way permanent control will be carried out in sense of possible environment impacts.

- Provide instruments within contract documentation, that the Investor will form with Contractors, on necessity to obey all prescribed protection measures in the phase of works execution.

- Provide instruments that will enable that the engaged subjects for realization of works from the field of construction and exploitation have professional staff for execution of defined tasks from the field of environment protection.

- Provide instruments for necessity of professional advanced training in the field of exploitation of the planned landfill from the aspect of environment control in the concrete spatial circumstances.

Technical – technological, sanitary hygienic and biological measures for prevention, reduction and mitigation of harmful impact on environment that are specified by the Authors in the following text include extensive diapason of necessary activities within each of the analyzed impacts, both in the phase of construction and exploitation.

2.5.4. MEASURES FORESEEN BY LAW AND OTHER REGULATIONS, NORMATIVE AND STANDARDS

2.5.4.1. Water and soil protection measures

- Construct base sealing system for new landfill part. Designed sealing system for new landfill part will be constructed according to the EU directive CD 1999/31/EC as combination sealing and consists of (from top to bottom):

    - Drainage layer 50 cm (drainage gravel 16/32) with drain pipes DN 200
    - Cover mat (geo-textile 1.200 g/m²)
    - Plastic liner 2 mm (HDPE - Highly-sealed polyethylene)
    - Mineral layer 3 x 25 cm (kf < 10-9 m/s)
    - Layer - geo-textile
    - Levelling layer (E > 15 MN/m²)

- Construct cover sealing system for old landfill part and as final cover of new landfill part. Designed landfill cover for new landfill part and parts of old landfill with high reactivity is to be constructed according to the EU directive CD 1999/31/EC as combination sealing and consists of (from top to bottom):

    - Top soil cover 100 cm
        - Dividing layer - geo-textile
        - Drainage layer 50 cm (gravel 2/40)
        - Cover mat (geo-textile 1.200 g/m²)
        - Plastic Liner 2 mm (HDPE)
        - Mineral layer 2 x 25 cm (kf < 10-9 m/s)
        - Dividing layer - geo-textile
        - Gas drainage layer 30 cm (gravel 2/40)
        - Levelling layer 50 cm
        - Waste

- In the time of construction work realization, the workers have to be very careful not to perforate sand layer and provoke filter breakthrough to underground waters. It is essential that special attention is given to slopes, in order to avoid erosion which can provoke leaking of sealing layer.

- After moving the waste to new surface test excavations have to be dug up, in order to determine soil pollution. On the basis of the soil analysis it has to be determined how much soil has to be dug up and removed together with waste. If it will be determined that bigger amount of the soil has to be taken away, the excavations which will be created will be rehabilitate by pure soil poured in.

- Construct separated drainage system for waters of different pollution type (filtered waters, precipitation waters, waters from vehicle cleaning and disinfection area and asphalted surfaces). Insure that all waters (filtered and precipitation) can be drained through waste water treatment unit. It must not be permitted to mix precipitation and filtered waters before treatment.

- Collected filtered water from new part bottom sealing system has to be drained by special drainage network to filtered water collection pool and be brought back by filtered water recirculation system to disposed waste – surface in work (about 25% of treated filtered water). If throughout the year there is an amount which can not be brought back to the landfill it will be stored in mobile units for filtered waters treatment (75% of the water) and drained downstream of the landfill body in receiving pit where it will be treated in treatment plant by the reverse osmosis system up to purity level which is in concordance with the standards for outflow in the river and only after positive quality analysis those waters will be let into Glogovac stream.

- Precipitation water which has no contact with waste disposed will be used for green areas watering or let into the recipient.

- Polluted water from the vehicle cleaning and disinfection area and asphalted surfaces (parking and manipulative surfaces) will be treated on the oil and grease separator and be re-used for tire cleaning or green areas watering and the rest will be let into the recipient.

- During the canyon construction well capture has to be made. Surface waters, as well as Jazovac well waters have to be collected and brought outside of the landfill by gravity pipes into precipitation water collector which will prevent their pollution from landfill filtered waters.

- Faces waste waters have to be collected by special canal network only for that kind of water and have to be treated on the local waste water plant (septic tank with sludge collectors and disinfection with the help of chlorinator or other corresponding plant type). It is necessary to regularly maintain septic tank and clean its content by firm authorized for that kind of activity.

2.5.5. Air protection measures

- Create educational and promotion material with the purpose of information and ecological message creation as well as advising the inhabitants in order to stimulate correct waste management. On the base of those materials promotion campaigns have to be prepared and realized for individual programs (bio waste – mini compost places in every yard, paper, glass, cans, special waste) in all communication means (local radio and newspapers, panels, recycle yards, »green islands«, Internet- web pages of communal services).

- Vehicle for waste transport to the landfill has to be equipped in a way to prevent expansion of the dust and odour.

- Cover the waste with soil layer every day to separate waste layers keeping working area for waste work as small as possible.

- Transport paths and working areas have to be splashed with waters in dry periods.

2.5.5.1. Flora and fauna protection measures

In order to protect flora and fauna of the subject location it is necessary to do the following:

- Prevent waste disposal in the area outside of the landfill.

- Separate biological waste component in order to reduce animal feed resource.

- Plant green areas within the landfill and prevent waste entrance.

- Maintain green areas by grass mowing

- Disinfection, desinsection and deratization of the landfill area have to be done regularly in order to prevent uncontrolled animal reproduction which can be potential carriers of contagious diseases. Deratization and desinsection has to be done by authorized legal entity.

2.5.5.2. Landscape protection measures

- Within the Final Design it is necessary to do Reclamation design and landscape architecture of landfill area design.

- By reclamation design and landscape architecture design it is necessary to give solutions for the following set of value system: relief, geomorphologic

characteristics, water and soil, vegetation, fauna, ecological diversity and visual qualities of the space with the problem issue of visual exposure.

- Final landfill formation and Reclamation of the intervention area has to be done on the basis of Reclamation and landscape architecture design.
- Landscape arrangement has to be done in the same time as rehabilitation.
- Entrance zone area at the landfill has to be maximally enriched by plant material.
- At the beginning of the rehabilitation protective green belt has to be planted towards east – along east landfill edge.
- Landfill body needs to be formed as organic structure of irregular and mild lines at the completion of the works which will not jump out from spatial relations within the wider area by its dimensions and forms.
- Immediately after covering individual landfill surfaces it is necessary to reclaim them with autochthonous plant species.
- Plant vegetation of different age and height within reclamation.
- Plant material for waste landfill area reclamation in concordance with organic visual order.
- After landfill closure it is necessary to remove all objects within the area which are no longer needed.

2.5.5.3. Noise protection measures

- Respect predicted working hours at the landfill rehabilitation. It is predicted that the rehabilitation works are done only during the day time. If there is a necessity of the work during night time additional measures will have to be undertaken in order to reduce noise emission to the environment.
- During further landfill use it is necessary to respect landfill working hours and maintain technically correct mechanization used by regular technical reviews.

2.5.5.4. Human health protection measures

- Regular examination for the workers has to be organized once a year.

The Investor is obligated to inform the public in case of any negative impact on human health and environment during the works execution on rehabilitation and expansion of Regional Landfill in Ramići in accordance with legal regulations of

the Law on environment protection and competencies of Ministry of Health and Social Protection of Republic of Srpska.

When it comes to protection of the population health it is necessary to obey The Health Policy and Strategy for Health in Republic of Srpska up to year 2010 and recommendations of Strategy 5. for monitoring and reduction of risky factors of living and working environment and strengthening of infrastructure institutions for health protection in process of preparation of spatial and other plans, i.e. basements and other technical-investment documentation (Official Gazette RS no. 56/02) which are related to National Environment and Health Action Plan (NEHAP) for Republic of Srpska, adopted by the RS Government (Official Gazette RS no. 1/02). ,

2.5.5.5. Public cooperation measures

- The public has to be informed about the landfill work and environment monitoring results through different media at local and regional level.

2.5.6. PROTECTION MEASURES IN CASE OF MAJOR ACIDENTS

- It is necessary to make intervention measures plan for:
  - Methane explosion case,
  - Fire case.

- At the landfill entrance type and amount of received waste should be controlled.

- It is possible to dispose only communal waste at the landfill and production waste of similar characteristics as the communal one.

- Construct temporal gas extraction system in compartments III/1 and II. Construct gas extraction system from sanitary (new) surface. Biogas from the new surface has to be lead to gas combustion unit (flame) or has to be economically used (setting up gas aggregate). Controlled evacuation of created gases has to be done in order to prevent gas concentration within landfill body.

- Cover the waste with soil layer every day to separate waste layers keeping working area for waste work as small as possible.

- Found and train permanent fire service with adequate machines, equipment and devices for announcing, extinction and preventing fire expansion,

- Construct fire protection road around the landfill.

- Arrange minimal fire protection belt around the waste landfill fence.

- Maintain the entire equipment and mechanization regularly which are used during rehabilitation.

- Install adequate number of fire fighting devices which do not contain halone, on earlier predetermined places.

- Construct smaller fire protection pool (400 m³) in the landfill centre where precipitation canal will be emptied with constant water level drained towards pipeline system heading to the canyon.

2.5.7. PLANS AND TECHNICAL SOLUTIONS FOR ENVIRONMENT PROTECTION (RECYCLING, WASTE SUBSTANCES TREATMENT AND DISPOSITION, RECLAMATION, REHABILITATION ETC.)

P.C. ”DEP-OT” was founded in 2003 with goal to rehabilitate the existing landfill of communal waste in Ramići and bring in to the level of a modern landfill that will satisfy all criteria of “Law on waste control” of Republic of Srpska and European Union in sense of waste deposition and environment protection.

From then and up to today (commencement of official rehabilitation of the existing landfill), the Investor has done a lot for environment protection, i.e. landfill development through extinguishing of long-standing fires, organized collection of new waste, proper deposition with compacting and covering of waste layers with earth layers, through construction of drill holes for undisturbed degassing and unloading of the landfill, protection of the landfill space by construction of fence around the landfill, landscaping etc.

Execution of all these activities witnesses the Investor’s determination to obey all relevant principles of environment protection, which is its intention and obligation for the future.

During the landfill normal works it is foreseen to initiate a process for waste selection and separation of secondary raw material, that will purchased by companies registered for trade and processing of secondary raw materials. For this process there is space dedicated for construction of plant for waste selection and recycling yards for temporary stockpiling of separated secondary raw material. The waste that will not be used as secondary raw material, will be deposited in department constructed for this purpose in Compartment C of the rehabilitated and expanded new landfill.
When the process of communal waste deposition on the location of the Ramići Regional Landfill it will be necessary to carry out reclamation process of the used landfill space. Reclamation process is a process of rehabilitation and transition into new purpose. With regard to that the Investor will have to prepare a special program of the landfill reclamation.

2.5.8. OTHER MEASURES THAT CAN IMPACT PREVENTION OR REDUCTION OF HARMFUL ENVIRONMENT IMPACTS

The described environment protection measures in articles from 2.5.1. to 2.5.7. encompass all necessary measures that will lead to prevention, reduction, mitigation or rehabilitation of environment impact of rehabilitation and expansion project of Regional landfill in Ramići.

2.6. DESCRIPTION OF MEASURES FOR ENVIRONMENT IMPACT MONITORING IN THE COURSE AND AFTER THE PROJECT REALIZATION

Taking into account possible potential negative impacts during the landfill rehabilitation, expansion and exploitation which will be identified, is necessary to predict monitoring plan for environment condition with the purpose of insight in the proposed living environment protection measures efficiency.

As the landfill impacts are also expected in rehabilitation, construction and exploitation phase and as the Authors will propose adequate measures for these impacts in order to prevent, minimize and mitigate harmful environment impacts, it will be necessary to do a monitoring of proposed measures efficiency in all of the phases.

In order to execute qualitative environment state monitoring as well as proposed protection measures efficiency monitoring it is necessary to create a monitoring plan.

The monitoring plan will be created within the framework of this study research and will contain the following states defined:

- Monitoring object;
- Parameter monitored;
- Location where monitoring will be done;
- Monitoring realization method of elected factor/monitoring equipment type;
- Monitoring execution time, permanent or temporal monitoring;
- Reason for monitoring of a certain parameter.

2.6.1. SUMMARY OF THE ENVIRONMENT CONDITION BEFORE PUTTING THE FACILITY IN COMMISSION ON THE LOCATIONS WHERE ENVIRONMENT IMPACT IS EXPECTED

Civil Engineering Institute “IG” Banja Luka carried out extensive quality measuring and testing in order to determine the quality of the nature basic elements: air, water and soil on the Ramići Regional Landfill location.
Analyses and results of these measuring, as well as comments of the environment condition before rehabilitation and expansion of the Ramići Landfill are stated within 2.2. „*Summary and Assessment of Environment Condition”.*

2.6.2. MONITORING DURING CONSTRUCTION

2.6.2.1. Air quality

2.6.2.1.1. Air quality monitoring

- In the surrounding area of the landfill location a complete station/equipment has to be installed for air quality monitoring. Additional monitoring has to be insured during waste excavation works with two additional measure locations at least (to be used for measuring with the help of mobile equipment). The positions of those three locations have to create triangle with the waste excavation area in the triangle centre, taking into account topography and meteorology. Senior expert for air monitoring has to be included into air quality monitoring station positioning as well as to monitoring itself. Positions of these three location must form a triangle with the area where waste will be excavated in the triangle middle, taking in consideration topography and meteorology.

- Automatic stations have to contain at least the following sensors:

    - o SO_2 analyser,
    - o NO,NO_2,NO_X analyser,
    - o O_3 analyser,
    - o THC, non-methane and methane analyser,
    - o PM10 monitor or Total Suspended Particles,
    - o Measurer of wind speed and direction,
    - o Measurer of temperature, relative humidity and atmospheric pressure,

And accessory equipment required for undisturbed automatic work of that station.

- o Calibration unit,
- o Gas calibration,
- o Sampling unit,
- o Accumulator for zero gas,
- o H_2 accumulator,

Automatic measuring units have to be in continuous, undisturbed work during the works execution.

Picture no. 43 Mobile automatic measuring unit

2.6.2.1.2. Landfill gases monitoring

- The landfill supervisor has to insure daily landfill gas checking with the assistance of portable analyzer over superficially positioned pipes. A station for methane, non-methane and total hydro carbonate analysis has to be installed in the surrounding area of the landfill body. During waste excavation works at the location additional unit for mercaptane and VOC measures has to be installed.

2.6.2.2. Water monitoring

2.6.2.2.1. Water quality monitoring of Jazovac spring

- Jazovac well water monitoring has to be insured at one location at least. Monitoring station has to insure constant well water quality measurement as well as of the well flow.

2.6.2.2.2. Seepage water monitoring

- After construction of tank for seepage waters collection, seepage waters have to be quantitatively supervised (per waste water level in the tank) and qualitatively.

2.6.2.2.3. Underground water monitoring

- Under first clay layer level at least 3 piezometers have to be installed. One piezometer has to be installed in the upper part and two in lower landfill part in concordance with underground waters flow. Measurements have to be done with the assistance of automatic equipment for water quality measurement and also for flow and level measurement. System has to have sampling unit.

2.6.2.3. Soil monitoring

- It has to be insured as zero monitoring of original soil from the landfill surrounding for minimally three samples for soil quality analysis. It also has to be insured as zero monitoring at old landfill part with minimally three locations for geodesic landfill construction control.

2.6.2.4. Waste monitoring

- Daily waste entrance control process has to be insured (weight measurement and so on). Supervisor or other institution has to put special attention to possible hazardous waste during waste excavation. Authorized expert has to execute daily radioactivity measurements. Significant amount of hazardous or potentially hazardous waste (oils, chemicals, radioactive material...) has to be immediately reported to supervision body and inspection. This kind of waste has to be correctly treated (thermal treatment or storage).

Supervision during rehabilitation

- Supervisor for environment has to be present each day during the reconstruction phase. He has to have the authorization to postpone or stop and works at the landfill. Supervisor has to have determined knowledge and skills from the environment monitoring area. That person has to have certain portable equipment for measuring and sampling, and also analytical laboratories at the landfill for the purpose of independent evaluation.

- Environmental state monitoring results during the rehabilitation after finished rehabilitation have to be handed in to competent republic body.

2.6.3. MONITORING DURING EXPLOITATION

2.6.3.1. Air monitoring

2.6.3.1.1. Air quality monitoring

- Selected air quality indicators measuring should be done continuously with the assistance of automatic station located at the landfill. Toxic air components and unpleasant odour gases concentration should be stopped on the basis of general and special parameters. General parameters for landfill air quality evaluation are parts in radius smaller than 10 μm (PM10) and sulphur (IV) oxide. Special parameters are nitrogen (IV) oxide, ammonia, methane, total gas carbohydrate – THC, carbon (IV) oxides and total mercaptanes as SH. Parallel with air quality measurements it is necessary to supervise basic meteorological parameters (wind speed and direction, temperature, precipitation amount and intensity, relative humidity, pressure, global radiation).

2.6.3.1.2. Landfill gases monitoring

- After gas collection system construction gas-monitoring analyst for permanent monitoring of gas quality has to be installed. Gas analyst has to be installed in final collection pipe prior to installation of any treatment unit. Manager of the shift at the landfill has to execute daily checking of landfill gas appearance with the assistance of portable gas analyst from laid pipes surface.

2.6.3.2. Water monitoring

2.6.3.2.1. Water quality monitoring of Jazovac spring

- It is necessary to supervise surface water quality downstream from Jazovac well at least on two locations. Two monitoring stations have to execute constant measurements of water quality and flow parameters. Minimum of the parameters for automatic monitoring:
  - pH,
  - turbidity,
  - conductivity,
  - dissolved oxygen,
  - temperature,
  - flow,
  - sulphides,
  - nitrates.

2.6.3.2.2. Seepage water monitoring

- Seepage waters have to be sampled and analyzed from the seepage waters collection pool. Selected sample has to be representative (it has to show average values for the entire landfill area which can be achieved by time programming). Apart from level, composition and water quality control it is necessary to determine flows in the dependence of hydro meteorological conditions. Technique of taking and sample transport has to be done according to laboratory practice rules. It is necessary to set up permanent monitoring of treated water quality which goes to recipient stream of Glogovac.

2.6.3.2.3. Precipitation water monitoring

- Precipitation waters from the landfill will be supervised with the assistance of water quality control automatic station.

2.6.3.2.4. Underground water monitoring

- Construction of two piezometer boreholes, one in upper part and the other

in the lower part from the underground water flow will insure permanent monitoring of underground water quality.

2.6.3.3. Soil monitoring

- Sampling and analyzing of minimally 3 samples every three years will be necessary in order to compare the values with zero samples.

2.6.3.4. Waste monitoring

- Keep a diary where all important data for landfill work is noted and especially data on: type and amount of accepted and disposed waste – conduct daily processes of waiting and registering (daily, monthly, yearly), on the method of disposal, covering, and disposed waste stability maintenance, on soil pollution monitoring, on landfill gases composition and amount monitoring, on filtered, precipitation and underground waters composition and quality monitoring as well as on reclamation of landfill part filled by waste. Part of the waste landfill diary has to be also the documentation: on waste (accompanying sheets for waste), on technical-technological equipment, on material incorporated into waste landfill, on inspections of all landfill parts and equipment, on measures undertaken according to the environmental protection inspection order and on the review of natural phenomena monitoring (floods, earthquakes and others) and sudden events at the waste landfill.
- Soil settling is to be controlled during landfill work once a year.

<u>Supervision during operations</u>

- Regular supervision has to be done by the professional inspector minimally twice a year. Special procedure has to be developed for this inspector work and special questionnaire has to be filled in.

- Environmental state monitoring results during the operations has to be handed in once a year, for the passed year, to competent republic body.

2.6.4. MONITORING AFTER LANDFILL CLOSURE

After the landfill location closure, environment quality monitoring has to be in function for the following 30 years.

All automatic and supervising monitoring activities done during the operations have to be continued minimally for 20 years after the closure.

2.7. SUMMARY OF MAIN ALTERNATIVES CONSIDERED BY THE INVESTOR AND REASON FOR THE SELECTED SOLUTION, TAKING IN CONSIDERATION ENVIRONMENT IMPACT

In 1973 Town of Banja Luka launched an initiative to find a location for sanitary deposition of communal waste. About 20 potential locations in Banja Luka area for communal waste disposal were analyzed in this process.

The current location in Ramići was selected as the most favourable location, from the aspect of local conditions, land morphology, hydro-geological, hydrological and climatic conditions, environment protection possibilities and transport distance.

The subject landfill has been exploited for about 30 years. The areas function has not been changed and it has not been reclaimed and according to basic planning documents: Solid waste control strategy in B&H, Regulatory Plan for the area of regional landfill of solid waste in Ramići, Banja Luka and Spatial Plan of Republic of Srpska, this area is foreseen for the purpose of solid waste deposition.

Due to all above stated reasons for selection of the subject location for sanitary Regional landfill, the Investor did not consider other alternative to project of rehabilitation of the existing landfill and its expansion to 44 ha.

Alternative to the project of rehabilitation and expansion of Regional landfill in Ramići could be rehabilitation of the existing landfill in accordance to Directive of European Union CD 1999/31 according to which the existing landfill would be rehabilitated as sanitary landfill and after that would be closed for further waste disposal. This would mean selection of a new location and construction of a new landfill according to Directive of European Union CD 1999/31 for deposition of solid communal waste from the Banja Luka region.

However, this would be in collision with the principle to decrease the number of landfills in B&H, it would require new land expropriations, change of B&H Solid Waste Control Strategy and it would require more financial means and new obligations toward the World Bank through new credit lines that are hard to get.

For that reason, the Investor decided that the project of rehabilitation and expansion of the existing Regional landfill in Ramići was the only acceptable solution.

2.8. HARMONIZATION OF THE PROJECT WITH REPUBLIC STRATEGIC PLAN OF ENVIRONMENT PROTECTION, OTHER PLANS BASED ON THE REQUIRED LAWS AND PLANS PROGRAMS OF ENVIRONEMENT PROTECTION OF LOCAL SELFGOVERNENCES UNITS TO WHICH THE PROJECT REFERS

The Final Design of rehabilitation and expansion of the Ramići Regional Landfill will be harmonized with Republic Strategic Plan on Environment Protection, other plans based on special laws and plans and programs of environment protection of local self-governance units to which the project refers based on application of all measures for prevention, reduction and mitigation of harmful impact on environment defined by this Environment Impact Study.

The project of rehabilitation and expansion of the existing landfill is in accordance with the Solid Waste Management Strategy in B&H, Regulation Plan for the area of Regional sanitary landfill of solid waste in Ramići and Spatial Plan of Republic of Srpska, according to which this area is foreseen for disposal of solid waste.

LEAP for the Banja Luka Region hasn't been adopted yet, but the subject project will found its place within this document and will be harmonized with it.

Environment Impact Study of the Ramići Regional Landfill is in accordance with regulation of Instructions on contents of an Environment Impact Study ("Official Gazette" of RS, no 118/05), and it is supported by the Law on Environment Protection – Revised version (Official Gazette RS, no. 28/07).

2.9. DIFFICULTIES DURING COLLECTION OF EVENTUAL DATA FOR PREPARATION OF ENVIRONMENT IMPACT STUDY

The Authors of the Environment Impact Study of the Ramići Regional Landfill did not meet significant difficulties during collection of eventual data for preparation of this Study.

Public discussion on request and draft of the Environment Impact Study was held on 18 June 2007 at 11.00 am in House of Culture in Local Community of Dragočaj.

The participants in the discussion asked many questions that were not directly related to the public discussion theme. There were no concrete questions or remarks on the Environment Impact Study of the Ramići Landfill.

3. CONCLUSION

Problem of environment impact, rehabilitation, expansion and exploitation of the existing disposal of public waste in Ramici was analyzed as a part of a special study documentation on the level of the detailed analysis content.

Conceptual design of rehabilitation and expansion of the existing landfill Ramici was made by consortium of companies GWCC“ Vienna, HIDROTEHNIKA limited liability company Banja Luka and „DVOKUT PRO“ Sarajevo.

Overall problem is analyzed within the framework of several goals through which are included basis for research, description and evaluation of existing condition, complete analysis of impact and necessary protection measures.

Based on all analyses of relevant impacts it is possible to draw a general conclusion that, by specific measures, the landfill impacts could be held within the acceptable limits, and therefore we can conclude that by the realization of the subject project we can secure the necessary conditions for environment protection and that the project is secure with its function or technical solution in the sense of environment impact.

In the course of the project execution of the landfill rehabilitation and expansion and later during the landfill normal work it is necessary to establish and carry out the process of monitoring described in Article 2.6. „*Description of measures for environment impact monitoring in the course and after the project realization”.*

In the course of preparation of the Final Design of rehabilitation and expansion of the Ramići Regional Landfill, it is necessary that the Designer incorporates all necessary measures for environment protection defined within this Study into the Final design and later in the Detailed Design.

4. NON-TECHNICAL RESUME

4.2. SUMMARY AND ASSESMENT OF THE EXISTING ENVIRONMENT CONDITION

4.2.1. IDENTIFIED EMISSION RESOURCES

The biggest identified emission resource in this area is the existing landfill of communal waste. The surrounding settlements which have no drainage of foul waters by public sewage system, very busy main road Banja Luka – Prijedor M4, industrial zone with many production and service capacities.

4.2.2. AIR CONDITION AT THE SUBJECT LOCATION

In order to determine the air quality on the location of Regional landfill in Ramići, Civil Engineering Institute „IG“ Banja Luka carried out 24hours/10 days continuous measuring of the air quality starting from 05 September 2006 on the location of the Ramići Regional Landfill owned by PC «DEP-OT» Banja Luka.

The mentioned measuring were carried out by Mobile Ecological Laboratory (MEL) in the zone of the Ramići Landfill impact, that is on the landfill exactly, (on the plateau above container made for workers, which is located on a plateau 100m above the entrance toward the landfill body).

Measuring of emission concentration of relative factors of the air quality were carried out and they included: measuring of pollutants emission concentrations, together with measuring of micro-meteorological parameters: speed and direction of wind, temperature and relative air humidity.

4.2.2.1. The air pollution analysis at the subject location

The average concentration of total suspended particles during the entire measuring was 21,0 µg/m^3. The biggest registered concentration was about 108,0 µg/m^3, on the first measuring day, and after that the maximal reached concentrations were up 78,0 µg/m^3.

The average registered concentration of CO was 563 µg/m^3. It is quite low concentration and it can not present a problem for the surrounding atmosphere because they are concentration below limit values. The spreading direction of carbon-monoxide was mostly toward south-east .

Concentration of CO_2 during the measuring has the constant value, without extremes from 824 µg/m^3.

The average daily concentration of nitrate-monoxide (NO) during the measuring was 4,0 µg/m^3, while maximal registered value was from 12,6 µg/m^3.

The average concentration of NO_2 in mentioned measuring period was 8,0 µg/m^3. During the measuring the maximal concentration were registered couple times of 26,0 µg/m^3. Maximal concentration is a consequence of increased traffic intensity on Banja Luka – Prijedor main road.

The average concentration of NO_x during the measuring was 13,0 µg/m^3. The maximal registered concentration of NO_x was up to 39,0 µg/m^3. The regularity of increase and reduction of concentration of NO_x is the same as if regularity for concentration of NO_2, which is logical.

Average 24 – hour concentration of SO_2 was 7,0 µg/m^3. The regularity of oscillations of sulphur-dioxide concentration coincides with oscillations of traffic intensity on Banja Luka – Prijedor main road, which brings us to conclusion that the oscillation intensity is caused by internal combustion engines, i.e. from the main road.

Higher concentrations are registered in the afternoon period of the first measuring day, with tendency for decreasing and continuous oscillations in the further measuring. The maximal concentration 27,0 µg/m^3 was registered then.

Average 24 – hour concentrations of H_2S were 5,6 µg/m^3. Concentration of H_2S had regular and balanced oscillations during the entire measuring period. Maximal registered H_2S concentration was 15,0 µg/m^3.

Average emission concentrations of methane originating mostly from the landfill where it is created as a product of segregations of waste organic components amounted to 1,307 mg/m^3 and the oscillation during the measuring was quite balanced.
With the non-methane carbon-oxygen the average 24-hours concentration was 0,615 mg/m^3, while the maximal registered concentration was 2,000 mg/m^3 and it was registered several times during the measuring .

The average ozone concentration during the measuring was 117,0 µg/m^3, and the maximal registered concentration was up to 160 µg/m^3, which is quite high concentration exceeding limit high values prescribed by the Book of Rules on limit air quality values (Official Gazette of RS no. 39/05) of 150 µg/m^3. The maximal registered concentration was reached several times and it was caused by atmospheric discharging and raining .

The achieved results of the measured pollutants do exceed neither limit nor aimed values according to the Book of Rules on limit air quality values (Official Gazette of RS, no. 39/05). The concentration of pollutants with higher values are the consequence of increasing traffic intensity on Banja Luka – Prijedor main road. Although all concentration are below the limit values it still represents a certain level of pollution of the surrounding air.

4.2.3. WATER QUALITY IN THE LOCATION VICINITY

All water testing were carried out in "Tatić" certified laboratory for water analysis, Osječani, Doboj.

The results of water samples taken from the main sewer under the landfill dam and samples taken from the Glogovac brook channel were commented in accordance with the Book of Rules on conditions for release of waste water into surface water (Official Gazette RS no: 44/01), and analysis results of Dračočaj river water, before and after Glogovac brook estuary were commented in accordance with Decree on classification and categorization of water flows (Official Gazette RS, no. 42/01).

Water samples from the landfill vicinity were taken on September 12th, 22nd and 25th 2006. The sampling was carried out by "Tatić" laboratory expert team on the following four locations

- On main sewer under the existing landfill's dam (beginning of the Glogovac brook),
- 300 m downstream in the Glogovac brook channel, in the culvert under Banja Luka – Prijedor main road, close to "Unis" factory,
- At the estuary of Glogovac brook into Dragočaj river, water from Dragočaj River before the Glogovac brook empting into Dragočaj River.
- At the estuary of Glogovac brook into Dragočaj river, water from Dragočaj River after the Glogovac brook empting into Dragočaj River.

Physical/chemical parameters as well as microbiological indicators of water pollution were determined in the taken water samples.

Observing the results of physical-chemical and microbiological analyses of water samples taken at the landfill main sewage we can make a conclusion that these waters are very polluted both by organic and inorganic substances, as well as in micro organic sense and must not be released into natural water streams without prior treatment.

Observing the results of physical-chemical and microbiological analysis of water samples taken from the river Dragocaj, after the Glogovac brook water mouth and comparing them to the results obtained by the sample analysis taken simultaneously from the river Dragocaj only above the mouth and to the Regulation on classification and categorization of water course (Official Gazette of Republic of Srpska, no 42/01), a conclusion can be drawn that the quality of the river Dragocaj, downstream from the mouth of the water of the brook Glogovac decreases, i.e. that the water of the brook Glogovac violates the water quality of the river Dragocaj.

4.2.4. LAND FERTELITY AND CONTENT OF HARMFUL AND WASTE COMPOUND IN SOIL

In order to define ''zero'' soil state at the very landfill location, the sampling was performed by dividing the total surface into five parcels, and on each was taken a surface compound sample and a deep compound sample.

Physical-chemical characteristics, analyses of microelements and heavy metals in the soil were determined in the taken soil samples

Complete soil testing is performed at the Agricultural Institute of Republic of Srpska, Banja Luka in the laboratory for pedology.

Bosnia and Herzegovina has no legal regulation that could be used for comparation of the analysis results of concentration values of certain harmful substances in the sampled soil.

Republic of Montenegro has passed *Book of Rules on permitted values of dangerous and harmful substances in soil and methods fop testing* (Official Gazette of R. Montenegro, no. 18/97).

According to this Book of Rules the Maximal Permitted Value (MPV) of dangerous and harmful substance in soil for:

- Cadmium, Cd amounts to 2 mg/kg of soil,
- Lead, Pb amounts to 50 mg/kg of soil,
- Zink, Zn amounts to 300 mg/kg of soil,
- Copper, Cu amounts to 100 mg/kg of soil.

Concentration of these dangerous and harmful substances in all soil samples are below Maximal Permitted Values according to the mentioned BoR, apart for samples: 2. – deep, 5. – surface, 8. – deep, 9. – surface and 10. deep in which the concentration of Cadmium, Cd, is slightly above or equal to Maximal Permitted Value (MPV).

In the subject samples, concretely speaking in soil sample 9. – surface analysis found cadmium concentration, Cd, of 5 mg/kg of soil, and maximal permitted value is 2 mg/kg of soil in accordance with the mention Book of Rules, and deep analysis on soil sample 2. revealed Cadmium concentration Cd, of 3 mg/kg of soil.

In soil samples 5. – surface, 8. – deep and 10. deep, the analysis found cadmium concentration, Cd, of 2 mg/kg of soil, and the maximal permitted value is 2 mg/kg of soil according to the mentioned Book of Rules.

According to the pedological chart of SFRJ (Section Banja Luka 2) the entire included area is placed on podzol pseudogley terraced soil (terraced brown soil placed on clay). Mechanical structure of B horizon disables flowing off of the surface water so that during the moist part of year it stagnates in the cross section of the soil. Natural draining is weak and incomplete. Chemical features

of the soil are also bad. Soil reaction is acid, humus is poor and base content is low. There's deficit of phosphorus and potassium. Having in mind natural conditions and the purpose of the area it can be concluded that, first of all, due to pedosphere pollution, at the stake are extreme conditions for the development of forest vegetation.

4.3. PROJECT DESCRIPTION, INCLUDING ITS PURPOSE AND SIZE

The existing Regional Landfill covers the area of 29 ha. Design for rehabilitation and expansion foresees expansion to 44 ha to the space bordering with the existing landfill.

According to Conceptual design for rehabilitation and expansion of the existing Landfill in Ramici the following necessary operations will be performed on the existing landfill:.
:

1. Construction of Eastern Border dam
2. Construction of "Canyon" through old waste compartment
3. Construction of top cover at the old landfill compartment 1 of the old part of the landfill ("low reactivity compartment")
4. Excavation and "cleaning" of compartments III.2 + IV and refilling in compartments III.1 and II
5. Use of compartment II and III.2 for intermediate phase until new landfill compartment IV is in operation
6. Closure of compartment II and III.2 (covering/cap sheet with the system for gas collection and recirculation system for seepage water)
7. Construction of new landfill compartments IV
8. Construction of storage tank for seepage water, gas incineration unit and recirculation system for seepage water
9. Extension of access and operational road system
10. Extension of entrance area, operational building and construction of storehouse for recycling material

The Landfill parts that will exist after the process of rehabilitation and expansion is finished are as follows:

- Compartment A1 at 2.8 ha,
- Compartment A2 at 2.9 ha,
- Canon K at 2.3 ha, between compartments A1 and A2,
- Compartment B1 at 3.0 ha,
- Compartment B2 at 2.8 ha,
- Compartment C at 8.5 ha,
- The landfill's part D foreseen for storing and collection of seepage and fire fighting water,
- The landfill's part E foreseen for seepage water treatment,
- The landfill's part F foreseen for gas combustion,
- The landfill's entrance zone and parking space,
- Part of EXPANSION in the first phase to 3.29 ha,

- Part of EXPANSION in the second phase to 1.78 ha,
- Part of EXPANSION foreseen for waste treatment to 0.86 ha
- Part of EXPANSION foreseen for recycling and sorting of waste to 0.45 ha.

Dislocation of all facilities and departments for stockpiling of the existing and future landfill is presented in drawing *Plan of space organization of the Ramići Landfill after rehabilitation and expansion to 44 ha* can be found in Attachments to this Study.

A new border dam will be constructed on the eastern part of the old part of the landfill – as well as on the northern and southern part of the access to the canyon. These parts of the dam will be constructed as earth dams with maximal height of about 2.0 m, inclination of 10% and length of 100 m (southern part) and 140 m (northern part).

Canyon will be constructed through the compartment A, starting from the area of the northern border all to the area for storage of seepage water, in the middle of the landfill location.

This canyon will be constructed in so called ''open construction'' by digging the waste along the planned canyon, starting from the eastern border dam (about 280.000 m³). Excavated waste will be put on the existing waste in the compartment A and it will be used for the compartment molding.

During the construction of the canyon there will be performed interception of the existing spring, which is located in the vicinity. The spring will be dug (and it will be checked if there is any former interception or pipe). After locating the points where the spring is coming to the surface, an interception of the spring as well as the area of the filtering with pebbles will be constructed.

After finalizing, the spring interception will be covered with mineral cover in order to prevent seepage water to penetrate. Spring water will be discharged with gravitational pipes into the main sewer for collection of precipitation water. Connecting points will be equipped with control/measuring chamber.

In order to create area for construction of the location for expansion and in order to reduce the areas of the landfill which do not have sealed surface/floor, the waste which has already been disposed (as well as polluted soil) in the III/3 and IV will be excavated (about 250.000 m³) and disposed in the compartments B1 and B2.

Before that, compartments B1 and B2 will be prepared by the construction of new border dam and by molding of the waste. Further on, these compartments will be used for waste disposal until the construction of the first part of the area of expansion is completed.

When compartments of the landfill are ready for disposal, compartments B1 and B2 will be covered with mineral sealing system, while the well and the recirculation system of seepage water will be constructed. A mineral sealing

system in accordance with EU standards CD 1999/31/EC will be constructed for the landfill's old parts with high reactivity and it will serve as a combined sealer.

New part of the landfill will be constructed for the disposal of non dangerous public waste.

New landfill compartment C will be constructed (in the southern-western part of the existing landfill) in strongboxes, starting with the compartment I. Planned compartments (II – VII) will be developed successively around the compartment I.

Projected sealing system shall be constructed for the new part of the landfill in compliance with EU standards CD 1999/31/EC as combined sealing and it consists of (from the top to the bottom):

Main sewer system for seepage water will secure gravitational drainage of the seepage water and supervision of the pipes for seepage water even after the landfill is closed.

The system for combustion of gas collected from the landfill and the system for seepage water treatment will be constructed under the east dam.

During the landfill expansion, the taken land will also be used during the works execution, so no additional land will be taken for this purpose. After the landfill rehabilitation and expansion this area will be used for basic landfill function – waste deposition and all auxiliary activities (waste receive, unloading, sorting, stockpiling, covering, vehicles washing,…).

4.4. DESCRIPTION OF POSSIBLE PROJECT IMPACTS TO LIVING ENVIRONMENT

Basic natural elements quality degradation can be created as a result of natural or anthropogenic processes. The specific location with all its natural elements is under anthropogenic degradation which lasts for long time period of time, thus presently has a cumulative character.

The existing degradation is reflected mainly through:

5. Water (surface and underground) pollution,
6. Accumulation of solid waste,
7. Atmosphere pollution,
8. Noise appearance etc.

Area defined by this plan was used as a waste landfill in previous period, but even though it was planned as sanitary landfill, the waste was not disposed in sanitary way.

Rehabilitation, expansion and exploitation of the subject landfill in determined situations can, regardless of all technical-technological solutions, namely working operations and equipment usage, present hazard for workers also as

source of living environment pollution. The success of each solution in the working and living environment protection area implies versatile consideration and definition of all possible impacts.

Living environment impact during rehabilitation and expansion of existing landfill in Ramići can be expected in two phases:

- Living environment impacts which will occur during the phase of works on the old part rehabilitation and construction of landfill enlargement area and
- Living environment impacts which will occur during landfill exploitation phase.

The most significant living environment impacts of rehabilitation works on the existing waste landfill are the impacts that can occur as a result of location preparation, as well as works during rehabilitation and landfill expansion process, namely realization of works per phases.

Impacts during rehabilitation and expansion as well as exploitation impacts can be manifested as characteristic impacts on:

- Water quality impacts,
- Air quality impacts,
  - Gas impacts,
    - Landfill gases impacts,
    - Impacts of emission gases and suspended particles of the landfill mechanization and transport,
  - Suspended particles impact,
- Soil quality impact,
- Total noise level impact,
  - Impact during rehabilitation,
  - Impact during exploitation,
- Impacts over vibrations and radiation intensity,
- Flora and fauna quality impacts,
- Impact on the population health,
- Impact on meteorological parameters and climate characteristics,
- Ecosystem quality impact,
- Impact over inhabitation, concentration and migration of population,

- Impact over quality, purpose and use of areas (constructed and unconstructed areas, use of agricultural land),

- Communal infrastructure impact,

- Impacts on natural heritage of special values, cultural heritage, material heritage including cultural – historical and archaeological heritage,

- Impacts on quality of the area landscape characteristics,
  - Impacts on visual quality of landscape,
  - Impacts on landscape exposure,

- Accidental situations impacts

4.5. DESCRIPTION OF MEASURES FOR PREVENTION, REDUCTION AND MITIGATION OF HARMFUL IMPACT TO ENVIRONMENT

After the analysis of environment impact assessment of the existing landfill in Ramići rehabilitation, expansion and exploitation, the conclusion has been made that taking into account the impacts character and importance certain impact level exists.

When analyzing each of the impacts, the Authors defined measures for prevention, reduction and mitigation of these impacts to environment through definition of measures for space organization, technical – technological, sanitary – hygienic, biological, organizational, legal and other measures.

Besides these measures we defined technical – technological, sanitary – hygienic and biological measures that are integrated into *the measures foreseen by the law and other regulations, normative and standards.* Within these measures we defined the following:

- Water and soil protection measures,
- Air protection measures,
- Flora and fauna protection measures,
- Landscape protection measures,
- Noise protection measures,
- Human health protection measures,
- Protection measures in case of major accidents.

Within the measures description for prevention, reduction and mitigation of harmful impact to environment we described *Plans and technical solutions for environment protection (recycling, treatment and disposition of waste substances, reclamation, rehabilitation and similar)* as well as *other measures that can impact prevention or reduction of harmful impact on environment.*

4.6. SUMMARY OF MAIN ALTERNATIVES CONSIDERED BY THE INVESTOR AND REASON FOR THE SELECTED SOLUTION, TAKING IN CONSIDERATION ENVIRONMENT IMPACT

the Investor decided that the project of rehabilitation and expansion of the existing Regional landfill in Ramići was the only acceptable solution and did not consider other alternatives to the project of rehabilitation and expansion of the existing landfill.

General Manager

Prof. PhD Zdravko Milovanović, BSME

ENVIRONMENT IMPACT STUDY OF REGIONAL LANDFILL IN RAMIĆI
REVISED VERSION

Reply to the Appraisal on given remarks of the interested public, interested bodies and preliminary professional attitude of the project Authors on the remarks

In accordance with the Appraisal no: 16-92-116/07 dated 20 July 2007 given by the Ministry for Spatial Planning, Civil Engineering and Ecology we have made the following amendments to the Draft Environment Impact Study of the Ramići Regional Landfill:

1. The Study was harmonized with Instructions on contents of environment impact studies (Official Gazette RS, no: 118/05), in the following way:

   - The Study has been divided into General and Technical parts,

   - The General part contains the following chapters:
     - Introduction explanations,
     - Starting points for the Study preparation,
     - Attached documentation.

   - In Technical Part of the Study, within chapter „*Description of the location and possible project impact to the environment"* the following subchapters have been elaborated and added:
     - Copy of cadastre plan copies foreseen for construction of the facility of the activities execution, with included plan of all facilities within the complex,
     - Data on the required land surface in m^2 during the construction, with description of physical characteristics and map presentation in appropriate scale, as well as the surfaces that will be included when the facility is constructed,
     - Summary of natural heritages and special values, immovable cultural heritage.

   - Within chapter *„Summary and Assessment of the Environment Condition"* the following subchapters have been elaborated and added:
     - Identified emission resources:
     - Level of industrial and traffic noise,
     - Level of ionizing and non-ionizing radiation,
     - Level of underground water, its moving directions and quality.

   - Within chapter *„The Project Description*" the following subchapters have been elaborated:

- Description of physical characteristics of the entire project and the land exploitation characteristics during the construction and the plant works foreseen by the project,
- Summary of type and quantity of required energy and energy sources, water, raw material, material necessary for construction etc.,
- Summary of type and amount of released gases, water and other liquid and gaseous waste substances in sense of technological units including: emissions into air, light, heat, radiation (ionizing and non-ionizing),
- Identification of type and assessment of quantities of possible waste, summary of treatment technologies (processing, recycling, deposition) of all kinds of waste substances.

- Within chapter *„Description of Possible Impacts"* the following sub-chapters have been elaborated:
  - Impact on vibrations intensity and radiation,
  - Impact on meteorological parameters and climatic characteristics,
  - Impact on ecosystem quality,
  - Impact on inhabitation, concentration and migration of populations,
  - Impact on purpose and exploitation of surfaces (constructed and non-constructed land, use of agricultural land),
  - Communal Infrastructure impact,
  - Methods description foreseen for environment impact assessment,

- Within chapter *„Description of measures for prevention, reduction and mitigation of harmful impacts to environment"* the following subchapters have been elaborated:
  - Measures for area arrangement,
  - Organizational,
  - Legal,
  - Measures foreseen by the law and other regulations, normative and standards and deadlines for their execution,
  - Plans and technical solutions for environment protection (recycling, treatment and disposition of waste substances, reclaiming, rehabilitation and similar),
  - Other measures that can impact prevention or reduction of harmful impact to environment.

- The following articles have been additionally elaborated *„Summary of main alternatives considered by the Investor and reasons for the selected solution, taking in consideration environment impacts", „The project harmonization.." and „Data on eventual difficulties…"*

- Chapter *„Non-technical Resume"* has been additionally elaborated.

2. Besides harmonization of the Revised version of the Study with Instruction on content of environment impact study (Official gazette RS, no: 118/05), there have been some minor modifications within the existing chapters, but the listing of these modifications would require a lot of time and space, so within this Reply to Appraisal of the competent Ministry we stated only significant changes of the Study contents.

ATTACHEMENTS

ATTACHEMENT 1.
REPORT ON REVISION
OF THE MINISTRY FOR SPATIAL PLANNING, CIVIL ENGINEERING AND ECOLOGY

ATTACHEMENT 2.
CADASTRAL PARCELS

ATTACHEMENT 3.
FAVOURABLENES OF THE LAND FOR THE LANDFILL LOCATION

ATTACHEMENT 4.
PLAN OF THE LAND ORGANIZATION AFTER REHABILITATION AND EXPANSION TO 44 ha

ATTACHEMENT 5.
GRAPHYC PRESENTATION OF ACHIEVED VALUES AND CONCENTRATIONS OF POLLUTANTS IN THE AIR ON THE SUBJECT LANDFILL LOCATION