Faculty of Natural and Technical Sciences, University "Goce Delčev"-Štip, R. Macedonia with a grant from the CEI-ES Know How Programme organize

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1st INTERNATIONAL WORKSHOP ON THE PROJECT

Environmental Impact assessment of the Kozuf metallogenic district in southern Macedonia in relation to groundwater resources, surface waters, soils and socio-economic consequences (ENIGMA)

PROCEEDINGS

Edited by:
T. Serafimovski & B. Boev

Kavadarci, 10th October 2013

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Language: English for presentations and papers

PROJECT SOLUTION FOR WATER USE FROM THE CATCHMENT AREA ON KOZUF, REPUBLIC OF MACEDONIA

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Abstract

In this paper will be show possible use of mineral waters from the catchment area on the mountain Kozuf. Project solution for using the mineral waters of this area, despite the general part gives way to the exploitation of mineral waters, technical - economic assessment of exploitation and environmental protection. Exploitation of mineral waters will be carried out from the catchment facilities - capturing the springs Bukata, Stenata and Studena Voda - Rimjanka and the captured water through the pipeline will be carry to the collection tank and from there will be distribute to the factory for filling water.

Key words: mineral water, spring, project solution, technical - economic assessment, environmental protection, capturing, exploitation of mineral water.

Introduction

The area in which are planned catchment facilities for exploitation of mineral water is located south of the village Mrezicko at a distance of about 2-3 km. Administratively, the area provided for investigative and exploratory work for exploitation of mineral water belongs within the area of the village Mrezicko, Municipality of Kavadarci, while the ground belongs to the geographical region of Mariovo from the Kavadarci side. The hydrographic network is poorly developed where as the main recipient of surface waters are rivers Mrezicka and Blastica.

Geological and hydrogeological researches in this area dated from the early mining activities at Mountain Kozuf. More detailed, geology and hydrogeology are studied in the period from 1970 to 1976 by the Geological Institute - Skopje during the development of basic geological maps scaled 1:100 000 for sheets Kozuf and Vitoliste, and the development of regional hydrogeological maps scaled 1:200 000.

Kotevski (1977) in the preparation of the study Hydrogeology of mineral, thermal and thermo mineral water in the territory of SRM has registered appearances, gives a brief description of the geology, hydrogeology, the conditions of their formation and water quality. Terzioski (1994) on the source village Mrezicko carried out detailed research in order to capture the mineral water for bottling. Within these studies was made a hydrogeological map at scale 1:25 000 of the wider vicinity and detailed hydro-geological map 1:500 around the source. Recent surveys and drilling were carried out during 2000 - 2001. Georgieva (1995) in her doctoral thesis gave general data about the thermomineral waters within this area. Hydrogeological features of the studied area lately were studied in more details by Petrov (2011).

Geological and hydrogeological characteristics

Wider vicinity of the terrain is presented with rocks that tectonically belong to the Vardar geotectonic zone. This terrain is composed of: amphibolite andesites; breccia tuffs; agglomerate breccia tuffs; fine grained andesite tuffs; calcareous tuffs; Pliocene sands, conglomerates and clays; dacites; Eocene conglomerates; cretaceous massive limestone; plate and bank limestone; clastic rocks, cherts and limestone; quartz - keratophyres, diabases; gabbro; Triassic sandstones, clayey schists, quartzite and cherts; bank and massive limestone; many colors of clay schists, cherts and sandstones; serpentinites; quartzites; quartz - porphyres; phylites, cipollino marble and marbles; cipollino marble and schists; phylites and philitic schists, marbles and cipollino marble and Precambrian muscovite gneisses.

According the lithological structure, the following types of aquifers areas are present: aquifers areas in rocks with karst - fissure porosity, aquifers areas in rocks with fissure porosity, relatively dry terrain (Fig. 1 and 2).

Based on the water - permeability, i.e. hydro - geological function of the rock masses, there are: water - permeable (hydro - geological collectors), low permeable (hydro - geological collectors - conductors) and water imperviousness areas (hydro - geological isolators, such as water impermeable parts within the Triassic and Cretaceous sediments).

Aquifers areas in rocks with karst - fissure porosity are developed within the Triassic marbleized limestone. In the near vicinity of the mineral spring, these rocks are present on small areas, and the large part of them composed the western part of the terrain. They are characterized with large folding and cracking in the near surface parts. According the location, karstification, and tectonic damage, this type of aquifer is primary type on this terrain.

Feeding the groundwater from this type of well is on account of rainfall and the draining is along the zones of faults and fissures.

According the hydro - dynamic characteristics, underground waters are characterized by a free level, and according the hydro - geological function, they are collectors of groundwater.

Aquifers areas in rocks with fissure porosity are present in faulted and cracked Cretaceous sediments (sandstones, slates, clay schists and alevrolites). They are thin layer sediments that exchange vertically and horizontally. With surrounding Triassic limestone these sediments are in tectonic contact and are treated as isolators. According the hydro - geological function, they are low - permeable and present conductors of groundwater.

Relatively dry terrains are separated in the areas composed of volcanic sediment rocks. They are thick from 50 to 100 m, and transverse overlap the marbleized Triassic limestone.

Based on the hydro - geological function, they are separated as hydro - geological isolators.

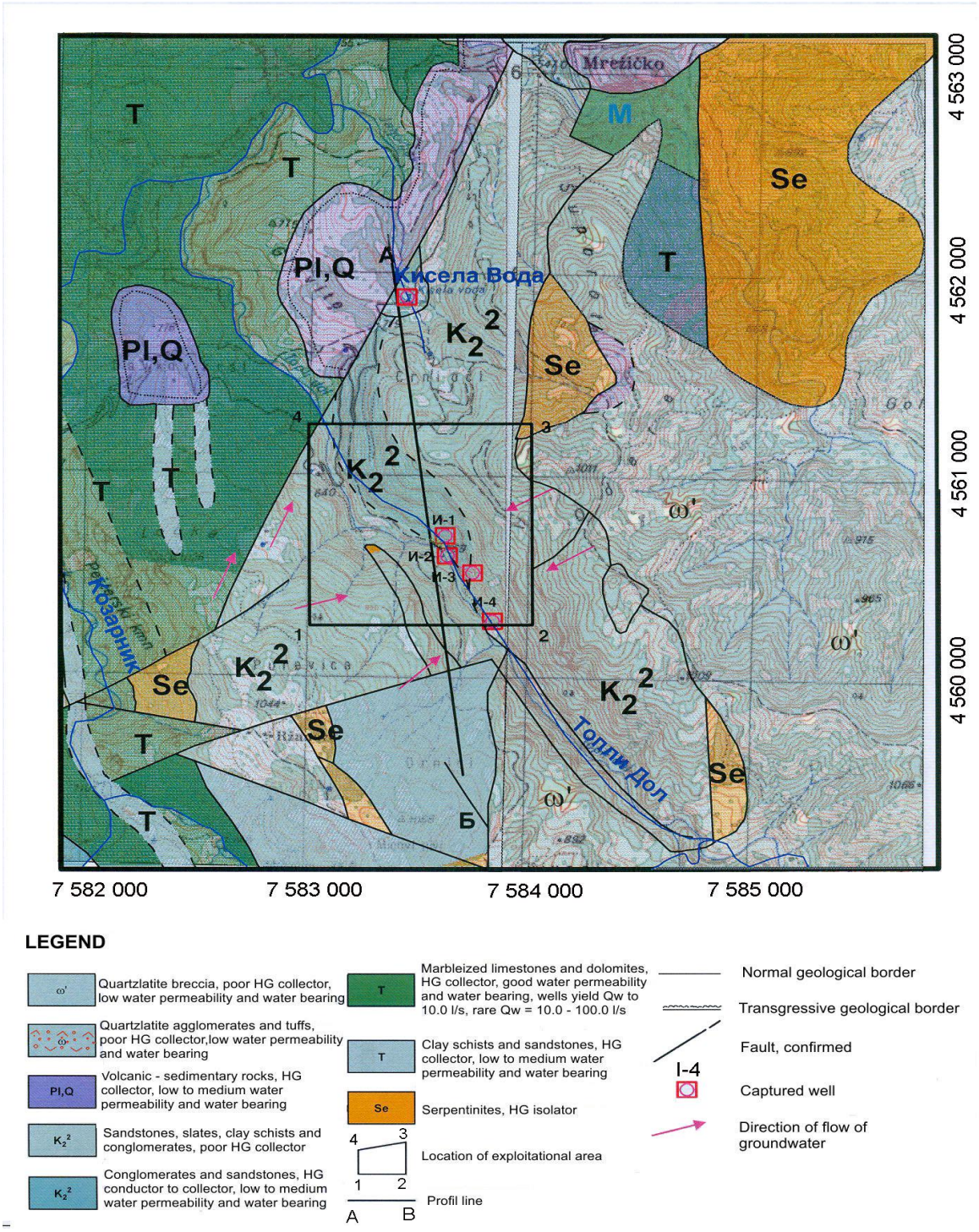

Fig. 1. Hydrogeological map of the studied area

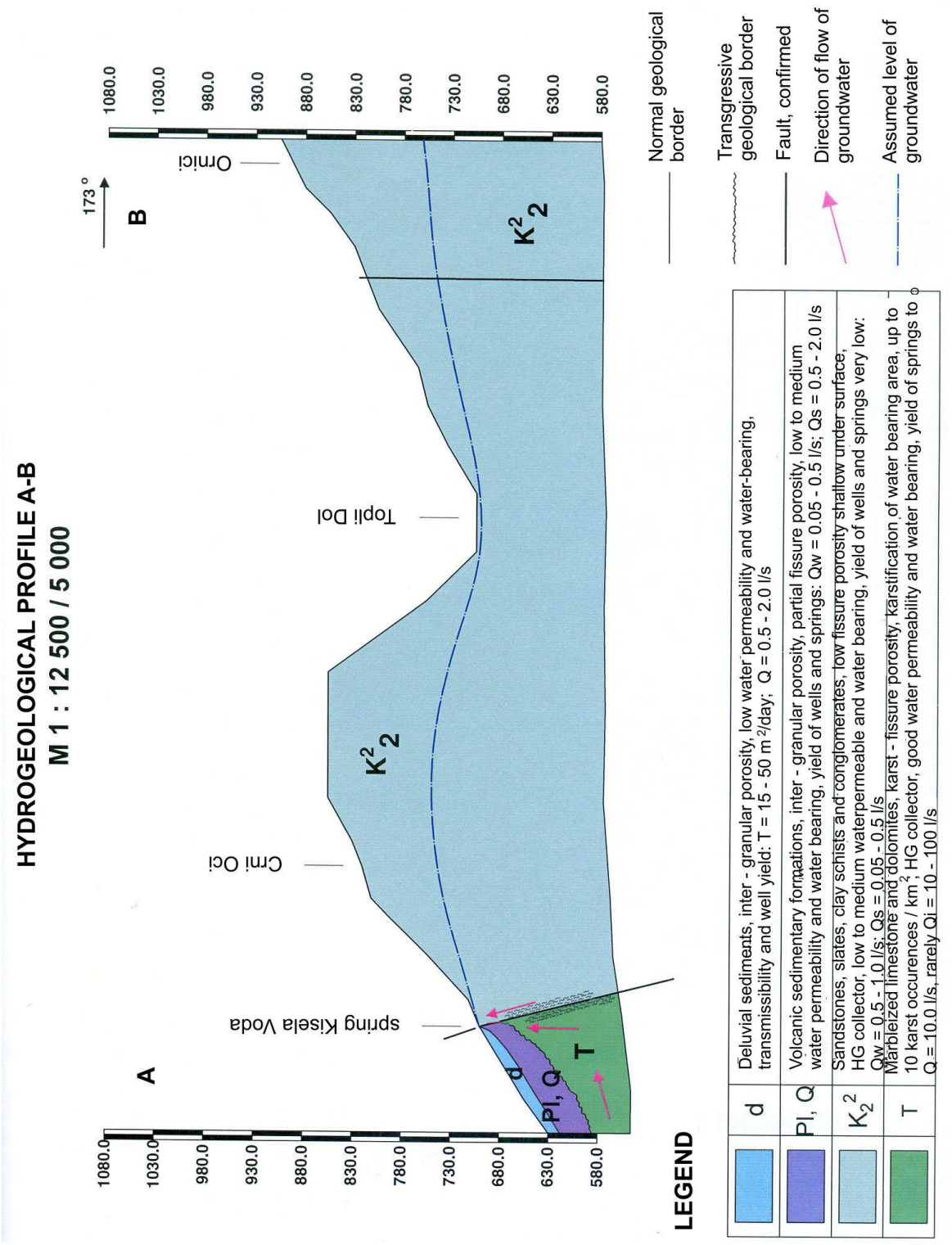

Fig. 2. Hydrogeological profile of the studied area

Water intake facilities

Water intake facilities are captured and located in fissure type of well and are characterized with the following features:

Well "Bukata" on the locality "Topli Dol" is characterized with permanent yield Q = 1,4 (l/s), and water temperature t_v = 14 °C.
To the facility for bottling is conducted with PVC pipes with Ǿ = 63 mm. From this water is bottled mineral water "Planinska".

Fig.3. Captured well "Bukata" in locality "Topli Dol"

Well "Stenata" on the locality "Topli Dol" is characterized with permanent yield Q = 1,2 (l/s), and water temperature t_v = 13 °C.
To the facility for bottling is conducted with PVC pipes with Ǿ = 63 mm. From this water is bottled mineral water "Planinska".

Fig.4. Captured well "Crvena Voda"

Well "Crvena Voda" is characterized with permanent yield Q = 1,0 (l/s), and water temperature t_v = 26 °C. To the facility for bottling is not conducted. And it is planned from this water to be bottled mineral water "Rimjanka".
Well "Crvena Voda" Rimjanka, is characterized with permanent yield Q = 1,80 (l/s), and water temperature t_v = 26 C.
To the facility for bottling is not conducted. And it is planned from this water to be bottled mineral water "Rimjanka".

Fig. 5. Captured well "Crvena Voda"

Basic feature for all wells is that they are characterized with permanent yield, parameter that shows that atmospheric falls have no direct influence on the wells. Unchangeable capacity shows that these waters are characterized with consistent quality.

Fig. 6. Captured well "Crvena Voda"- Rimjanka

Quality of thermal - mineral water

For assessment of groundwater quality from water intake objects for exploitation of mineral water, samples of water are taken in 2011 from the captured wells.
Analyses of water are made in the Republic Institute for Health Protection - Skopje. Based on the macro - component composition underground mineral waters, according the formula of Kurlov, the cationic and anionic composition belongs to the next type of water:

Well "Bukata"
- cationic composition is *Ca(68,2) /Mg(29,0) /Na + K(2,8)* type
- anionic composition is *HCO^3 (91,4) /CI (2,3) /SO^4 (6,3)* type

Well "Stenata"
- cationic composition is *Ca(37,1) /Mð(23,1)/Na + K(39,8)* type
- anionic composition is *HCO^3 (73,5) /CI (21,6)/SO^4 (4,9)* type

Well "Crvena Voda" Rimjanka
- cationic composition is *Ca(69,9) /Mð(28,1) /Na + K(2,0)* type
- anionic composition is *HCO^3 (91,8)/C1 (2,3)/SO^4 (5,9)* type

According to the Rules for specific security requirements of natural mineral water, natural mineral water meets the legal and technical regulations in terms of parameters examined for physical and chemical analysis. It is necessary to perform regular conditioning and disinfection by ultraviolet lamp on mineral water so it could be used for drinking or for production of carbonated bottled natural mineral water.

Technical - economic assessment

To begin with the exploitation of the mineral water it is necessary to address all infrastructure problems of exploitation, processing and transportation of finished products, and to provide placing for them.
Water intake objects, i.e. captured wells are found near the village Mrezicko, municipality of Kavadarci. Wells are captured and conducted to the place for bottling which is found in village Mrezicko, and which is traffic associated with Kavadarci i.e. it is provided a requirement for ranking the bottled mineral water across markets in the country and abroad.

Socio - economic factors

Providing additional quantities of mineral water from the captured sources close to the village Mrezicko, Municipality of Kavadarci and ensuring proper placement market from the economic aspect will be created to conditions for stable sources of income. While the increase in production of existing capacity would open about 10 new jobs, and locally, this part would have a major impact on the economic power of the population in these conditions of unemployment.

Cost - benefit analysis of economic (value) viability for exploitation of the site

The assessment of the feasibility of investing in the opening and exploitation of mineral resources is based on today's technological opportunities and knowledge. It depends on the dynamics of future market conditions and technological development, and that in the coming years are likely to change i.e. today they are hard to predict.
The basic criterion for assessing the economic viability of the investment is cost-effectiveness, i.e. whether investments provide sufficient funds to cover the costs of the company, but despite profitability, significant factor is the liquidity of the project. To obtain the best possible realistic assessment of profitability and liquidity of the project i.e. feasibility of exploitation of mineral water from the captured sources close to the village

Mrezicko, Municipality of Kavadarci, following detailed analysis and calculations are made:

Total revenue

Anticipated annually revenue, which would be realized from the sale of products from packaging mineral water is calculated by the formula:

$$P_{vk} = (Qi \times Ci)$$

where: Qi - capacity of production of mineral water l/year,
Ci - selling price of bottled water in €.

Production is planned to be carried out 12 hours a day, or 22 days per month. In the calculation is assumed that the average production capacity of mineral water average would be around 10.800,00 l / hour or 3,0 l / s. The utilization of the total capacity of the sources at the beginning would be about 60% of exploitation reserves. Selling price under current market conditions in the Republic of Macedonia is 0,16 € / liter, and in that case the annual income from the sale of products packaged mineral water would be approximately 5.474.304,00 € / year.

Direct production costs

Costs that appear during the production of packed mineral water are expressed in worker salaries, production and distributive costs, concession fee etc. The costs are presented in Table 1.

Table 1. Overview of direct production expenses

No.	Type of expense	Sum (€/year)
1	Salaries for 10 workers in amount of 500 €/month	60.000,00
2	Concession fee for exploitation area for thermal - mineral water for 1 km^2	2.000,00
3	Concession fee for exploitation of mineral water (3 % of 4 denars/liter)	66.760,00
4	Production, distribution costs, marketing, management and control	4.639.806,00
5	Other expenses	30.000,00
	TOTAL	4.798.566,00

Annual profit

Total annual profit is difference between the total sales revenue (P_Vk) and direct production costs (Td)

Bb = Pvk - Td = 5.474.304,00 €/year - 4.798.566,00 €/year = 675.738,00 €/year

Net annual profit is obtained by deducting the value added tax of the gross annual income and it is:

Bn = Bb - VAT (18%) = 675.738,00 €/year - 121.632,80 €/year = 554.105,20 €/year

From the calculation is seen that planned gross annual profit will be about 554.105,20 €/year, and the profit for the entire duration of the contract of 30 years would be around 16.623.155,00 €.

Investments

Investments in equipping the facility and plant for production and sale of final products - packaged mineral water contained in the direct previous investments which are shown in Table 2.

Table 2. Overview of direct previous investments and total investments

No.	Type of investment	Amount (€/year)
	Direct investments (Id)	190.000,00
1	Making capturing, intake and pipeline of thermal - mineral water	30.000,00
2	Lodge	10.000,00
3	Electricity (substation and transmission line)	30.000,00
4	Motor vehicles (trucks, forklifts, etc.).	100.000,00
5	Setting building place (fencing, concreting, greening, etc.)	10.000,00
6	Water and sewerage network	10.000,00
	Previous investments (In)	69.000,00
7	Repurchase of facilities	60.000,00
8	Technical documentation for obtaining concession for exploitation	4.000,00
9	Technical documentation for getting a licence for exploitation	5.000,00
	Total investments (I = Id - In)	259.000,00

From the table 2 is seen that related to total investments, direct investments contribute with 77,2 %, and the previous investments contribute with 22,8 %.
Previously calculated amount of net profit represents net current (present) value of the funds or calculations gave the static appraisal of the project. However, when deciding the feasibility of investing in opening deposits and construction of a factory for packing water should take into account the time course of revenue, i.e. to perform dynamic appraisal.

Dynamic assessment of the viability of investments

Dynamic assessment takes into account the time in the process of analysis and assessment of the investment project, covering the entire period of investment in exploration. It is possible with the techniques of discounting which include investments and profits from all years of the investment period and the period of exploitation. One of the methods that are used for dynamic evaluation of projects: net present value, internal rate of return, the return period of investment, the annuity method and others.

Net present value (NPV), in the world literature in the field of investment in mineral resources is widely used, and most in the assessment of feasibility of investment. Numerous problems of mineral resources such as reconstruction of water catchment facilities, maintenance and reconstruction of water supply and equipment for filling and packaging of water, the way of development, purchase of equipment and others, are associated with investments that later in the exploitation to be paid, or to return through income. These investments should not commence until an analysis of the feasibility of the project is made. Net present value is actually the difference between costs and profits reduced to present value. Net present value of the stream of costs and benefits is:

$$\mathbf{NPV} = \sum_{n=1}^{t} \frac{B_n}{(I+r)^n} - T_n$$

- B_n - annual income (benefit) in the year "n"
- T_n - annual cost (total investment) in year "n"
- r - discount rate for the exploitation projects ranges from 10 - 15% (15% is adopted for the most adverse conditions of funding).

According to this method, the net present value of investing in different annual income and expenses amounted to 259.000,00 € (NPV> 0), so that project or investment in the exploitation of mineral water surrounding the village Mrezicko, Kavadarci can be considered as a profitable and viable.

Internal rate of return (IRR), presents an annual average rate of the period of investment. The evaluation of this method was taken into account discount rate of 15% which compares the resulting rate of profitability. For the proposed project internal rate of viability is > 50%, so according this method, the project can be considered feasible because annual earnings will exceed the annuity payments.

The return period of investment, indicates the time it takes to return all invested funds with realized benefits in the economic life of the project. In this case return on investment of the concessionaire will be held after the first year of exploration and production.
According to the above, i.e. presented economic analyzes and evaluations can be concluded that the project is cost-effective and liquid or economic assessment for it is positive.

Exploitation of mineral water

Exploitation of the mineral water will be in the water catchment facilities - captured wells.
Water catchment exploitation facilities are further detailed. Providing water impoundment is based on the capturing of the wells "Bukata", "Stenata" and "Studena Voda" - Rimjanka where captured water, using a pipeline, is carried to the collection tank from where it is distributed to the plant for filling water.

Total capacity of catchment of mineral water from the catchment facilities is about Q_{total} = 4,78 l/s, and the unit maximal catchment capacity is:
• well "Bukata" - Q_{max} = 1,26 l/s;
• well "Stenata" - O_{max} = 1,00 l/s;
• well "Crvena Voda" - Q_{max} = 0,90 l/s and
• well "Crvena Voda " Rimjanka - Q_{max} = 1,62 l/s;

Mineral water is exploited from captured wells in water bearing area with fissured porosity, and technological process of production of mineral water contains several operations:
• getting mineral water from the water catchment facilities - wells;
• transport of water from the catchment facilities - wells;
• preparing the water for filling;
• filling the water and transport of empty and full packaging and
• control of the technology for filling water.

With proper capturing and by preventing the impact of storm water provides bacteriological clean water in sufficient quantity to lead to the production plant. Transportation of water from the sources to the production plant is done through PVC - pipe. The length of the pipeline is about 3.5 km.

Conclusion

Exploitation of mineral water will be performed from the water intake objects / captured wells: well "Bukata" - Qmax = 1,26 l/s; well "Stenata" - Qmax = 1,00 l/s; well "Crvena Voda" - Qmax = 0,90 l/s and well "Crvena Voda" Rimjanka - Qmax = 1,62 l/s.
Total capacity of catchment of the mineral water from the water intake facilities is about Qsum = 4,78 l/s.
According the chemical composition, mineral water from the wells has cationic composition Ca/Mg /Na+K type, and anionic composition is HCO3 /CI/SO4 type.
The planned maximum daily required amount is about 7,200, bottles per hour or about 10,000.00 liters of water per hour. This amount of water can be provided with continuous pumping of water with 2 l / s for 24 hours.
The project - a plant for production of mineral water is represented with modern technical and functional content.
According to calculations, the projected net annual profits of the project will amount to approximately 554.105,20 € / year, while profits for the entire duration of the contract of 30 years would be around 16.623.155,00 €.
Total investment assets are estimated at 259.000,00 €, of which direct investment accounted for 77.2%, while the previous investment for only 22.8% .For this project internal rate of viability is > 50 %, so it can be considered feasible because annual earnings will exceed the annuity payments.
Based on the economic analyzes and evaluations can be concluded that the project is cost-effective and liquid or economic assessment of it is positive.

Captures on the sources are well done and provided with all protective measures to prevent contamination of mineral water or groundwater.
Although this plant for exploitation of mineral water belongs to the group of objects that are big polluters, there are proposed technical, business, organizational solutions (methods, method of construction, selected equipment, etc.) and measures to protect the environment.
Significant proposed measures to protect the environment are: purification of wastewater with treatment plant construction, sanitary and fecal waters collection with two-chambered septic tank; determining exploitation area and protection zone; greening of space, collection, storage and disposal municipal and other waste; performing permanent control for excessive emissions from vehicles, a drop of fuel, oil and various chemicals, noise and vibration and other measures.
Based on the above it can be concluded that the envisaged solutions for the performance of activities, then the proposed measures to protect the environment as well as the measures of safety and technical protection and permanent monitoring of the situation, will prevent jeopardizing the environment.

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