REPUBLIC OF MOLDOVA

APA CANAL CHISINAU

CHISINAU WATER SUPPLY & SEWAGE TREATMENT - FEASIBILITY STUDY

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Underground Water Resources Assessment - FINAL

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LIST OF ABBREVIATIONS AND ACRONYMS

ACC	ApaCanal
CAPEX	Capital Expenses
EBRD	European Bank for Reconstruction and Development
EU	European Union
O&M	Operation and Maintenance
OPEX	Operation Expenses
PS	Pumping Station
ToR	Terms of Reference

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1. FOREWORD

Basically, the objective of this report is to provide an overall assessment of the underground water resources within the Study Area.

The first part presents the geological and hydrogeological context.

Then the current use of underground water resources is detailed. Although the water supply of Chisinau relies almost exclusively on the River Nistru, the other villages and localities of the Study Area are being supplied from groundwater resources. The current situation being assessed, we provide then a set of proposals that aim to secure the supply of population with “potable” water.

The last point concerns the Emergency Plan. In the current situation, the security of supply within Chisinau is very vulnerable, as there are no facilities available to maintain supplies should the Nistru River be polluted. In the extension of the current plan developed by ACC, we propose some recommendations mobilizing underground water resources.

2. GEOLOGICAL AND HYDROGEOLOGICAL CONTEXT

2.1. GEOLOGY

A full and detailed description of the geological context is presented in Appendix 1.

The Study Area presents the same geological proprieties that characterize the entire country. It is situated on a stable Pre-Cambrian (much older than 560 million years) crystalline shield often denoted as the European Platform or locally known as the Russian platform.

The rocks overlaying this very old stable platform date from the Paleozoic and Mesozoic ages (actually they are “sandwiched” between the crystalline basement and the Miocene rocks).

Within the perimeter of the study area, the Miocene sediment pile is of paramount importance from hydrogeological point of view. Miocene strata are almost sub-horizontal without orogeny, and widely developed in the perimeter of the study area. Present-day area is built up by the clayey and sandy marine rocks of Miocene age. They are exposed in the valley of the River Nistru. A dip South-West is noticed.

2.2. HYDROGEOLOGICAL CONDITIONS

2.2.1. BEARING AQUIFER

The storage capacity of a layer depends on its constitution, in particular on the presence of sand, clay and calcareous rocks.

A general hydrogeological description of the study area is provided below.

Shallow (phreatic) aquifer

This aquifer is located within the geological strata that are exposed on a plateau between the valleys of Bîc, Ishnovet, Botna and Nistru.

Water bearing rocks are presented by thin strata of sand, sandy clay or sandwiched stratum of clay, sand and gravel. Usually these strata are not thickener than a few meters and not very deep. Water is abstracted using traditional wells: ground water tables are usually within 10 m and the wells never become dry. Shallow (phreatic) ground water is widely used in rural areas surrounding Chisinau. Nearly every house has its own well(s) in the yard with diameters ranging from 0.5 to 2 m. Some of the wells are equipped with small pumps.

Shallow groundwater vulnerability to surface pollution is high.

Middle and lower Sarmatian aquifer.

Middle – Lower Sarmatian horizon is composed from limestone. This aquifer is widely present in Moldova and is mainly used for fresh water supply.

The top of this permeable horizon is about +50m asl in the Northern part of the city and about -50m in the Southern part. The thickness of the aquifer ranges between 30m and 110m with an average around 50m. This aquifer is a confined type.

Within the study area the aquifer is well used for water supply purposes, in particularly by ACC itself. The capacity of wells ranges from $10m^3/h$ to $50m^3/h$, with an exceptional peak at Ialoveni ($100m^3/h$). Most of the wells are more than 100m deep.

Cretaceous aquifer

Below the Sarmatian aquifer, and separated by an impermeable layer, there is the chalky limestone horizon, which belongs to the superior cretaceous.

Within the Study Area, the top of this aquifer is deeper than 150m and its thickness ranges between 20m and 40m.

Discharges flows abstracted for this aquifer are lower than for the Sarmatian aquifer and the quality of the water is very poor.

Deeper aquifers

Deep aquifers exist in the perimeter of the Study Area but the water is too much mineralized for potable purposes.

2.2.2. GROUNDWATER QUALITY

Many official publications describe the ground water geochemistry of Moldova. Most of the data available have been analyzed in order to characterize the quality of underground water resources within the Study Area.

Shallow aquifer

Statistical mean values of the chemical elements in ground water are presented in the Table 2 of the Appendix 1.

It mainly appears that:

- Water from the aquifer can be locally mineralized with high concentrations of sulphates (average: 511 mg/l, max: 3,000 mg/l), sodium and chloride;
- The nature of the layers containing the aquifer explains the mineralization of the water (geological origin);
- Concentration of nitrates is high (average: 158 mg/l; max: 1,045 mg/l), probably caused by pollution directly related to land use (fertilizers for agriculture);
- It is most likely that the water from this aquifer contains pesticides; here again because of agricultural land use;

- Bacteriological pollution is also observed in the shallow groundwater, probably caused by the domestic pollution (infiltration of domestic wastewater because of leaking toilets, pit privies, etc.).

Drinking water from this aquifer is dangerous for human health.

Sarmatian aquifer

Table 3 of the Appendix 1 summarizes the concentrations contained in the water of this aquifer.

This tables show that concentrations of sulphates and sodium are high. The origin of this mineralization is geological. It is due to the presence of salt and gypsum contained in the Midle Sarmatian reef.

The fact that this aquifer is confined gives reductive property to the water. The reduction of salts that appears in the aquifer when there is no oxygen is characterized by the following:

- Removal of nitrates (average 4.9 mg/l to be compared to the 158mg/l observed in the shadow aquifer);
- Presence of ammonia generated by the reduction of nitrates
- Frequent presence of H2S generated by the reduction of sulphates

We also notice the presence of iron, also due to the reductive property of the water.

This aquifer does not suffer from bacteriological pollution as it is quite well protected from direct infiltration.

A statistical analysis of the non compliance with norms is provided further in the report.

Cretaceous aquifer

Fresh water contained in this aquifer is abstracted in the North West of Chisinau (in Straseni for example) and most probably in Vadul lui Voda. This water is very mineralized, aggressive and does not fit for human consumption.

High concentration of fluorine is noticed.

3. CURRENT USE OF UNDERGROUND WATER RESOURCES

Several villages and localities within the Study Area rely currently on groundwater resources, which also, in a moderate extent, contribute to the supply of Chisinau.

3.1. SUPPLY OF CHISINAU CITY

It is worth recalling that before the construction of the water treatment plant (SAN) in 1958, which treats the water from the Nistru River, the City of Chisinau was exclusively supplied from groundwater resources. Exploitation of ground water even increased until the construction of the second water treatment plant in 1971 (SAN).

Water is abstracted from well fields operated by ACC but also from private wells drilled by economic agents. 600 wells have been counted.

There are 7 well fields within the perimeter of ACC. A detailed description is provided in Appendix 2. Their location is shown on the following Figure.

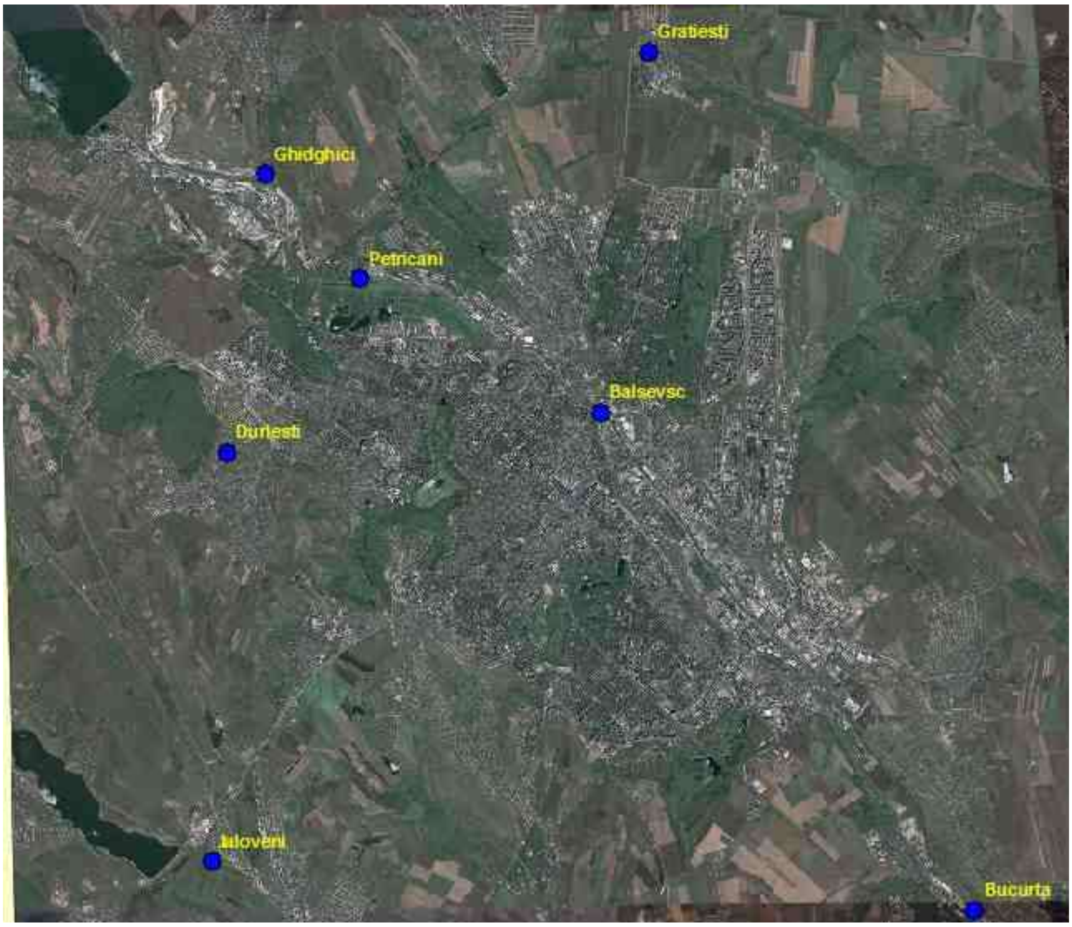

Figure 1: Location of well fields in Chişinău municipality

3.1.1. VOLUMES ABSTRACTED

The table below summarizes the current capacity of each well field.

Table 1: Current situation of the well field in Chişinău municipality

Name	Total number of wells	Nbr of wells in operation	Max flow rate drawn (m^3/d)	Max current flow rate (m^3/d)	Comment
Ilaloveni	21	4	19,200	3,100	
Ghidigich	12	11	11,400	2,400	
Petricani	9	0	9,960	0	Stop in 2001
Balisevsc	6	5	9,800		
Gratiesti	4	0	1,000	0	Stop in 2002
Durlesti	6	0	1,500	0	Stop in 2005
Burcuta	2	0	700	0	Stop in 1990

In addition to the well fields located within the city, there is another one at Vadul lui Voda. Sixty wells have been drilled after the pollution of the Nistru River in 1983.

The following graph shows the annual volume abstracted from the well fields, excluding Vadul lui Voda.

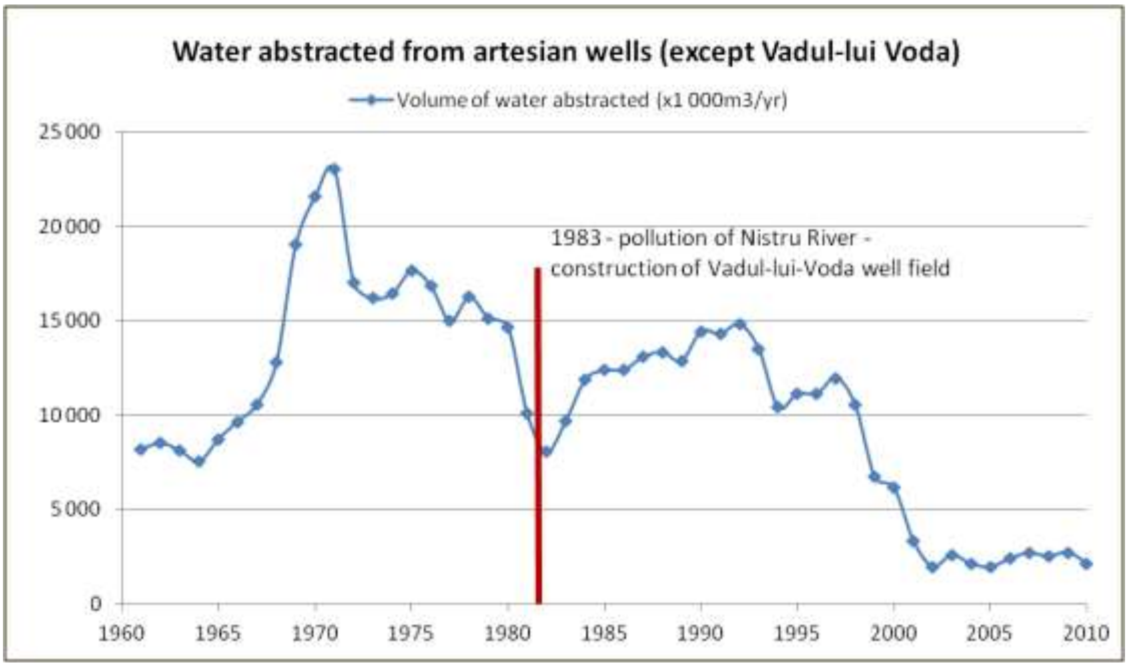

Figure 2: Historical data of water volumes drawn from the well fields within Chişinău municipality

The total underground water production reached 23,000,000 m^3 per year in the 70s. Then the annual production has gradually decreased over the years to become more or less steady, around 3,000,000 m^3, since 2002. It represents about 4% of the total production of ACC, 96% of the water being produced from the Nistru River.

Reasons of the drops observed from 1983 to 1984 remain unexplained.

The intensive exploitation of the aquifer within the study area is clearly evidenced by a continuous decrease of the groundwater levels, as shown on the piezometric maps we have consulted at AGeoM office. However, it seems that groundwater resources have not been exploited beyond the sustainability limits.

The table below shows the characteristics of the well fields.

Table 2: Drawdown and volume abstracted

Well field	Volume drawn m^3/yr	Volume drawn m^3/d	Thickness of aquifer	Elevation of limestone	Initial static level	Drawdown	Dynamic level	Penetration in aquifer
Ialoveni	7,000,000	19,200	80 m	20	45	40	5	15m
Petricani	5,000,000	13,700	75 m	0	15	30	-15	15m
Balişevsc				10	15	20	-5	15m
Ghidighici	3,000,000	8,200	80 m	-10 ; 10	25	30	-5	15m

The following graphs illustrates the impact of the exploitation of the aquifer on it static level. The two piezometric lines shown come from points located near Balisesvc and Petricani well fields.

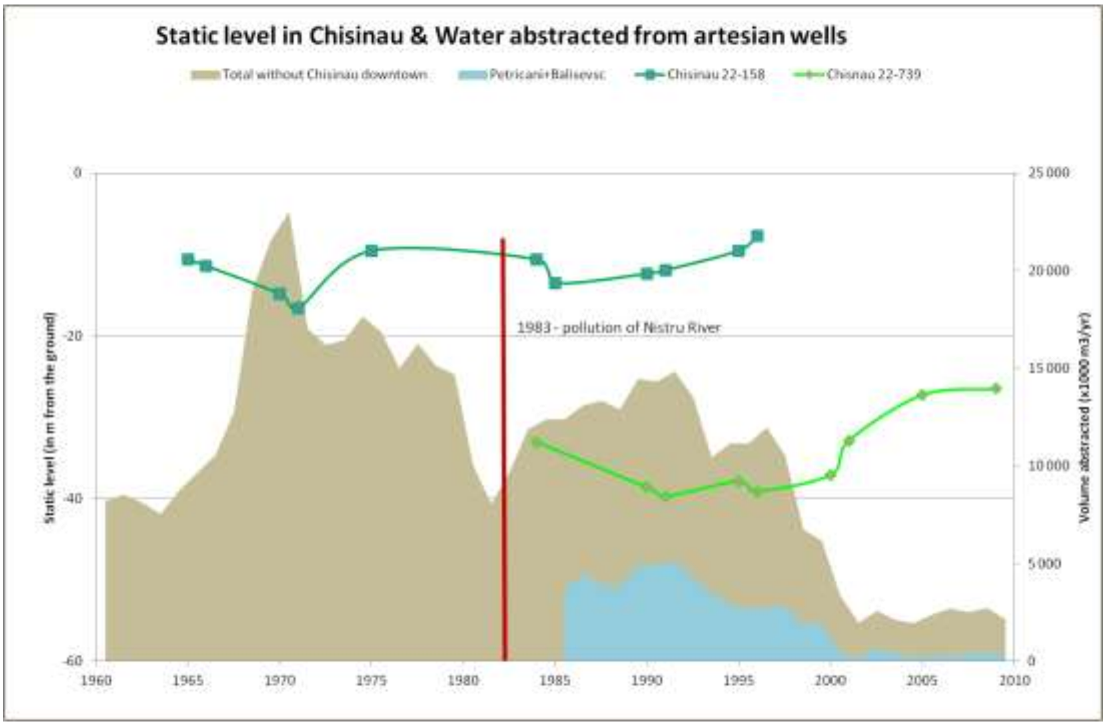

Figure 3: Static level in artesian wells monitored by AGeoM – Chişinău city

AGeoM have assessed the maximum volume that can be abstracted from the different sites in Chişinău area.

Table 3: Maximum flow per zone (AGeoM)

Well field	m^3/d
Ghidighici	22,000
Ialoveni	37,000
Balişevsc	10,000
Petricani	13,000
Airport	5,600

3.1.2. QUALITY OF THE WATER

Regarding the assessment of the water quality, we focus on the 4 main well fields operated by ACC.

We noticed in the Chapter 2.2.2 that for a few parameters, the quality of water in the Samartian aquifer often does not meet the standards required for potable water. It concerns sulphates, ammonia and hydrogen sulphide.

The Table below shows the limit values compliant with the Moldovan, the European and the French legislation.

Table 4: Moldovan, European and French for drinking water norms

Parameter	Moldovan Norm	European Norm	French Norm
Sulphates	250 mg/l 500 mg/l acceptable	250 mg/l	250 mg/l (quality reference)
Ammonia	0,5 mg/l	0,5 mg/l	0,1 mg/l, except if from natural origin
Hydrogen Sulphide	100 µg/l	NA	NA

Considering the current concentrations, sulphates and ammonia present in the water are not considered as health risks factors. Below 500 mg/l, sulphates do not have any impact on the taste of the water or on current uses of potable water (cooking). Ammonia is toxic for many fishes but not for man. It is a parameter controlled and limited in potable water as it is a reliable indicator of pollution generated by infiltration of wastewater or animal feces. In a Sarmatian aquifer, it comes from the reduction of nitrates and cannot be used as an indicator of pollution from surface origins.

The EU norm considers these 2 parameters as 2 indicators of water quality, while the French norm uses them in the quality references (values of these parameters are not considered as limits of quality.)

Treatment of sulphates is very expensive and does not present any financial benefit. Concentrations are reduced by dilution.

Ammonia is oxidized with liquid chlorine. When concentrations are higher than 2 mg/l, treatment with bio filtration is preferred in order to avoid huge consumption of chlorine, which would be required, and to avoid the risk related to chloramines (the presence of chloramines is not acceptable in potable water).

Hydrogen sulphide, coming from the reduction of sulphates, is very toxic when gaseous. In water, this element is very volatile, so it is easily removed from water during aeration (for example at the entrance of a reservoir when filled from the top). It is not included in the French or European norms since it is very unusual, even exceptional, to detect presence of hydrogen sulphide at the customer level (tap). However, it has to be noticed that hydrogen sulphides corrodes metals (steel) and is dangerous for employees working where degassing occurs.

The two tables below present the percentage of non compliance with the norm for sulphate and ammonia.

Table 5: Statistical analysis of the concentrations of sulphate

Concentration (mg/l)	C<250	250<C<500	500<C<1000	C>1000
Ghidighici	0 %	100 %	0 %	0 %
Ialoveni	100 %	0 %	0 %	0 %
Balisevsc	0 %	35 %	65 %	0 %
Petricani	0 %	100 %	0 %	0 %

Table 6: Statistical analysis of the concentrations of ammonia

Concentration (mg/l)		C<0.5	0.5<C<1.0	C>1
Ghidighici	raw	73 %	27 %	0 %
	after chlorination	100 %	0 %	0 %
Ialoveni	raw	0 %	20 %	80 %
	after chlorination	100 %	0 %	0 %
Balisevsc		42 %	44 %	14 %
Petricani		12 %	88 %	0 %

3.2. SUPPLY OF SURROUNDING LOCALITIES

3.2.1. GENERAL

As said previously, several villages and cities around Chisinau are being supplied from underground water resources.

Some of the wells fields are operated by ACC, other by the municipalities/localities.

The table below presents the list of villages which are not connected to ACC network.

Table 7: Municipalities supplied with groundwater

Rayon or Municipality	Sector	Commune	Village	Assessed[1] 2009 Population
Chisinau	Botanica	Bacioi	Bacioi village	8,703
			Braila	919
			Frumusica	467
			Straisteni	501
		Sangera	Revaca	976
	Buiucani	Condrita	Condrita	662
		Truseni	Truseni	7,890
	Ciocana	Bubuiesci	Humulesti	235
		Cruzesti	Ceroborta	43
	Riscani	Ciorescu	Ciorescu	5,460
			Fauresti	456

[1] Assessed by the consultant based upon year 2004 National Population Census

Rayon or Municipality	Sector	Commune	Village	Assessed[1] 2009 Population
			Goian	1,112
		Cricova	Cricova	10,039
Straseni		Straseni	Straseni	18,365
		Cojusna	Cojusna	7,008

All the localities above mentioned, located on the following Figure, have been visited by our team in order to assess the current situation and to determine the best option to supply potable water everywhere. The Appendix 3 includes a detailed description of the data gathered during our field visits.

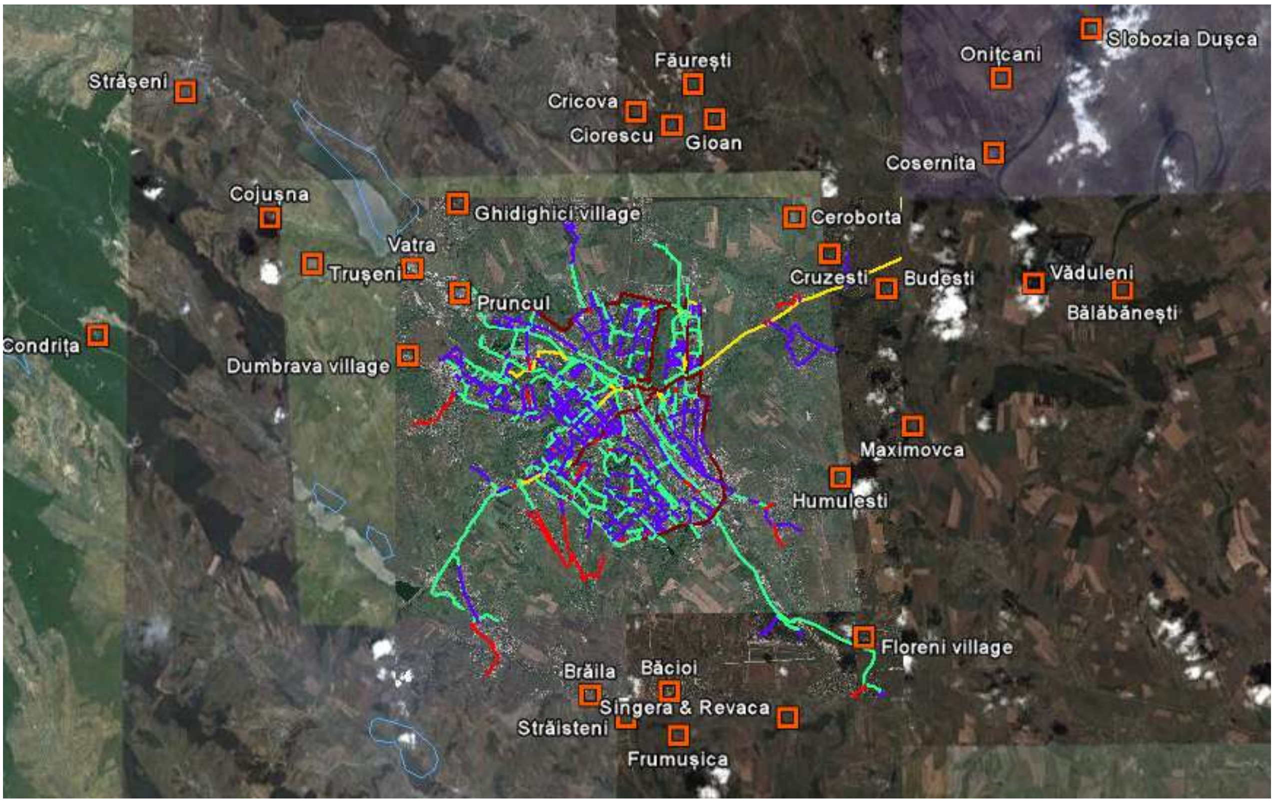

Figure 4: Map of localities visited and Apă Canal network

3.2.2. QUALITY OF THE WATER

It has to be noted that a part of the population, sometimes the entire population, of these localities are supplied with water from open wells. The quality of this water is very poor, as mentioned previously.

We can distinguish 4 groups, ranked from the most critical to the best one, in terms of water quality:

First Group:

Inhabitants are supplied with bad quality water from artesian wells. This water may have consequences on human health (because of high concentrations in NH4, Fluor, mineralization…). This water cannot be considered as potable. Truseni and Cojusna are included in this group. Water is likely to come from Cretaceous aquifer.

Aware about the poor quality of the water, people use water drawn from shallow wells, this is the second group.

Second Group:

Inhabitants use shallow wells for water supply. Generally, shallow wells have large diameter, they are properly built and covered. Water is not treated, although several pollutions may affect the quality of the water:

- Bacteriological when the wells are open
- Nitrates pollution (use of fertilizers, feces, …). Concentrations in nitrates, and possibly in nitrites can be high (above 200 mg/l for nitrates).

Use of water from shallow wells might cause health problems.

Third Group:

Part of the population is connected to a network fed with water abstracted from artesian wells. The water is drawn from the lower Sarmatian and is supplied without any treatment. Not doing any chlorination increases the risks of bacteriological pollution, in particular when the water is out of the bore, in the reservoir or in the network. Furthermore the oxidation of ammonium (NH4) is inhibited.

Although the water is not compliant with drinking standards, it can be used as potable water because it is not dangerous for health (as there is no high concentration in NH4 or F)

Fourth Group:

Inhabitants are connected to Apă Canal network or to another network delivering chlorinated water compliant with quality standards (for example in Cricova)

The following table details the percentage of each group described above for each locality around Chişinău.

Table 8: Current situation in Chişinău's suburbs

Village	Population 2010	% Chlorinated and compliant with quality standards water	% Network + non chlorinated water	% Bad quality water (shallow wells, bad quality in artesian wells)
		4th situation	3rd situation	1st and 2nd situation
Straseni	18 622	0%	60%	40%
Cojusna	7 010	0%	0%	100%
Truseni	7 901	0%	0%	100%
Cosernita	1 523	25%		75%
Onitcani	2 066	0%	0%	100%
Slobozia Dusca	2 662	0%	0%	100%
Bălăbăneşti	3 660	9%	91%	-
Floreni Village	3 722	28%	72%	0%
Bacioi Village	8 710	0%	46%	54%
Braila	920	0%	98%	2%
Frumusica	467	0%	100%	0%
Straisteni	501	0%	100%	
Cricova	10 185	66%	0%	34%
Ciorescu	5 544	0%	70%	30%
Goian	1 129	0%		100%
Fauresti	463	0%		100%
Goian Noi	629	100%	0%	0%
Condrita	670	0%	0%	100%
Budesti Village	4 578	2%	10%	88%
Maximovca	1 791	46%		54%
Revaca	983	0%	0%	100%
Ghidighici Village	5 144	52%		48%
Pruncul	-	100%		
Vatra City	3 315	100%		
Vaduleni	554	36%	0%	64%
Humulesti	234			100%
Dumbrava Village	419	59%	0%	41%
Cruzesti	1 656	90%	0%	10%
Ceroborta	43	0%	0%	100%
Sangera	7 596	83%		17%
Total	99 037	24%	24%	52%

4. PROPOSALS FOR THE FUTURE REGARDING WATER SUPPLY

4.1. Supply of Surrounding Localities

Based on the assessment we made of the current water supply conditions in the localities included within the Study Area, we have some proposals to secure and improve the water production.

A detailed description of our proposals is provided in Appendix 5. From a technical point of view, the 2 solutions we have looked at are:

- Connection to the water supply network of Chisinau (laying of pipes, construction of pumping stations, …)
- Improvement of the underground water production to ensure a satisfactory quality (treatment).

Of course financial feasibility of the solution has been taken into consideration. When both options are possible, the preferred one is the most economical.

We recall hereafter the summary of our proposals.

4.1.1. Truşeni, Cojuşna, Străşeni

These 3 localities face difficulties to supply their population from underground water resources because of: i) the poor quality of the water abstracted and ii) the small capacity of the deep wells.

4.1.2. Onitcani, Slobozia-Dusca et Cosernita

In the perimeter of these villages, the underground water from the Sarmatian aquifer constitutes an acceptable source of production.

We propose to implement this solution for Onitcani and Slobozia-Dusca as an alternative to the current system of supply from the water-table (wells and springs), which is probably not enough good for drinking purposes. It is worth pointing out that high investments would be necessary to build a supply network (pipes, reservoirs, …) in these 2 villages.

For Cosernita, the priority is to replace the exsiting connection pipe to Chisinau network (ND180 in replac ement of the ND120) and to increase the connection rate.

4.1.3. Bălăbăneşti

For this village located very close to the Nistru, we recommend to make a connection with the network of ACC. The existing wells could be maintained as a back-up system.

4.1.4. FLORENI

The three following options are feasible to secure the water production of Floreni: supply from the existing wells and the ones under construction, or from ACC network, or even from both sources (a mix).

It has to be noted that in case of the underground water resources being preferred, ammonia should be treated in addition to the current chlorination.

4.1.5. BĂCIOI AND CRICOVA

For these 2 localities, our proposal consists in increasing the current production capacity by drilling 3 new wells. Water abstracted from the old and new wells must be chlorinated.

Because Bacioi is quite some distance from Chisinau, connecting this locality to ACC network is an expensive option.

4.1.6. CIORESCU

We recommend to maintain the current production facilities (wells) but chlorination must be implemented. Indeed, even if the concentration in sulphates exceeds the norm (250 mg/l), it is still acceptable and not dangerous for the human consumption.

4.1.7. CONDRIŢA

The quality of the water supplied to this village is poor. Chlorination is the first step to be implemented.

Then, another source of water should be identified; either to drill new wells providing water with a better quality, or to make a connection to a neighbouring village.

4.1.8. BUDEŞTI, CEROBORTA

Provide a connection to ACC network appears to be the best option.

4.1.9. MAXIMOVCA

This city is already connected to ACC network. Extension of the supply network is on-going and will allow supplying the entire city from this source.

4.1.10. REVACA

Supply from ACC network is to be implemented (works on going).

4.1.11. GHIDIGHICI

The wells supplying this city are out of age and partially clogged. As Ghidighici is close to Chisinau, the connection with ACC networks should be privileged.

4.1.12. VATRA

Vatra is already almost entirely supplied from Chisinau water works. We recommend also to connect the residential area, currently supplied by a well, to the network.

4.1.13. HUMULEŞTI

The preferred option is to drill a new well to supply this small village.

4.1.14. CRUZEŞTI

Supply from ACC network should be maintained.

4.1.15. SINGERA

Singera is already almost entirely supplied from Chisinau water works. We recommend also to connect the residential area, currently supplied by a well, to the network.

4.1.16. GOIAN NOI

We recommend to maintain the current supply from ACC network.

4.1.17. PRUNCUL, DUMBRAVA, VADULENI

No problem with the current production. Nothing is proposed.

4.2. SUPPLY OF CHISINAU CITY

4.2.1. PRODUCTION SCHEME

Underground water production has gradually decreased over the years to supply Chisinau mainly because the quality of the surface water from the Nistru River is much better.

However, it is worth pointing out that relying almost exclusively on a solely source jeopardize the supply of Chisinau. A reliable alternative must be defined in case of pollution of the Nistru River for example. From a technical and financial point of view, the mobilization of underground water resources appears as the only feasible option. A detailed description of the emergency plan we propose is provided in the next Chapter.

Some of the well fields must be rehabilitated in the frame of the emergency plan. Once rehabilitated, the wells must be operated, at least for a part of their total capacity, for maintenance reasons, to ensure a proper functioning when needed. Therefore we must think of the use of the ground water under normal conditions.

Given the poor quality of the ground water in most of the wells fields, the production of drinking water from these sources will require the implementation of treatment facilities.

Regarding treatment issues, it must be distinguished:

1. The current uses under normal conditions (routine supply), in complement to the surface water, for which the quality must meet the standards of potable water. It mainly concerns ammonia and salinity, which, at the concentrations met in the wells, are harmful for the health only on long term,
2. The exceptional uses (during pollution of the Nistru for example) where it can be contemplated to use this water without any treatment for limited periods of time, as an emergency and provisory supply only.

Depending on the strategic choices concerning the emergency plan, there are three options for the splitting of the production between STA and the wells:

- **Option 1**: the ground water is mobilized at maximum capacity (with reasonable cost) for the emergency supply; Ialoveni is operated at high capacity for the routine supply, which requires the construction of a medium size treatment plant. The other wells are also rehabilitated and the water produced is treated. The routine production represents 10% of the maximum capacity. The rest is produced at STA.
- **Option 2**: Ialoveni is operated at a low capacity, compatible with the rapid implementation of a *package treatment plant*. The other wells fields are not mobilized for the emergency plan, and decommissioned.
- **Option 3**: the ground water is mobilized at maximum capacity (with reasonable cost) for the emergency supply; during the normal periods, Ialoveni is operated at a low capacity, compatible with the implementation of a package treatment plant.

The following table summarizes the treatment capacity (for normal situation) and the hydraulic capacity (for emergency situation, with distribution of raw water partially treated only):

Table 9: Treatment capacities of underground water

Future required capacity (horizon 2014) m3/d	Option 1	Option 2	Option 3
Ghidighici	790	0	790
Ialoveni	15,000	5,000	5,000

Future required capacity (horizon 2014) m3/d	Option 1	Option 2	Option 3
Balisevsc	850	0	850
Petricani	1,130	0	1,130
Goianul Nou	0	0	0
Singera	0	0	0
Sat. Ghidighici	0	0	0
Vatra	0	0	0
TOTAL	**17,770**	**5,000**	**6,980**

Table 10: Increased capacities for emergency plan (m^3/d)

Well field	Capacity m^3/d
Ghidighici	7,900
Ialoveni	20,900
Balisevsc	8,500
Petricani	11,300
New well field near STA	15,000
TOTAL	**63,600**

4.2.2. INVESTMENTS REQUIRED

4.2.2.1. Production

As presented in the Table 10 above, well fields have to be rehabilitated (or created for STA). However the capacities indicated correspond to the maximum that will be produced in case of accidental pollution of the Nistru River.

Under normal conditions (routine), we propose to limit the production (10% of their max capacities for the wells supplying Chisinau) to reduce the costs but maintain the sites in operational state.

Table 11: Routine production flow of the wells (m^3/d) – Option 3 (the preferred one)

Well fields	routine production flow (m^3/d)
Ialoveni[2]	5,000
Balişevschi	850
Petricani	1,130
Ghidigici	790

The rough cost estimates for the rehabilitation of the wells (max capacity) are summarized in the table below.

[2] For Ialoveni, the wells is to supply Ialoveni and the excess water will be used to supply the South-Western part of Chisinau where the m3 of water supplied from STA is expensive

Table 12: Estimated CAPEX for the rehabilitation of wells

Well field	Description	Max capacity	CAPEX (EUR)
Ghidighici	Rehab 11 wells	7,900	370,000
Ialoveni (Option 3)	Rehab 21 wells	20,900	707,000
Balisevsc	Rehab 6 wells	8,500	202,000
Petricani	Rehab 9 wells	11,300	303,000
New well field near STA	Realization 15 wells	15,000	1,010,000
TOTAL		**63,600**	**2,592,000**

It is worth pointing out that the mobilization of underground water to supply Chisinau (in normal condition or in emergency) requires to modify slightly the water distribution system of Chisinau (pumping stations, pipes). This is detailed in a separate report on the water supply system (the cost estimate for the adaptation of the system to the new scheme of production is provided).

Table 13: Estimated CAPEX for the distribution of the water produced from the wells

Name of the project	Facilities	Length (m) or number	CAPEX (EUR)
Petricani PS to Zone 1	Stage 1: Pumps 140 m3/h vs 55 m	2	19,000
	Stage 2: Pumps 140 m3/h vs 55 m	2	19,000
Petricani PS to Zone 2	Stage 1: Pumps 201 m3/h vs 120 m	2	41,000
	Stage 2: Pumps 201 m3/h vs 120 m	2	41,000
Ghidighici PS	Stage 1: Pumps 165 m3/h vs 54 m	2	21,000
	Stage 2: Pumps 165 m3/h vs 54 m	2	21,000
Balsevsc PS	Stage 1: Pumps 177 m3/h vs 125 m	2	38,000
	Stage 2: Pumps 177 m3/h vs 125 m	2	38,000
Buiucani Z4 PS from Buiucani tanks	Stage 1: Pumps 285 m3/h vs 97 m	2	44,000
	Stage 2: Pumps 285 m3/h vs 97 m	2	44,000
Ialoveni PS to Chisinau	Pumps 421 m3/h vs 165 m	2	380,000
Schinoasa PS to Z4a Telecentru	Stage 1: Pumps 402 m3/h vs 30 m	2	25,000
	Stage 2: Pumps 402 m3/h vs 30 m	2	25,000
Connection Petricani PS to Transfer pipe of Doina (Zone 2)	ND 600 DUCTILE IRON	500	320,000
TOTAL			**1,077,000**

4.2.2.2. Treatment

The following strategy is detailed in the following table:

Table 14: Treatment proposed depending on the mode of supply

Parameters treated	Permanent (normal) Supply	Emergency Supply
H_2S & NH4	Full Treatment	Partial treatment[3] only of NH4 and H2S (by aeration and chlorination)
TDS & SO_4	Dilution of the water in the reservoirs	No treatment² of TDS and SO4 for the emergency supply

In light of the above, the following facilities are proposed:

- Aeration for the emergency flow capacity
- Biological treatment of NH_4 and H_2S for the normal supply flow only
- Disinfection with break-point chlorine injection, based on emergency supply and average concentration of NH_4 and H_2S.

Therefore, depending on the water production scheme, the following treatment works must be implemented to treat underground water:

Table 15: Treatment works to be implemented

Well field	Option 1	Option 2	Option 3
Ialoveni	Construction of a treatment (capacity of 15,000 m^3/d; treatment of ammonia, turbidity and H_2S)+(aeration and chlorination, for 22,900 m^3/d)	Construction of a treatment plant for a capacity of 5,000 m^3/d: treatment of ammonia, turbidity and H_2S	Construction of a treatment plant for a capacity of 5,000 m^3/d: treatment of ammonia, turbidity and H_2S + aeration and chlorination, for 22,900 m^3/d
Ghidighici	Construction of a treatment plant (aeration and chlorination, for 7,900 m^3/d)	Nothing	Construction of a treatment plant (aeration and chlorination, for 7,900 m^3/d) – SAME AS OPTION 1
Balisevsc	Construction of a treatment plant (aeration + filtration + chlorination for 850 m^3/d – aeration + disinfection only for 8,500 m^3/d)	Nothing	Construction of a treatment plant (aeration + filtration + chlorination for 850 m^3/d – aeration + disinfection only for 8,500 m^3/d) – SAME AS OPTION 1
Petricani	Construction of a disinfection (for 11,300 m3/d)	Nothing	Construction of a disinfection (for 11,300 m3/d) – SAME AS OPTION 1

A detailed description is provided in a separate report on the water treatment.

The rough cost estimates are summarized in the table below.

[3] In order to minimize the investment (at least for the priority investment plan), it is proposed to accept temporary non compliance of water quality during emergency. This would concern mainly the TDS and the sulphate concentrations, which haven't any immediate effect on health.

Table 16: Estimated CAPEX

Well field	CAPEX (EUR)
Ghidighici	190,000
Ialoveni (Option 3)	700,000
Balisevsc	187,000
Petricani	236,000
TOTAL	**1,313,000**

5. IMPLEMENTATION OF AN EMERGENCY PLAN

5.1. Overall Objective

As already stressed in this report, the main and almost solely source of water for Chisinau is clearly the River Nistru; it represents about 97% of the production.

In the current situation, the security of supply within Chisinau is thus very vulnerable. Furthermore, there are no facilities available to rapidly detect pollution within the river, or to maintain supplies should the river be polluted.

It is necessary to complete and improve the existing Emergency Plan[4] developed by ACC in case of accidental pollution of the Nistru River and assess the conditions and requirements for its implementation.

As developed in the following chapters, mobilizing underground water resources appears to be a reliable alternative to mitigate the risk.

5.2. Assessment of the Risks

To quantify the vulnerability of the Nistru River we have gathered information on the risk of pollution.

5.2.1. General Information

The Nistru River is the largest river in Western Ukraine and the Republic of Moldova and belongs to the Black Sea's basin. The total length of the river is 1,362 km. The catchment area of the Nistru River basin is 72,100 km², about 70% are in Ukraine, and 30% in Moldova. Population living in this area is over 7 million, (5 million in Ukraine and 2 million in Moldova).

Within the perimeter of the basin, there are about 62 cities and 95 localities in Ukraine, and 2 municipalities and 41 cities in Moldova. The region is densely populated (d>110p/km²).

Within the upstream part of the basin (in Ukraine) are located the following cities:

- Lviv;
- Ivano-Francivsc;
- Ternopoli;

The main significant industrial centres are:

[4] It is worth pointing out that an Emergency Response Plan has been submitted on September 2011, but it includes only a strategy, not specific actions for every emergency that might occur.

- Drogobytch,
- Borislav,
- Stry,
- Kalush,
- Stebnik.

5.2.2. POLLUTION SOURCES

A brief inventory of possible pollution sources of the Nistru River has been made, in order to assess its vulnerability.

In Ukraine

The main sources of pollution are mining, chemical and machine building industries and also oil refining.

The most environmentally hazardous industries are located upstream Nistru River (Lviv and Ivano-Frankivsk regions). In those regions major mining and chemical companies are located (Rozdolskoye GGHP "Sulfur", Stebnitskoe GGHP "Polimineral", GGRP "Podorozhnensky mine," SE "Potash Plant", SA "Oriana"). Environmental management of those industrial centres is insufficient compared to the threats they can represent.

The following illustrates the general context of this area:

- The Area around Kalush, near Ivano-Frankivsk, was proclaimed an “area of disaster” on February 10, 2010, by the Ukrainian government. Indeed, industrial activities (mining) in the Kalush area have left the ground unstable and prone to subsidence, with mine tailings dams at risk of bursting as a result of snowmelt and spring floods. As a result, ground and surface water have become highly salinized and contaminated. Moreover, storage of 11,000 tons of hexachlorobenzene (HBC) was identified in a former industrial centre. A mission was conducted in April 2010 at the request of Ukrainian authorities by UN-EU experts. The final report describes the situation there as “critical”. There is a high probability that an open-cast mine could break through into the Sivka River (a tributary of Nistru River) and thus spread the dangerous organic pollutant hexachlorobenzene (HBC) into the local environment.
- Another risk is the failure of the dam from the „CIRKA” factory, located near Razdolie, Micolaev district. The company is actually in bankruptcy and cannot deal with environmental issues. The probability of failure of the dam is high. In that case about 90 million tons of high mineralized liquid waste could be discharged into the Nistru River.
- Furthermore, due to insufficient wastewater treatment capacities the State Environmental Inspection of Lviv Oblast fined the City utility "Mykolaiv vodokanal" for pollution of the Nistru River.

In Moldova

The main pollution sources on the territory of the Republic of Moldova are:

- The Municipal Apă Canal Company of Soroca (about 447,000 m^3/year of wastewater discharged directly into the Nistru River, without treatment);
- The Municipal Apă Canal Company of Otaci, Ocnita district (wastewater from this locality is discharged directly into the Nistru River);
- Metallurgical Plant & Cement Plant in Ribnita;
- Cement Plant from town Rezina;
- Waste polygon of Ribnita town, the storage capacity is fully exceeded;

Pollution hazard can also come from the weapons depot in the locality Colbasna, near Ribnita. According to assessments made by the Academy of Sciences of Moldova, weapon reserves exceed 20,000 tons. These weapons occupy an area of 1 km^2.

Another danger is the storage of pesticides in the Transnistrian region, where 150 tons of pesticides are stored, according to estimates of specialists. It was found that in 70% of cases, conditions of storage are irregular.

An unstudied source of pollution is the military airfield from locality Marculesti, which is located on the shore of the Raut River, tributary of the Nistru River with the discharge area downstream Vadul lui Voda.

5.2.3. POLLUTION OCCURRENCES

In 1983

A serious crash occurred in 1983 in potassium fertilizers factory in Stebnyk (Ukraine). More than 5 Mm^3 of salt solution was discharged into the Nistru River.

Following this crash, the mineralization in the river increased; two months after, mineralization at Moldavian border was 2 g/l including chlorides 0,8-0,9 g/l. These high concentrations lessened slowly during more than one year.

Following this disaster, the Stebnytsky Potassium Plant in Lviv Oblast has been abandoned (the activity stopped). However it still remains one of Ukraine's largest deposits of potassium salts.

In 2005

Calcium hypochlorite pollution occurred in Sivka River, tributary of the Nistru at the end of December 2005. Though it was a minor pollution, about 30 kg of calcium hypochlorite were discharged.

It has to be noted that in Moldova, there is only one preventive information centre regarding the pollution. It concerns the Prut River. Indeed the warning system AEWS was developed and is currently operated to monitor Danube River Basin.

Implement such a system on the Nistru River is highly recommended.

5.3. AUDIT OF THE EXISTING ACC EMERGENCY PROCEDURES[5]

ACC prepared and issued in April 2010 an Emergency Plan titled: "*Planul proteței civile a serviciului de provizionare cu apă municipul chișinau în situații excepționale*".

The plan includes:

- an assessment of the availability of the water resources (surface water with the Nistru River and artesian wells located within the municipality of Chişinău);
- An inventory of current assets (pumping stations, network…);
- A description of operations under normal conditions and under extraordinary circumstances that might occur such as:
  - The collapse of the dam of Ghidighici;
  - An earthquake;
  - Power outage;
  - Toxic or radioactive pollution of Nistru River.

In case of pollution of the Nistru River, the Emergency Plan prepared by ACC stipulates that using alternatives resources (underground water) could allow to supply about 644,000 inhabitants with a daily consumption of 50 l/d/capita. It is forecasted that water will be produced by the 5 well fields managed (Nistru wells, Ialoveni, Petricani, Ghidighici, Balişevsc) with a total capacity of 132,600 m^3/d.

However, taking into consideration the current condition of those well fields, it is not possible to abstract such a volume of water. Indeed, the current capacity is estimated to be 9,420 m^3/d. Water produced will be supplied via the drinking water network but also with tanker trucks. No information are given regarding the operation of the network during an emergency; but it is worth pointing out that the network is likely to be disturbed because the production sites are different and because the volume to be supplied is much lower than in normal conditions.

5.4. PROPOSED EMERGENCY PLAN

5.4.1. ASSESSMENT OF THE RELIABILITY OF SOURCES

The Emergency Plan elaborated by ACC proposes to mobilize underground water resources in case of pollution of the Nistru River.

But other alternatives exist, there are listed in the above mentioned plan. They must be assessed.

[5] This section is extracted from a separate report already submitted, which draws up an initial list of priority "emergency" investments to that should be done to ensure the operation of the water supply and wastewater collection systems.

5.4.1.1. Fântâni Artezine Departamentale

The emergency plan mentions the existence of so-called “departamentale” artesian wells. These are not directly operated by ACC but by others state companies or private ones. The plan lists 102 artesian wells within the municipality of Chişinău (Emergency plan annex n°3). But over these 102 wells, only 32 produce water compliant with water quality standards (Emergency plan annex n°16). The estimated capacity of these wells is about 9,000 m^3/d.

These wells are connected to the central water network however pumps are probably not in condition to deliver the water to the network.

Furthermore, these wells are not equipped with chlorination facilities. It is therefore impossible to control the quality of the water abstracted and supplied. We recommend not to use this water as potable water.

5.4.1.2. Springs

The emergency plan mentions the existence of 22 springs. The total capacity of this water resource is 700 m^3/d, which is too low to envisage a connection to ACC network.

Regardless the problem of the quality of this water, it could be used for a local supply.

5.4.1.3. Swallow Wells

The emergency plan mentions the existence of 48 swallow wells. The total capacity of this water resource is 3,288 m^3/d (or 137 m^3/h).

Although these wells are mentioned to be producing water compliant with water standards, the vulnerability of the shallow aquifer is important. Furthermore, protection perimeter can often be deficient in an urban area.

Therefore, we assess this resource too vulnerable to be used for domestic purposes.

5.4.1.4. Small Rivers

There are some other rivers than Nistru River in the vicinity of Chişinău, but they are much smaller: Ichel, Bîc, Ishnovec and Botna.

Each one of these river crosses villages, town or even Chişinău in the case of Bîc. The quality of this surface water is very likely to be affected by this urban environment. Agriculture can also have a strong impact on quality of water.

Furthermore, quality analyses in Bîc River are not compliant with drinking water standards.

As a conclusion, the alternative consisting in mobilizing small rivers as an emergency resource is not recommended because it is too vulnerable.

5.4.1.5. Lakes

There are several lakes in the vicinity of Chişinău: Ghidighici, Danceni and a smaller one near Costeşti.

It is currently uneasy to monitor, control or prevent pollution of these lakes, making this resource vulnerable.

5.4.1.6. Other Raw Water Intake on Nistru River

There is another water intake on Nistru River in the town of Dubăsarii Vechi, 15 km downstream Vadul-lui-Voda. This water intake is not currently operated but can be rehabilitated. It was built for the purpose of irrigation.

According to ACC operators, the flooding risk is lower for this water intake than in Vadul lui Voda and there is no risk of landslide contrary to the water intake in Vadul-lui-Voda.

But in case of a major polluting event in Nistru River, water in Dubăsarii Vechi will be polluted at the same time, the distance between the 2 water intakes being 15 km.

5.4.1.7. Well Field at Vadul Lui Voda

Data collected on this well field are provided in Appendix 2.

65 wells have been drilled to supply Chisinau during the 1983 pollution, of the Nistru River. However 63 of these wells have not been operated for 20 years. The 2 others have produced 11,553 m^3 in 2010.

The quality of this underground water, abstracted from the Cretaceous aquifer (below the lower-middle Sarmatian), is very poor. We consider that the decision taken by the Executive Committee of ACC to abandon the production from these wells is reasonable, considering: i) the quality issue, and ii) the high investments requested to rehabilitate these wells.

Furthermore, the aquifer, where the water is drawn, is very thin and in contact with the Nistru River. In case of pollution of the Nistru River, the vulnerability of the water abstracted from these wells would be very high.

Below the Cretaceous aquifer, there are other aquifers but most probably they contain salty water not compatible with domestic purposes. This should be verify by analysing the water analyses made on 2 deep wells (respectively 384m and 764m deep) located at Vadul lui Voda.

In light of the above, we recommend not to mobilize this source in the frame of the Emergency Plan.

5.4.1.8. Conclusion

As ACC, we recommend to mobilize underground water resources to mitigate the risk of pollution of the Nistru River regarding the water supply of Chisinau. Other sources exist but we assessed them unsatisfactory (quantity or quality).

5.4.2. Our Proposal

As already mentioned, we propose to:

- Rehabilitate the well fields of Ialoveni, Chidighici, Petricani and Balisevsc;
- Create a new well field near STA (see Figure below).

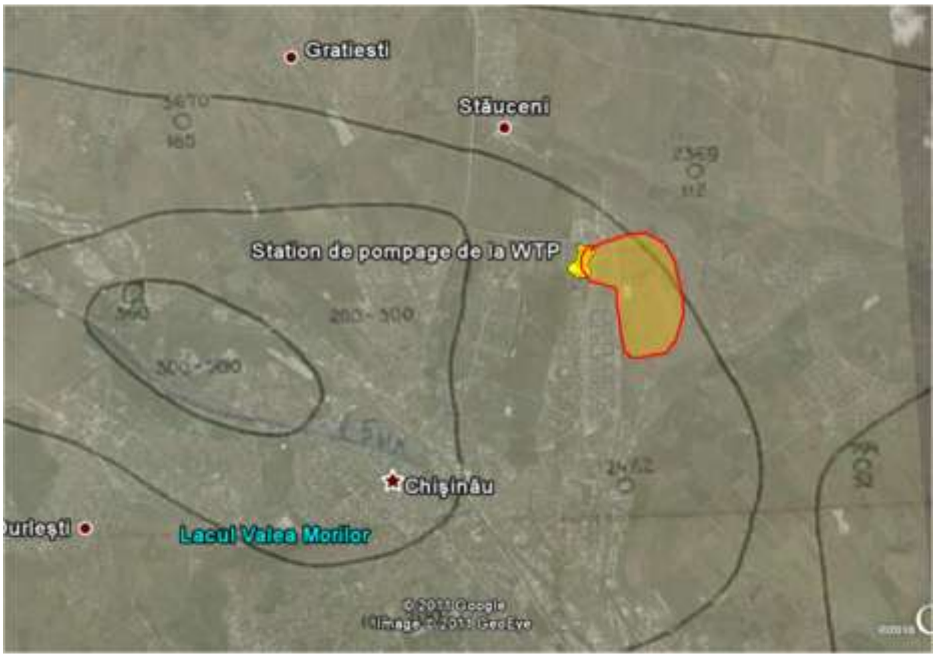

Figure 5: Possible location of the new STA well field

The hydrogeological characteristics of this zone are detailed below.

Table 17: Characteristics of the new wells field

Item	Value
Ground elevation	130 m (/ Baltic Sea)
Top of the aquifer	25 m (/ Baltic Sea)
Width of the aquifer	50 m at least
Permeability	medium (100 m^2/d)
Depth of the well to build	150 m

According to the permeability map we estimated that newly built wells would produce about 1,000 m^3/d with a drawdown of 10m. Up to 15 wells can be built in order to reach 15,000 m^3/d capacity.

Further investigations (it is recommended to command to the AGeoM a hydrogeological study) have to be made in order to determine more precisely the capacity of the aquifer in this area.

No treatment facilities are to be built because the WTP installations of STA will be used.

Capacities of the well fields and treatment required have been presented in Chapter 4.2.

With a cumulated capacity estimated at 63,600 m^3/d, the rehabilitation of well fields will allow to supply Chisinau and meet about 34% of the current volume into supply and 50%

of the estimated volume into supply in 2035 (reduction of water losses and decrease of the demand).

5.5. OPERATION MODE

Mobilizing the underground water resources to supply Chisinau in case of accidental pollution of the Nistru River requires to adapt the operation mode of the current system.

As said before the expected capacity of the well corresponds to 34% of the current volume supplied by the existing system in Chişinău city (with the exception of Tohatin, Coloniţa, Cruzeşti, Vadul Lui Voda and Coşerniţa). The cities of Coloniţa, Tohatin, Cruzeşti, Coşerniţa and Vadul Lui Voda will be supplied by a well to be implemented in the North-East suburbs of Chişinău. The concerned volume is 1,850m^3/d.

A new operation mode must be defined to take into consideration these new sources location, the limited capacity of production, etc.

It is worth pointing out that the production does not meet 100% of the demand (only 45% of the demand will be satisfied). Therefore a shift shall be envisaged: the city will be divided in different sections that will receive water only a few days in the week.

The details of the changes required are provided in a separate network (Drinking Water network).

Annexes

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1. GEOLOGICAL AND HYDROGEOLOGICAL SETTING

1.1. INTRODUCTION

Study area is located in the central part of the Republic of Moldova. For this area Chişinău City is the biggest geographical settlement (fig.1). The geographical size is as 56 km x 44 km with total area of 2464 km^2. Geographical coordinates of the area are as following: $X_{min} = 28^{O}30^{/}$, $X_{max} = 29^{O}15^{/}$, $Y_{min} = 46^{O}40^{/}$ and $Y_{max} = 47^{O}15^{/}$. For this study Slobodzea Dusca, Onitcani, Fauresti, Cricova, Coiresti, Goian, Ceroborta, Crusesti, Cosernita, Budesti, Vaduleni, Balabanesti, Maximovca, Humulesti, Floreni, Singera, Revaca, Straisteni, Frumusica, Braila, Bacioi, Dumbrava, Pruncul, Vatra, Ghidigici, Truseni, Cojusna, Condrita villages, town Străşeni and Chişinău City are main points of interests. General geological structure and hydrogeological conditions of the central part of Moldova is analyzed. Present description is based on data of the Laboratory of Hydrogeology and Engineering Geology, Institute of Geology and Seismology, Academy of Sciences of Moldova and other sources [1-7].

1.2. GEOLOGICAL STRUCTURE

The study territory has the same geological proprieties that are characteristic for all country. Moldova is situated on a stable Pre-Cambrian (much older than 560 million years) crystalline shield often denoted as the European Platform or locally known as the Russian platform. This very old stable platform represents in fact the roots of mountain ranges formed during the many orogenic cycles in Archean and Proterozoic times (2 300 – 560 million years). The mountains were leveled down by long periods of erosion, which finally resulted in a relatively flat platform, and may have been a landmass for a long time prior to the Paleozoic (starting from 560 million years). It follows that the crystalline platform consists of highly metamorphic rocks that may have been subjected to several orogenic cycles. The literature on the geology of Moldova suggests that this crystalline platform has been reached in many exploration drillings throughout the country [1].

The rocks overlying the stable platform are practically undeformed with sub-horizontal strata on a regional scale. Much of the stratigraphy, overlying the crystalline basement, is missing due to non-deposition or erosion afterwards. These stratigraphical gaps in sedimentation indicate that the area may have been a landmass for most of the time.

An important geological event that has influenced the geological development of Moldova (and study area) is the Alpine orogeny. This event has created indirectly most of Moldova in geological sense and vice versa also the present-day groundwater situation. Although located outside the Alpine orogenic belt, the crystalline basement has been influenced by deep crust processes related to the Alpine orogeny, which in fact represent the collision of the African continent with the European continent. West of Moldova the Carpathian mountain ranges can be found, which form a peculiar curved belt in Hungary and Romania. This mountain belt consists of eastward upthrusted (even napped formation) strata onto the stable crystalline basement, which extends underneath Moldova. This has resulted in down-buckling of the crystalline basement under the enormous load of the upthrusted strata. This flexural loading and down-buckling of the basement, including other crystal processes related to continental collision, has resulted in subsidence of the area below sea level at that time (Miocene sea levels were much higher than the present sea level). This occurred during the Miocene period, from 5 to 25 million years ago. The upthrusting of strata in the East Carpathians also resulted in a huge supply of sediments which were deposited in the newly created basins east of the Carpathians, thus in Moldova and surroundings. This explains the very thick pile (some hundreds of meters) of Miocene marine clayey rocks in Moldova, which form the major water-bearing strata nowadays. The Miocene pile shows a trend from open marine conditions in the lower parts to near-coastal (lagoons, deltas and swamps) settings in the upper part, indicating the filling of the Alpine created basins. The Miocene sediment pile is of paramount importance when it comes to groundwater and groundwater flow systems. The underlying rocks of Paleozoic and Mesozoic age (sandwiched between the crystalline basement and the Miocene rocks) are much less important from hydrogeological point of view. They are of interest for oil and gas exploration with the exception of the northern part of Moldova, where the top of the crystalline basement becomes shallow and is tapped by deep wells. The Paleozoic and Mesozoic rocks become exposed in the valley of the River Nistru.

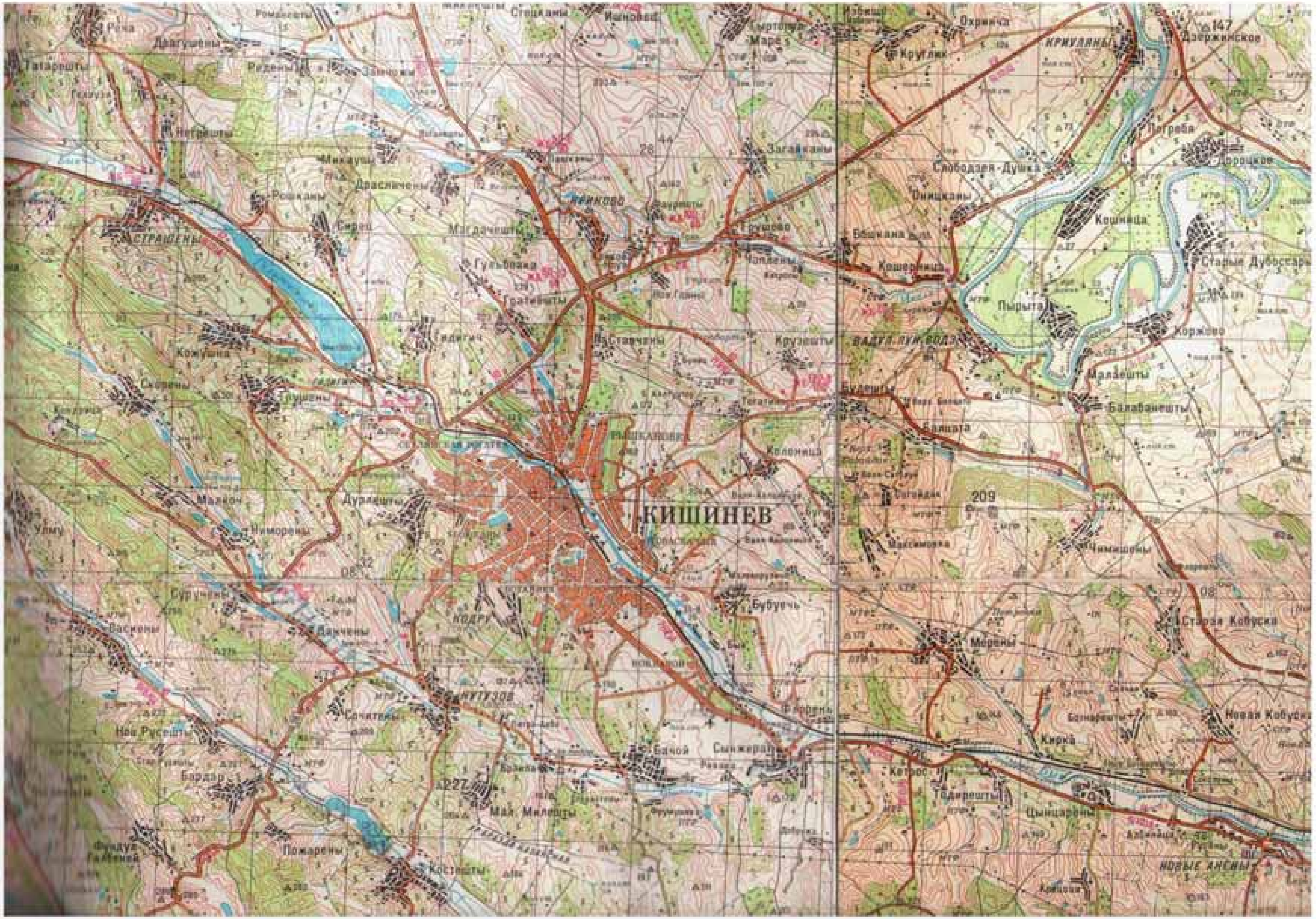


Figure 1. Topographical map of the study area (scale 1 : 200 000)

Geological map of the study area is presented in Figure 2. Associated geological cross-sections are shown in Figure 3, Figure 4 and Figure 5. Accordingly to this data local geological structure is as following.

The crystalline basement rocks (Archean - Proterozoic period) consist typically from a variety of high-grade metamorphics, from light colored gneisses and schists with a sedimentary origin to very dark colored metamorphosed (basic) igneous rocks (amphibolites and norites). Many secondary and coarse-grained light colored veins seem to accompany the complex. The rocks, subjected to several orogenies, are tightly folded and exhibit a joint and fracture pattern from intense crustal stresses.

The crystalline basement is overlain by *vendian* sandwiched rocks of metamorphic – sedimentary origin. Mainly, these rocks consist from sequences of argillites and sandstones.

*Silurian strata (*408 – 438 million years old) have a thickness of about 450 m. Dolomite and limestone are the predominate rocks in the cross – section.

Cretaceous strata consist of the typical chalk facies, being fine-grained m-bedded or massive dense organic limestones. The limestones are friable built up by the calcispheres of Foraminifera and have a primary porosity. Many horizons of chert can be recognized. Marls (calcareous clays) can also be found as intercalations in the chalk facies. The thickness is also estimated at some tens of meters of these sub-horizontal strata. The chalks are permeable to groundwater. Same wells tap these rocks and at the contact with the underlying Silurian strata often rich water zone can be found.

Miocene Strata are widely developed in the perimeter of the study area. Present-day area is built up by the clayey and sandy marine rocks of Miocene age. They are exposed throughout the whole area, only locally some thin veneers of Quaternary alluvial sediments are found. Eolian loess deposits from the Pleistocene glacial periods are widespread in the study area, giving rise to the fertile black-coloured loamy chernozem soils. In terms of Alpine Geology, this Middle to Late Miocene rocks (10 –15 million years) represents the so-called Molasse deposits of the Eastern Carpathian mountain ranges.

The Miocene strata and geological development have dominated also the geo-morphological development during the Quaternary. After Miocene sedimentation ceased and the area emerged from the sea (global drop of sea level) a flat landmass or platform was created. Many horizons with local reef limestone lenses are found enveloped in the clayey monotonous sediments. These reef lenses represent periods with interrupted sedimentation due to insufficient supply from the Carpathian sources in combination with a shallower environment (sedimentation outpacing basin subsidence). One often finds former beaches along the reef lenses consisting of carbonate sands. Once the sedimentation was re-established the reefs were engulfed and finally buried under the clayey sediments causing the reef building organisms to perish. The sedimentary environment as gathered from the exposures can probably be described as an open marine shelf environment outside the influence of waves (low energy).

Some exposures show horizons (1- 3 m) of cross-bedded sands indicating high-energy, near-coastal (littoral) environments.

Quaternary deposits, in many cases, caps the Neogene formations. The Quaternary period is represented both by Pleistocene and Holocene epochs. Alluvial, deluvial, proluvial, eolian, and lacustrine deposits were formed on the top of Neogen strata. Sandwiches of clay, sand, gravel, silt, and paleosoil are the most characteristic rocks. The deposits are 1.0 to 25.0 m thick, sometimes more.

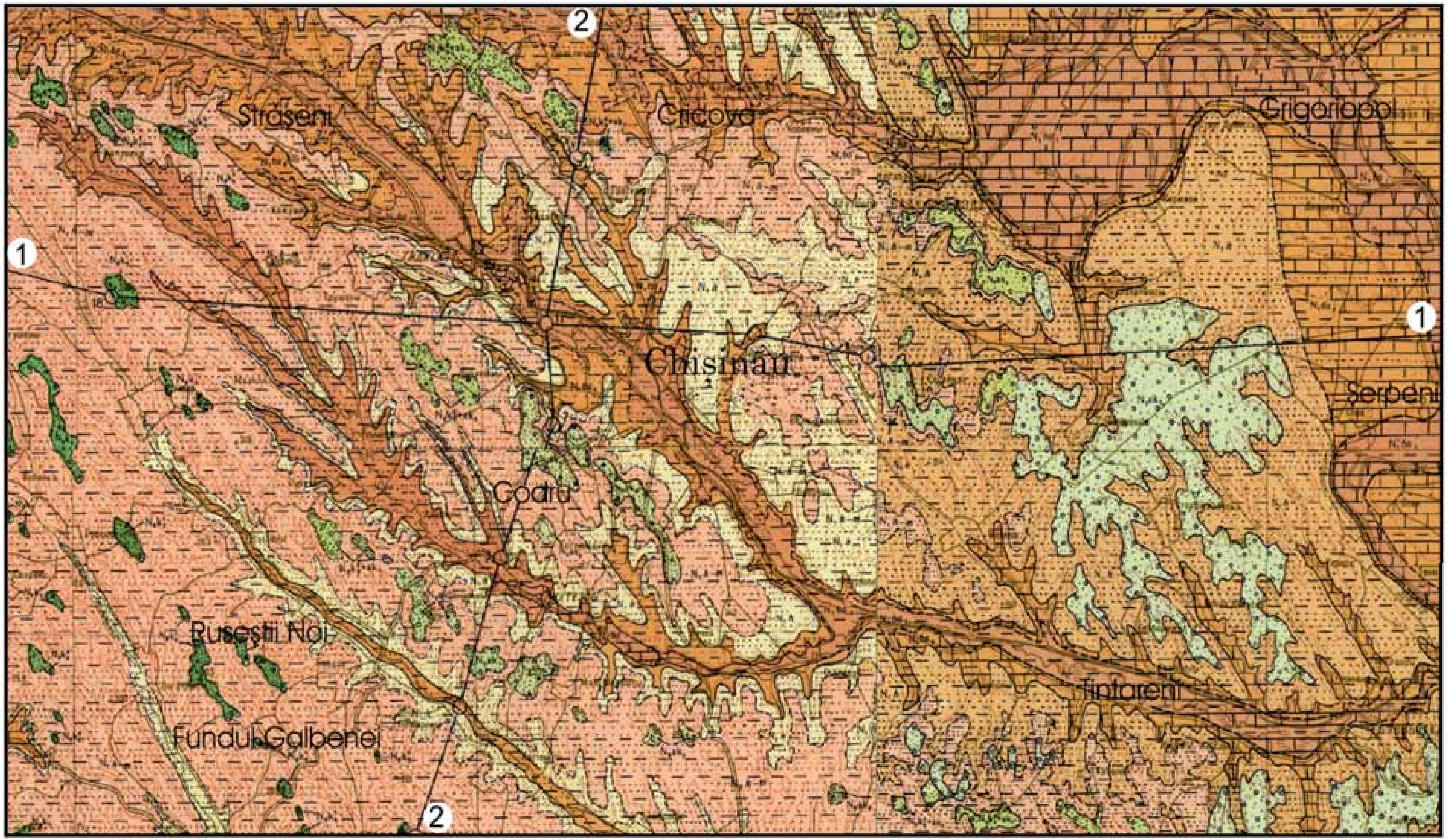


Figure 2 Geological map of the study area (scale 1 : 200 000)

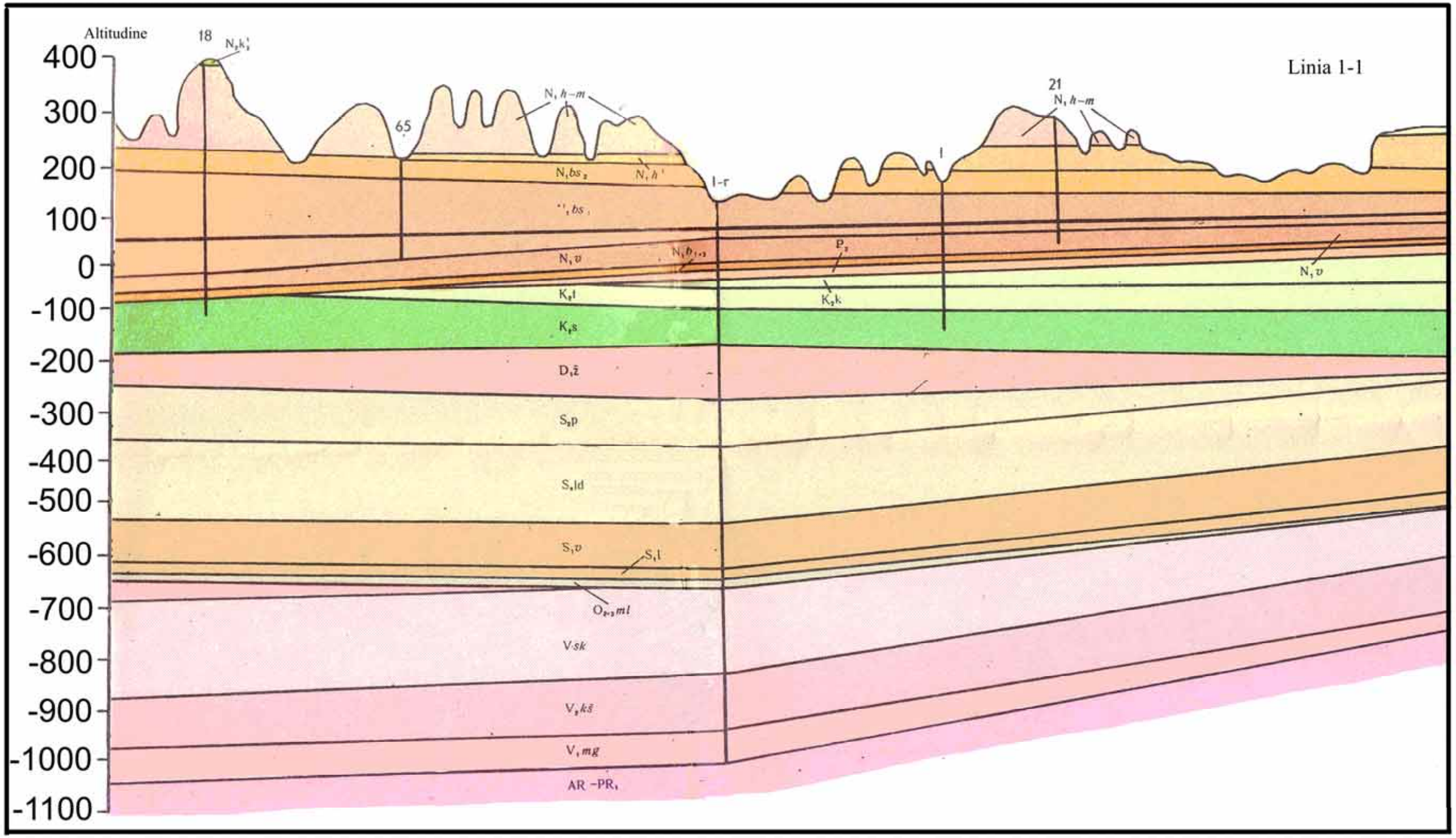


Figure 3 Geological cross – section (line 1 -1)

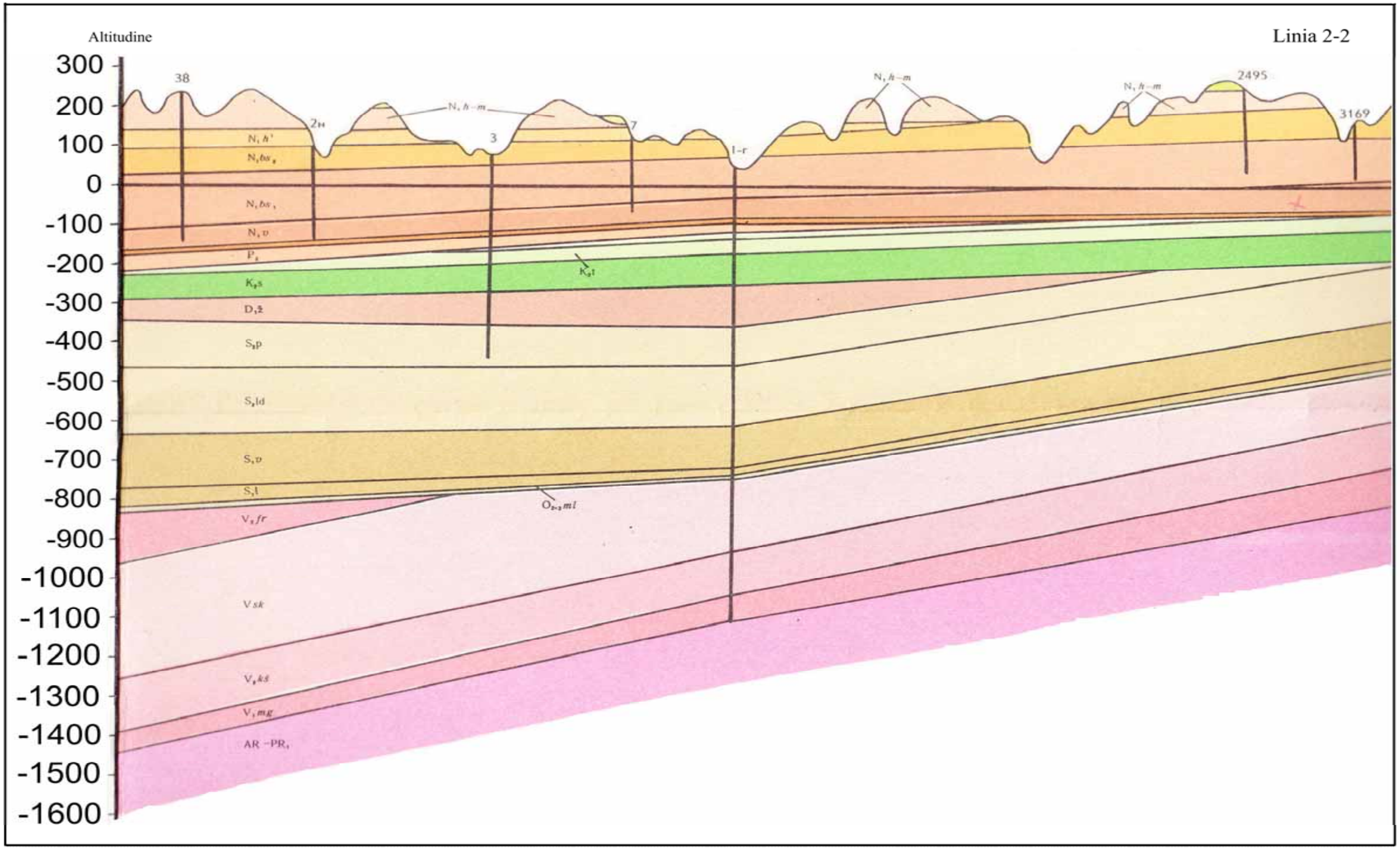


Figure 4 Geological cross – section (line 2 – 2)

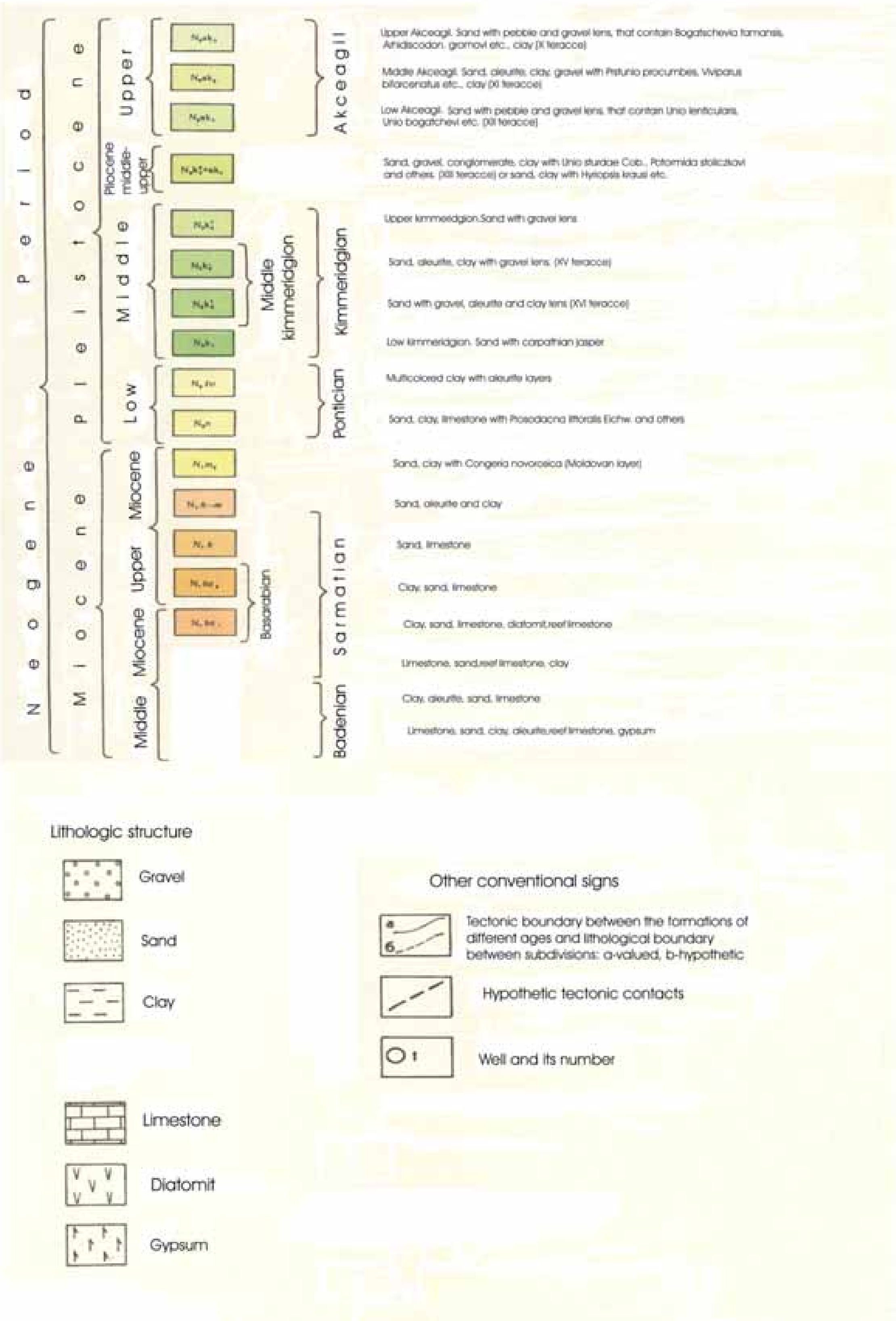


Figure 5. Legend for geological map and geological cross - sections

1.3. HYDROGEOLOGICAL CONDITIONS

On a national scale, the hydro-geological system of Moldova consists of a sequence of “aquifers,” locally indicated as water bearing horizons, and “aquitards,” or less pervious layers. From the surface downward, 17 aquifer complexes are distinguishable. Only the upper aquifers have fresh water. The lower geological formations are filled with brackish and saline water, and are not subject to groundwater exploitation. Table 1 is a chart of major (fresh water) aquifers and aquitards, with their geographic coverage. In Figure 6, Figure 7, Figure 8 and Figure 9 is shown schematic hydrogeological map and representative hydrogeological cross-sections for the study territory.

Geological Formation	Hydrogeological interpretation	Coverage of Moldova		
		South	Middle	North
Q	Local aquifers	X	X	X
N2P	Aquifer	X	-	-
N1S3 + N1m	Aquifer	X	-	-
N1S3	Aquitard	X	X	-
N1S2	Aquitard	X	X	X
N1S2 – sand	Aquifer	X	-	-
N1S2	Aquitard	X	X	X
N1S2 – limestone	Aquifer	X	X	-
N1S2 – clays	Aquitard	X	X	X
N1S1	Aquifer	X	X	X
K2S2 + N1b	Aquitard	X	X	X
K2S1 + S	Aquifer	X*	X*	X

Table 1 Aquifers and aquitards distinguished in Moldova (study area is the part of Middle)

X*: Aquifer is present, but locally filled with brackish groundwater

The classification “aquifers” as opposed to “aquitards” should be considered as indicative of .the fact that aquifers are more pervious than aquitards. The interfaces between the aquifers and aquitards (less pervious layers) are often not very sharp. Local patches of quaternary aquifers are unconfined. General hydrogeological description of the study area is indicated as follows.

Shallow (phreatic) ground water is widely used for local water supply (uncentralized system). People in rural areas usually fetch their drinking water from wells that they have dug. These dug wells tap the Upper Neogen and Quaternary formations which are hydrogeologically unite in one common phreatic aquifer. Nearly every house has its own well(s) in the yard with diameters ranging from 0.5 to 2 m. Ground water tables are usually within 10 m and the wells never become dry. The dug wells are generally very well constructed with good quality brickwork or concrete ring linings; they are often fenced and equipped with a corrugated iron roof. Some wells are even decorated, demonstrating a sense of hygiene among the rural population in the matter of drinking water. Also, the gear for fetching water is very well built and maintained with roller bearings.

Water bearing rocks are presented by thin strata of sand, sandy clay or sandwiched stratum of clay, sand and gravel. Usually these strata are not more than a few meters. Aquifers, as a rule, are as unconfined type. Mostly aquifers are associated with alluvial deposits, which are distributed in river valleys and slops of these structures. Debit of the dug wells consist 0.01 – 0.2 l/sec and rarely 0.5-0.7 l/sec with drawdown 0.5 – 1.5 m. Variations in groundwater levels in the shallow aquifers do not show a direct relation to variations in precipitation. In wells no deeper than a few meters, seasonal fluctuations of the water level are correlative with the precipitation changes. In local or shallow systems, flow lines connect a topographic high that acts as a recharge/infiltration area with the immediately adjacent topographic low and the corresponding discharge/exfiltration area. In the case of local flow systems, the in- and ex-filtration areas are juxtaposed, and flow takes place via phreatic groundwater which implies that no other flow systems are positioned on top of the system. These local or shallow groundwater flow systems are found in the fluvial dissected parts, thus there are hills between the streams. The infiltration or recharge areas are found on top of the hills and discharge or exfiltration occurs in the adjacent streams. The travel times of groundwater flow in these systems may be on the order of years to tens of years. The majority of dug wells tap the water from these superficial groundwater systems. Shallow groundwater vulnerability to surface pollution is high and very high.

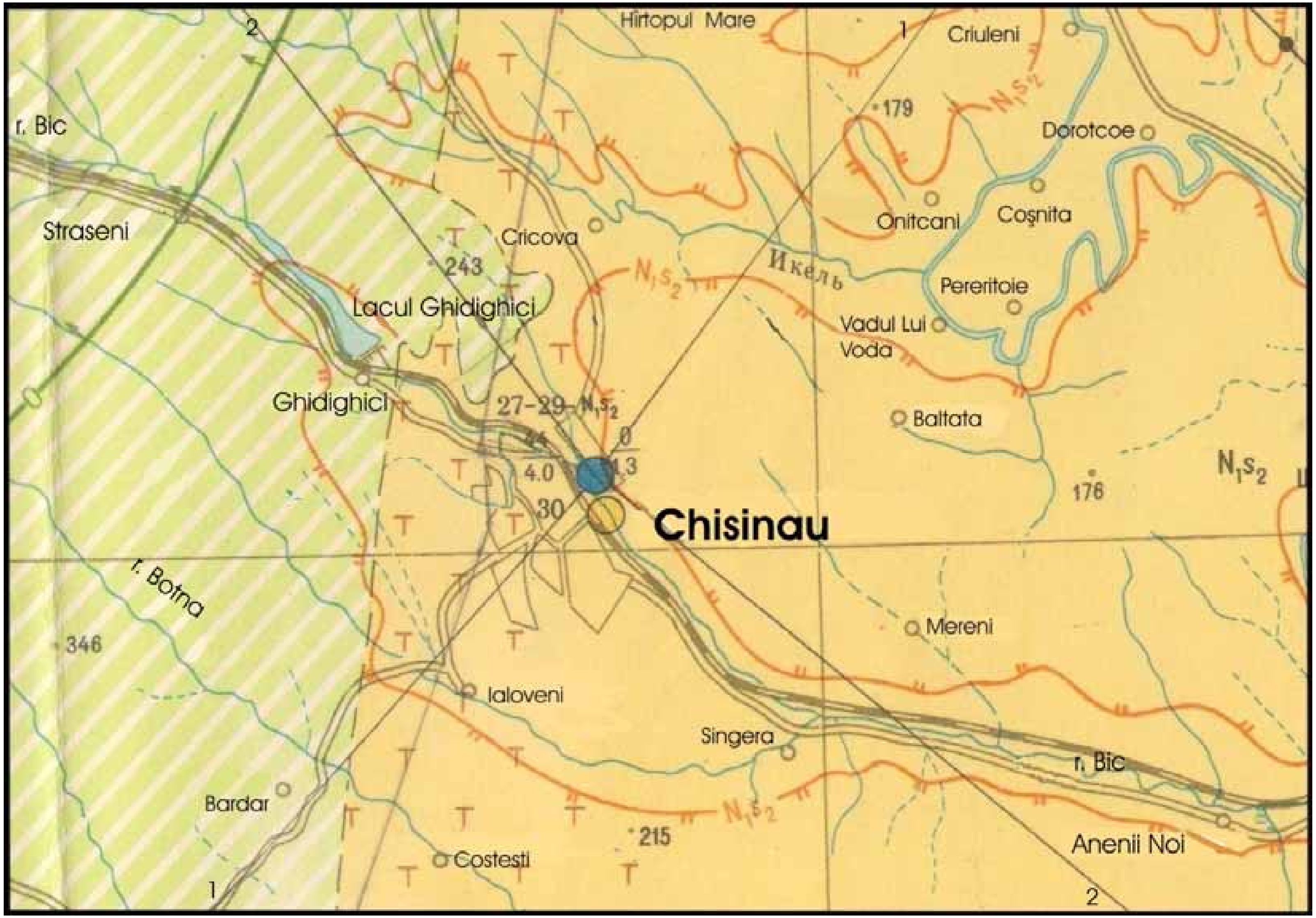


Figure 6 Hydrogeological map of the study area (scale 1 : 500 000)

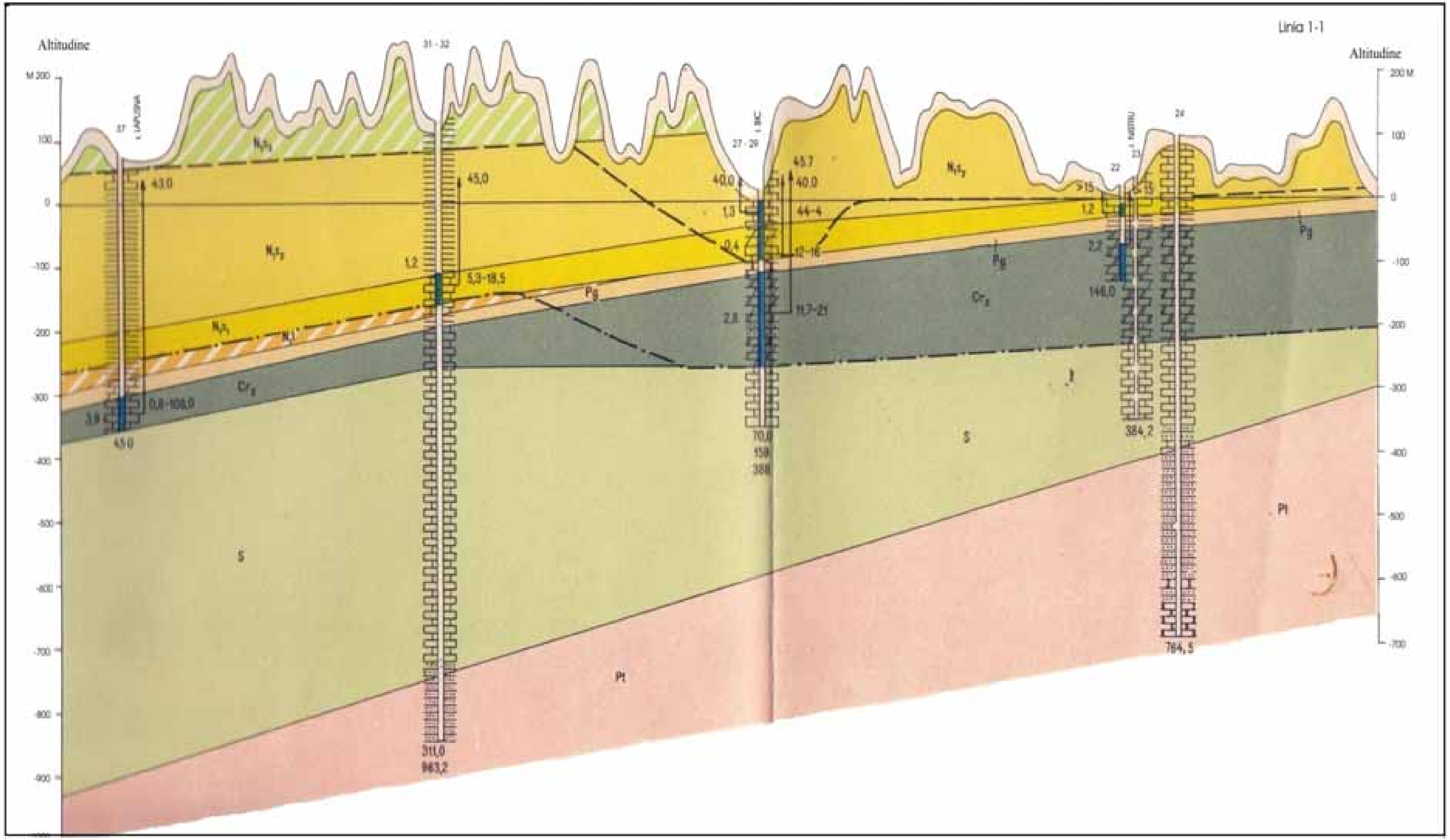


Figure 7 Hydrogeological cross –section (line 1 -1)

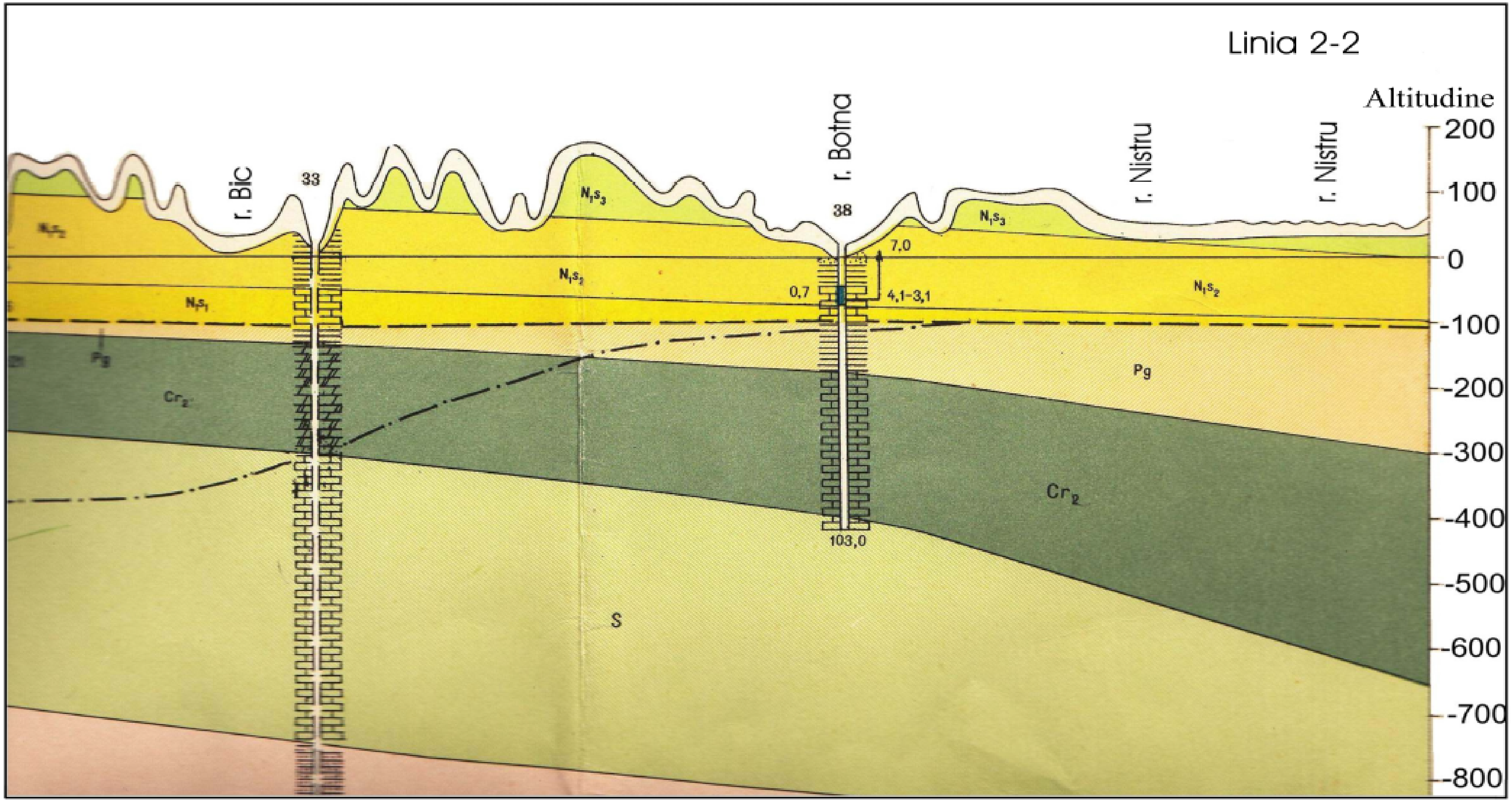
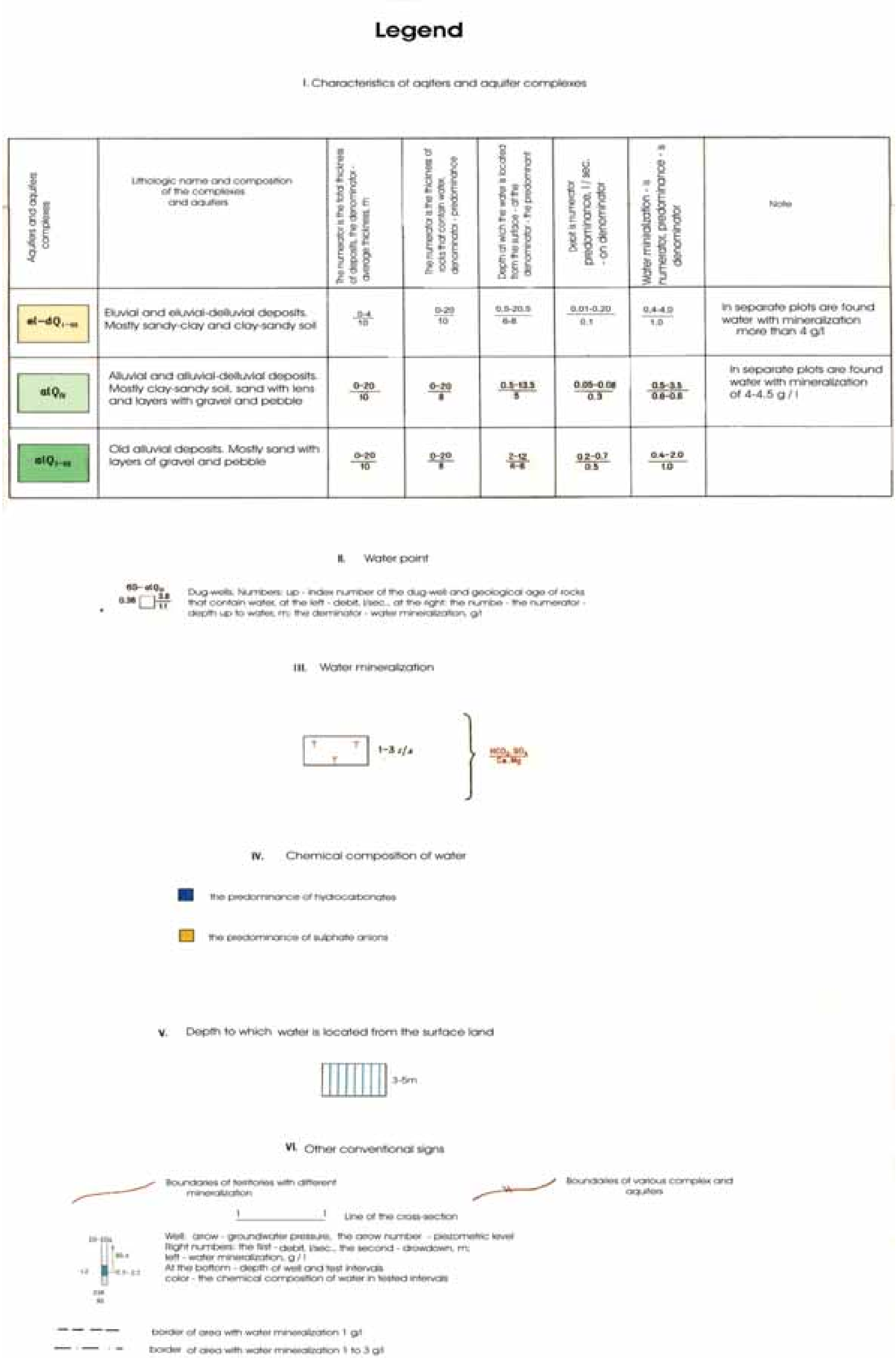


Figure 8 Hydrogeological cross –section (line 2 - 2)



Legend

I. Characteristics of aqiters and aquifer complexes

Aquifers and aquifers complexes	Lithologic name and composition of the complexes and aquifers	The numerator is the total thickness of deposits, the denominator - average thickness, m	The numerator is the thickness of rocks that contain water, denominator - predominance	Depth at wich the water is located from the surface - at the denominator - the predominant	Debit is numerator predominance, l / sec. - on denominator	Water mineralization - is numerator, predominance - is denominator	Note
$el-dQ_{I-III}$	Eluvial and eluvial-deluvial deposits. Mostly sandy-clay and clay-sandy soil	0-4 / 10	0-20 / 10	0.5-20.5 / 6-8	0.01-0.20 / 0.1	0.4-4.0 / 1.0	In separate plots are found water with mineralization more than 4 g/l
alQ_{IV}	Alluvial and alluvial-deluvial deposits. Mostly clay-sandy soil, sand with lens and layers with gravel and pebble	0-20 / 10	0-20 / 8	0.5-13.5 / 5	0.05-0.08 / 0.3	0.5-3.5 / 0.8-0.8	In separate plots are found water with mineralization of 4-4.5 g / l
alQ_{I-III}	Old alluvial deposits. Mostly sand with layers of gravel and pebble	0-20 / 10	0-20 / 8	2-12 / 4-8	0.2-0.7 / 0.5	0.4-2.0 / 1.0	

II. Water point

Dug-wells. Numbers: up - index number of the dug-well and geological age of rocks that contain water, at the left - debit, l/sec., at the right: the numbe - the numerator - depth up to water, m; the derminator - water mineralization, g/l

III. Water mineralization

IV. Chemical composition of water

the predominance of hydrocarbonates

the predominance of sulphate anions

V. Depth to which water is located from the surface land

VI. Other conventional signs

Boundaries of territories with different mineralization

Boundaries of various complex and aquifers

Line of the cross-section

Well. arrow - groundwater pressure, the arrow number - piezometric level
Right numbers: the first - debit, l/sec., the second - drowdown, m;
left - water mineralization, g / l
At the bottom - depth of well and test intervals
color - the chemical composition of water in tested intervals

border of area with water mineralization 1 g/l

border of area with water mineralization 1 to 3 g/l

Figure 9. Legend for hydrogeological map and hydrogeological cross – section

Deep ground water (only fresh one) is located in the Neogen stratigraphical units. Middle Sarmatian horizon is the first formation from the top. This horizon has outcrops in the valley of Bic, Ishnovet and Botna Rivers and in other places (Figure 10). The upper part of the unit is composed from sandy clay with lens of fine sized sand. The thickness of upper part is variable from 50.0 m (Petricani, Chişinău) to 110.0 m (Ialoveni). In some places thickness is less than this limits and is about 25 -30 m (Ciocana, Chişinău). Ground water does not form an aquifer in the upper part of the middle Sarmatian. Occasionally, water bearing lens are discovered during the well drilling.

The lower part of the middle Sarmatian is presented by limestone. Hydrogeologically, they form one common aquifer with Lower Sarmatian stratigraphical unit, whi ch is composed from limestone to (see Figure 10). Middle – Lower Sarmatian aquifer is widely distributed in Moldova and is one the main horizon used for fresh water supply. In the frame of the study area the aquifer is well investigated and is penetrated by tens of study wells. As well many wells are used for water supply.

Position of the aquifer top is changeable from a few meters (absolute altitude compared to Baltic Sea) till (-100) m and more (Figure 11). Bottom of the aquifer is located between (-50) and (-150) m. (Figure 12). Surface of the aquifer top declines in the direction South, South- West. In this direction is extended the thickness of the water bearing rocks.

Aquifer is as confined type. Static water level in the wells is stabilized in the wide interval from 10-15.0 m till 40 – 60.0 m. Hydraulic heads are variable to. As the results of intensive exploitation cones of water level depressions appear around big batteries of wells. In area the most developed coned of depression is associated with the batteries of wells located in Chişinău municipality. In the beginning of current century this cone has the depth of about 90 m with the diameter of several tens of km. At present Chişinău ground water level depression is reduced in size due to decreasing of regional ground water abstraction.

Discharge of wells is estimated from tens to 300 m^3/ day. For the Chişinău site well specific yield consists: Petricani – q = 0.89 – 2.0 l/sec, Ialoveni – 0.17- 2.50 l/sec and Ciocana – 0.1- 2.0 l/sec. Hydraulic conductivity is estimated in the interval 2.0 – 10.1 m/day and transmisivity consists 109.0 – 231.0 m^2/day. Values of storage coefficient are as 0.001 -0.003. Such hydrodynamic parameters are characteristic, in general statistical terms, for all study territory.

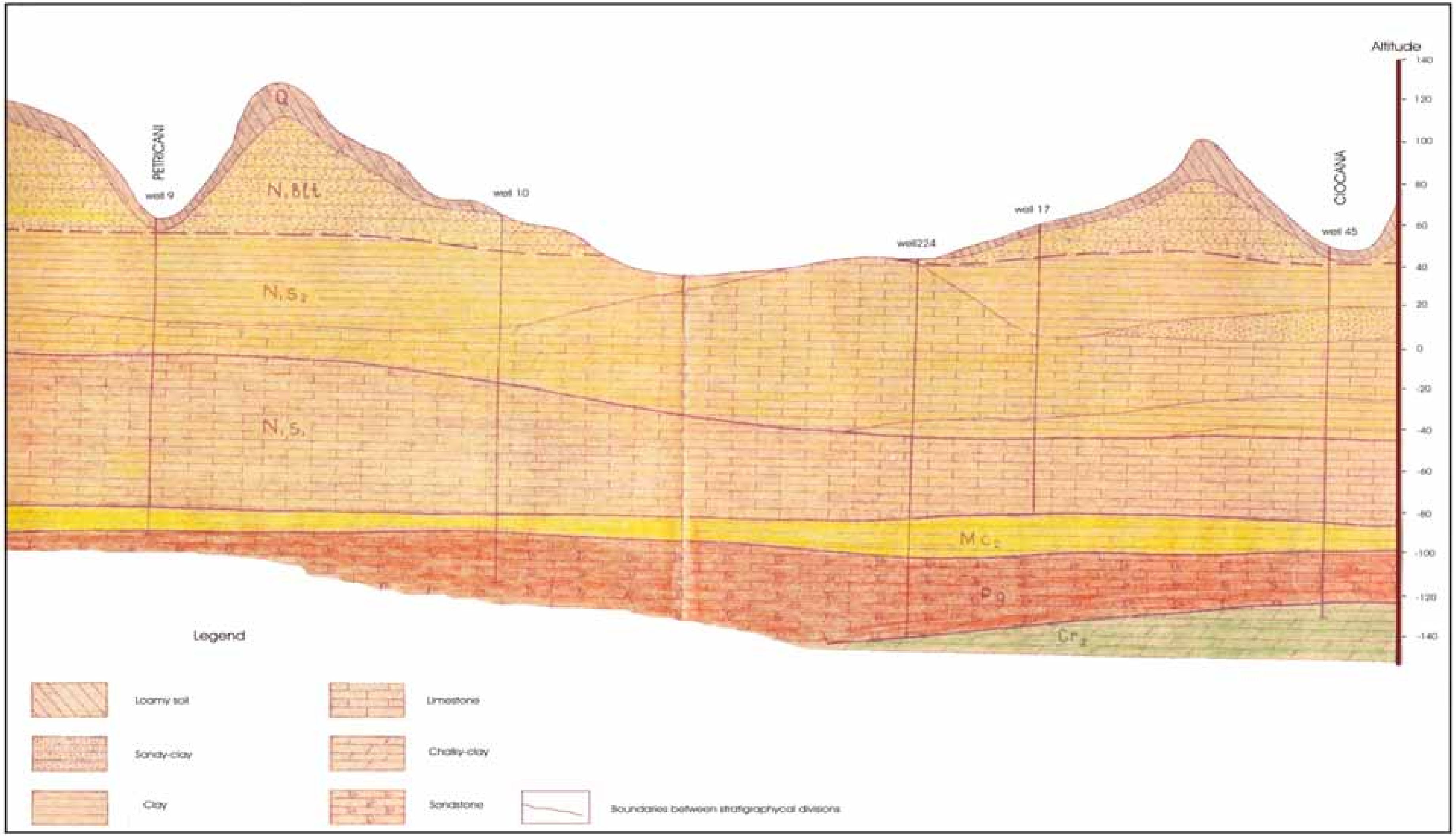


Figure 10 Representative geological cross – section (line Petricani – Cocana, Chişinău City)

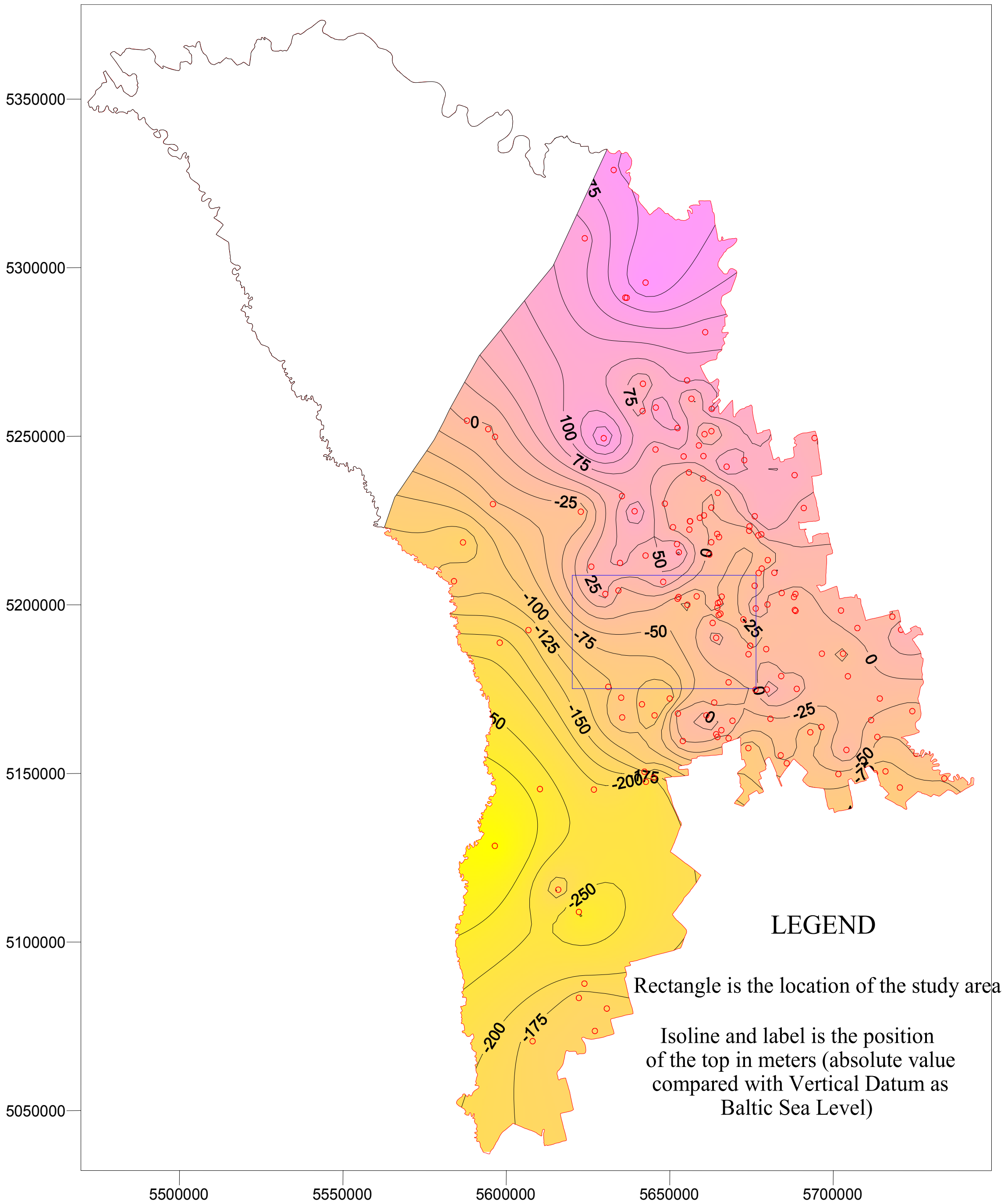


Figure 11 Top of the Middle Sarmatian aquifer

For the Sarmatian aquifer regional flow systems top the hierarchical organization and are the highest level of scale. All other flow systems (local and sub-regional) are within the regional one. The recharge areas from the highest morphological plateau drive these regional systems. Discharge occurs along the valleys of the rivers Prut and Nistru. Potential infiltration zones occur where the land surface is higher than the heads in the deep aquifers; potential drainage zones occur where the conditions are opposite. It can also be inferred that many small streams may (seasonally) drain the superficial aquifers and simultaneously be potential infiltration zones for the deeper aquifer systems.

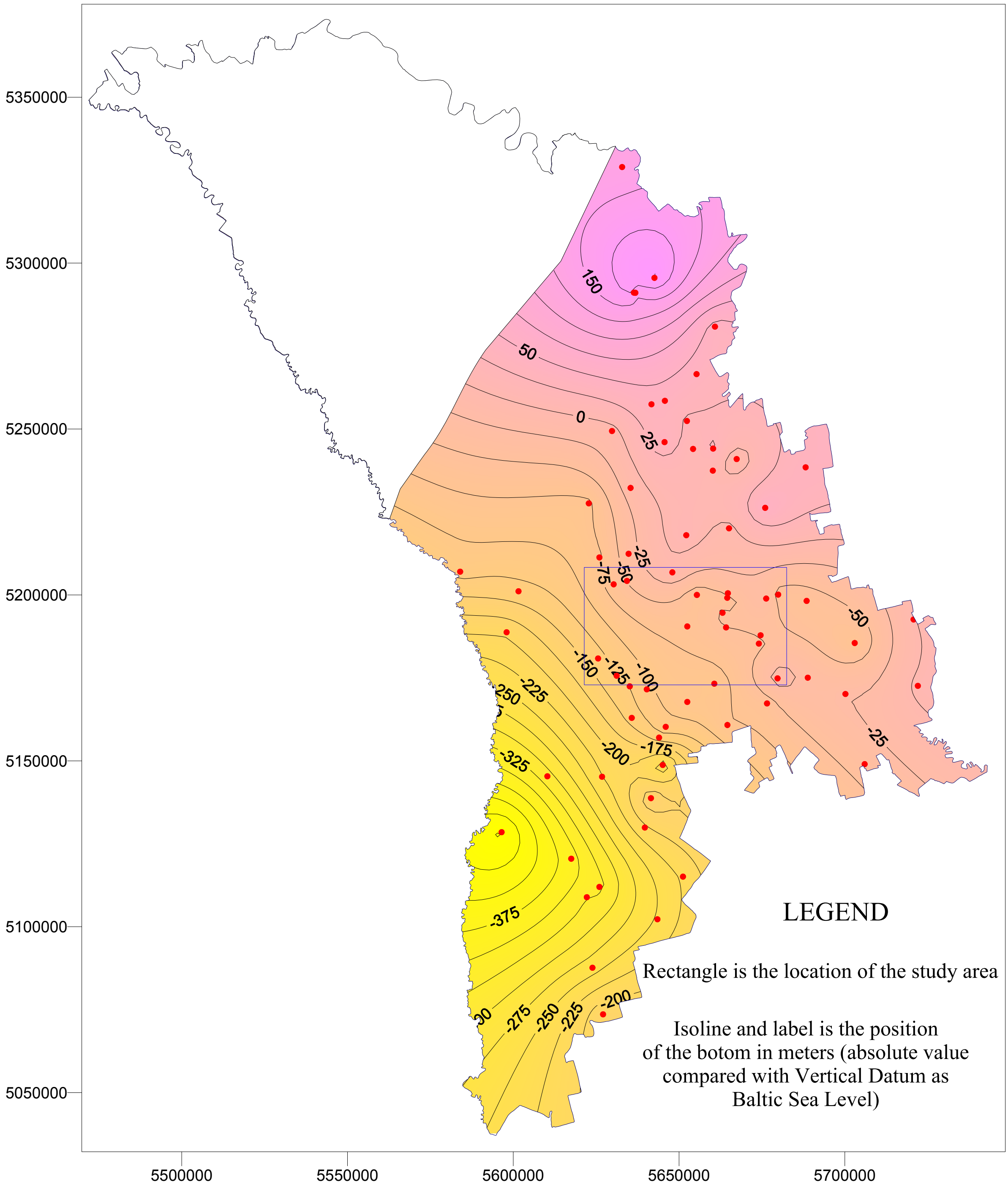


Figure 12 Bottom of the Middle Sarmatian aquifer

In the perimeter of area sometimes *Cretaceous aquifer* is used for water supply, probably mostly for technical water. Water bearing rocks are presented by chalky limestone (Chişinău), marl with lens of limestone (village Puhoi) and marl in other places. The top of the aquifer is drilled at 153.0 m (Chişinău, Petricani), 158.0 m (Chişinău, Ciocana) and about 160.0 m (village Puhoi). Thickness of the aquifer consists about 20.0 m (Chişinău) and 40.0 m (village Puhoi). Aquifer is unconfined. Hydraulic head is located near value of (+40) m (Chişinău). Hydraulic coefficient varies between 0.1 – 3.0 m/day and transmisivity consist 10.0 – 120.0 m^2/day (Figure 13).

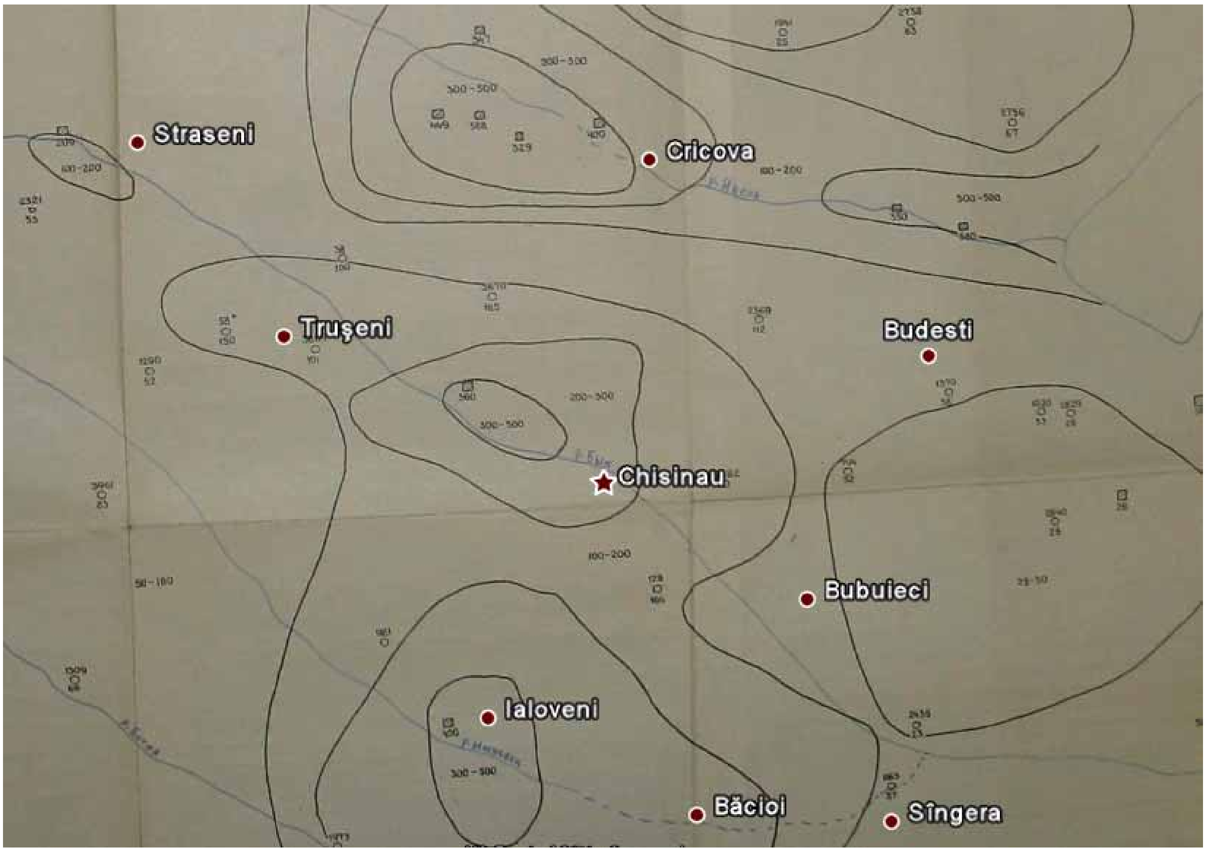


Figure 13 Bottom of the Middle Sarmatian aquifer

1.4. HYDROGEOCHEMISTRY

Many official publications describe the ground water geochemistry of Moldova [3-7]. Water quality of the study territory is performed on the basis of selective data. These data are the most complete and organized as well as representative of the whole study territory.

Shallow (phreatic) ground water. Statistical mean values of the chemical elements in ground water are presented in Table 2. It is evident from statistical data evaluation that the geochemistry of ground water is complex, as well as water quality territorial distribution

Parameter	Ca	Na	K	Mg	HCO3	NO3	SO4	Cl
Mean	148.44	245.25	10.27	113.83	570.29	158.65	511.27	185.44
Minimum	11.30	2.62	0.20	10.12	9.40	0.93	1.91	1.69
Maximum	512.20	1150.00	350.00	433.05	1073.60	1045.00	3000.00	1285.78

Parameter	Ni	Sr	Cu	F	Fe	Se	Cr	Ti
Mean	0.000764	5.70	0.003034	0.81	0.06	0.0139	0.0095	0.0014
Minimum	0.00005	0.24	0.00009	0.05	0.02	0.000001	0.0014	0.000010
Maximum	0.00402	49.00	0.042	8.00	0.41	0.28	0.025	0.0074

Parameter	Mn	Pb	Al	Mo	Hg	Ba	Sn	V
Mean	0.0048	0.0015	0.010	0.0034	0.000046	0.0244	0.00032	0.0016
Minimum	0.00002	0.000030	0.000040	0.00025	0.000005	0.00104	0.00006	0.00026
Maximum	0.107	0.036	0.18	0.043	0.000189	0.12	0.00085	0.0062

Parameter	Ag	As
Mean	0.00042	0.0024
Minimum	0.000010	0.0002
Maximum	0.0019	0.023

Table 2 Statistical data for shallow aquifer (average values, concentration is in mg/l)

Water quality of the shallow aquifers is dependent from local surface topography. It is observed that TDS (total dissolved solids) is increasing from the water divide line to river valley. Since there is no natural barrier between aquifers and pollution sources at the surface, contamination of these open phreatic aquifers by anthropogenic sources of pollution may occur at any place where these sources are unprotected. Polluted water will infiltrate and join the ground water flows on their way towards the discharge areas. The level of chemical substances in the ground water will increase in the direction of flow as the ground water passes more polluted locations. When conditions are favorable, reactions between chemical substances and the subsoil may cause this process to partly reverse. In some cases decay may bring decrease concentration levels.

Pollution sources are usually directly related to land use. In the hilly areas, the main land uses are agriculture (maize, grapes, etc.) and nature. Most villages and industries are situated in the valleys and on the lower slopes of hills, while arable lands or natural vegetation cover the high slopes and plains. In many cases, diffuse pollution from arable lands at higher elevations may affect the ground water in the villages. The lowest values of nitrate (usually between 0.0 and 50.0 mg/l) are in the natural areas. In a few cases, the water had no nitrate at all. Spring water from natural areas lacks nitrate if the area and the spring are well protected. In arable lands, the average nitrate content of dug wells and springs was 50.0 mg/l, and the 75th percentile was about 100.0 mg/l. However, there is a wide range of values with maximum scores up to 250 mg/l. In the built-up areas of villages (i.e., urban areas), the median value of nitrate contents from shallow wells was about 290 mg/l. There is a wide range of values with maximum values over 500.0 mg/l. The only explanation for these high values is local accumulation of nitrate from domestic pollution.

The following are two major sources of nitrate that may end up in the shallow groundwater:

Local pollution from leaking toilets, pit privies, animal stables and sheds, pigsties, chicken farms, uncontrolled open and leaking sewerage systems, etc.;

NO_3 from an overdose of fertilizers and/or manure

The villages and arable lands show higher chloride (Cl^-) concentrations and much more variability. Four sources of Cl are significant:

- Cl^- from precipitation and evaporation processes, estimated to account for 50.0 mg/l;
- Cl^- from flushing marine Miocene sediments which is expected to show increasing concentration along a flow line and so increasing towards the groundwater exfiltration areas;
- Cl^- from human pollution such as sewerage, human and animal excrements, etc.;
- Cl^- from the application of inferior fertilizers.

Middle and Lower Sarmatian aquifer. As mentioned previously, the Midlle-Lower Sarmatian aquifer is one of the main sources of fresh water in the study area. Statistical data is presented in Table 3. These data are not statistically reliable and the majority of constituents do not show a normal distribution. The differences between maxima and minima are high for chemical elements (null for minimum signifies conventional lower analytical level of detection). Such statistical characteristics are common for complex geochemical conditions where many factors influence water chemistry. Sarmatian aquifer is a typical representative of changeable hydrogeological and geochemical conditions predominantly in space dimension.

Parameter	Mean	Minimum	Maximum
Ca	35.219	1.00	542.00
Na	348.26	11.17	2721.00
K	3.5373	0.46	24.00
Mg	28.54	0.20	348.00
HCO_3	738.31	128.10	2696.00
CO_3	43.46	1.00	264.00
NO_2	0.56	0.00	14.00
NO_3	4.934	0.00	97.40
PO_4	0.27	0.04	1.00
SO_4	210.108	1.00	1422.10
SiO_2	12.722	0.50	63.70
Cl	85.592	1.00	3085.00
NH_4	2.205	0.02	35.00
Ag	0.0011	0.0001	0.04
Al	0.0428	0.002	0.46
As	0.0049	0.0001	1.00
B	1.0855	0.09	4.40
Ba	0.06	0.0003	1.00
Br	0.59136	0.12	6.00
Cr	0.002	0.001	0.02
Cu	0.015	0.0001	1.00
F	2.60	0.05	13.20
Fe	0.18	0.0006	5.36
Fe_2	0.21	0.02	3.00
Fe_3	0.262	0.02	2.50
I	0.2369	0.10	2.50
Mn	0.0311	0.0002	1.00
Mo	0.0336	0.0001	3.60
Ni	0.0055	0.0004	0.15
Pb	0.0044	0.0001	0.04
Se	0.0107	0.0001	1.00
Sn	0.0032	0.0017	0.01
Sr	2.432	0.02	11.70
Ti	0.0053	0.0001	0.05
V	0.0131	0.0001	0.46
Zn	0.0348	0.01	1.00
CO_2	17.22	0.43	53.20
H_2S	9.5625	5.61	15.47
TDS	1098.00	288.60	1500.20
pH	7.95	6.8	9.90
HD	4.24	0.01	59.60
EC	1400.33	490.00	4520.00

(concentration is in mg/l; pH is in units; HD is hardness; EC is conductivity in μS/cm)

Table 3 Statistical data for the Midlle-Lower Sarmatian aquifer

The geological position of the Middle- Lower Sarmatian aquifer influences the distribution of major chemical elements. This occurs in the deep southwest. The Middle Sarmatian reef covers the Lower Sarmatian limestone on the large part of Moldovan territory. The concentrations of TDS, Cl, Na, F, and NH_4 increase in the south – southwest direction. The reef area serves as a regional recharge zone, and this territory has elevated concentrations of Ca, Mg, NO_3, pH, hardness, and Sr. In the south part the H_2S in detected in water samples. This fact complicates the fresh water supply, because of unpleasant odor of water and reaction of the gas with metal.

Cretaceous aquifer. This aquifer contains fresh water only in the southern part of Moldova and it used to supply water for many localities as well as for industrial and agricultural enterprises. In the central part of Moldova cretaceous aquifer is used occasionally. Nevertheless, some wells are in use in Chişinău City and in other localities of the study area. General data about water quality of this aquifer can be obtained from the well located in Straseni district

Chemical element, mg/l	Străşeni town	Zubresti village
Ca	6.0	8.0
Mg	4.2	5.5
Na	619.4	459.2
SO_4	104.7	252.6
HCO_3	1416.5	1054.4
Cl	74.71	27.3
F	6.55	5.6
TDS	1523.41	1285.4

Table 4 Water quality data for Cretaceous aquifer

It should be noted, that in area water quality of this aquifer depends of the location of wells and its position pertaining to tectonic faults.

The groundwater quality of deep wells differs significantly from that of shallow wells. The most striking differences are the much lower hardness, the higher pH, and the total absence/or low concentration of NO_3. Hardness, measured by test strips, is usually much lower than 7 German degrees. This is typical for deep groundwater with residence times in the aquifers of thousands of years. The groundwater is anoxic, implying that all of the NO_3 has been totally reduced (possibility of creating H_2S). Due to lengthy residence times of many thousands of years, this deep groundwater has exchanged Ca and Mg ions for Na from the marine Miocene clayey sediments. The clay minerals adsorb the sodium ions in the marine Miocene sediments. When flushed with Ca-HCO_3 types of groundwater, the Ca and Mg are adsorbed, and Na is expelled from the clay minerals into the groundwater. This well-known cation exchange occurs when marine sediments are flushed with fresh groundwater yields the common $NaHCO_3$ or NaCl types (according to the Kurlov classification) of deep groundwater with higher pH values of about 8.0. The long travel times of the deep groundwater in the Miocene sediments have also resulted in higher Cl content.

The prominent minor element is fluoride (F), the high contents of which are rather unexpected. Wells with fluoride concentrations exceeding the limits are randomly distributed. The explanation for this distribution is the fact that the typical groundwater is the very soft $NaHCO_3$. The solubility product of NaF is much higher than CaF_2 (mineral fluorite). Thus, removal of Ca ions from the solution by adsorption and replacement with Na will result in increasing fluoride concentrations. High concentration of fluoride is connected with tectonic faults as well.

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2. CURRENT STATE OF EACH GROUNDWATER RESOURCE - APĂ CANAL WELL FIELDS

2.1. IALOVENI WELLS FIELD

There are 21 wells in Ialoveni. There were built between 1968 and 1976. The forecasted life span of the wells was 25 years.

Historic:

From 1986 to 1997, the field well was exploited at its full capacity. In those years, the maximum production was 7 000 000m3 per year, or 19200 m3/d. In 2010, the production was 782 000m3. It can be assessed that in 2010, the daily peak production was 3120 m3/d.

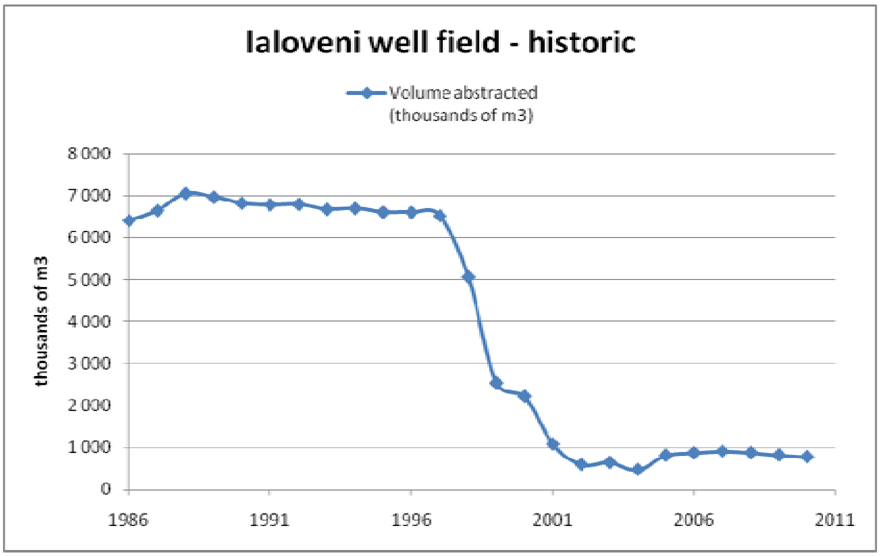


Figure 14 Volume abstracted from Ialoveni well field

Current situation:

Currently 5 of these 21 wells are in a good working order. The 16 others need rehabilitation. Pumping station has also to be rehabilitated and is not currently suited if the 21 wells are being operated.

<u>Quality:</u>

Nr. fîntînii arteziene (adresa)	Normativul conform HG nr.934	n°8		n°9		n°10		n°11		n°23		n°24		n°26	
		2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
Turbiditate (UNT)	≤5	1	1	0,5	0,5		0,5	1,5		2,5	0,5	1,5	0,5	0,5	0,5
Gust (puncte)	Accept consumatorilor	0	0	0				0		0		0		0	
Miros (puncte)	Accept consumatorilor	2	2/2 H2S	2	1/2 H2S		2/2 H2S	2		2	2/2 H2S	2	1/2 H2S	1	2/2 H2S
Culoare (grade)	Accept consumatorilor	5	5	5	5		5	5		10	5	5	5	5	5
pH	6,5-9,5	7,8		7,75				7,65		7,7		7,9		7,9	
Amoniac şi ionii de amoniu (mg/dm3)	0,5	1,57	0,91	1,86	1,49		0,94	1,57		1,47	0,91	1,96	1,18	2,72	1,57
Nitriți (mg/dm3)	0,5	0,01	<0,003	<0,003	<0,003		<0,003	<0,003		<0,003	<0,003	<0,003	<0,003	<0,003	<0,003
Nitrați (mg/dm3)	50	<0,44	<0,44	<0,44	<0,44		<0,44	<0,44		<0,44	<0,44	<0,44	<0,44	<0,44	<0,44
Cloruri (mg/dm3)	250	30	50	48	37,7		56,1	57		35	32,6	25	29,6	43	43,9
Sulfați (mg/dm3)	250	88,5	88,1	98,6	91,4		170,8	171,2		101,7	98,3	93,2	95,1	97,1	101,6
Reziduu fix (mg/dm3)	1500	425,5	482	458,5	488		620	724,5		467	475	507,5	513	505,5	520
Fier total (mg/dm3)	0,3	0,09	0,21	0,05	0,05		0,13	0,13		0,11	0,14	0,26	0,12	0,075	0,11
Duritatea totală (grad German)	> 5	15,4	15,1	16,8	14,9		18,2	18,5		16,5	16,8	14	14	15,1	15,2
Dureté (degré français)	> 8,9	27,4	26,9	29,9	26,5		32,4	32,9		29,4	29,9	24,9	24,9	26,9	27,1
Aluminiu rămas (µg/dm3)	200														
Fluor (mg/dm3)	1,5	0,28	0,13	0,28	0,24		0,22	0,58		0,26	0,2	0,67	0,34	0,31	0,26
Zinc (mg/dm3)	3	<0,005		<0,005				<0,005		<0,005		<0,005		<0,005	
Plumb (µg/dm3)	10	<0,5		<0,5				<0,5		<0,5		<0,5		<0,5	
Arsen (µg/dm3)	10	<5		<5				<5		<5		<5		<5	
Cupru (mg/dm3)	1	<0,02		<0,02				<0,02		<0,02		<0,02		<0,02	
Mangan (mg/dm3)	50	<10		<10				<10		<10		<10		<10	
Clorul rezidual: liber(mg/dm3)	0,5														
Clorul rezidual total (mg/dm3)	nu se normeaza														
Floculant rămas (µg/dm3)	0,1														
Escherichia coli (număr/100ml)	0	0	2	0	8		1	0		0	0	0	1	0	1
Coli-fagi	0/100 ml														
Ceanuri (µg/dm3)	10														
Selen (µg/dm3)	10														
Crom (µg/dm3)	50														
Substanțe organice oxidabile (mgO/dm3)	5	0,56	0,96	0,64	1,36		1,36	0,48		0,4	1,2	0,72	1,84	0,4	1,28
Numărul total de colonii la 37 gr. C (număr/1cm3)	20/1ml	2		2					0	9		0		10	
Clostridium perfingens (număr/100ml)	0														
Populatia microbiana generala (UFC/cm3)	20														
Sulfuri si hidrogen sulfurat	100 µg/l		1730		1038		1384				2080		1384		1384
$Na^+ + K^+$ (mg/l)	200														

Table 5 Quality analyses for Ialoveni well field

Quality analyses in 2009 and 2010 show that the following parameters are above the norms.

	NH_4^+	H_2S
	mg/l	µg/l
Limit (norm HG nr:934)	0,5	100
Average – in mg/l	1,51	1500
Max –	2,72	2080
Min –	0,91	1038
Nb of excess/nb of analyses	12/12	6/6

Rehabilitation:

In summer 3 wells are being operated at the same time and 2 in winter. Two or three electrical installations should be changed.

CCTV of some wells showed that 30 to 40% of the filters were clogged. So cleaning them is mandatory.

Another group of 3 wells are in good condition. Only the pump has been removed.

The other 13 wells are not in a proper working order. They have been stopped for 10 years. According to the operator, some elements have to be changed in order to operate them again:

- Electrical installations
- Pumps
- Submersible cable and pipe inside the well.
- The liaison pipe (□=100mm) from the well to the collector
- The upper part in concrete, that closes the well, should be changed.

According to the operator, the state of the collector (⃠=300mm and ⃠=400mm) is unknown.

The 2 big pumps that used to work when the well field was fully operated are still installed. They are being rotated manually twice a year. But they haven't worked for 10 years. At least 50% of the hydraulic equipment of those two pumps (pipes, valves…) have to be changed (high pressure may break them).

2.2. GHIDIGHICI WELLS FIELD

There are 12 artesian wells in the well field of Ghidighici. They were built between November 1967 and March 1968. The operator explained that their forecasted life span was 35 years.

In 2010, 875 000m3 were abstracted from this well field (or 2 400 m3/d) but the maximum production was about 3 000 000 m3 in a year.

Historic:

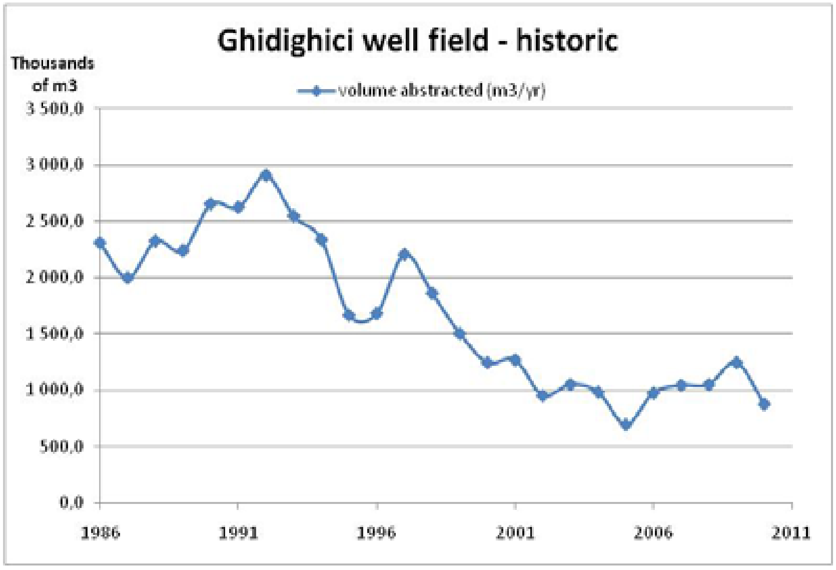


Figure 15 Water abstracted from Ghidighici well field

Current situation:

Although the general state of installations is correct, several rehabilitation works have to be done on pipes, electrical installations, pumps… Furthermore, wells have now exceeded their forecasted life span.

Water quality

Nr. fîntînii arteziene (adresa)	Normativul conform HG nr.934	nr.1, (2509)	nr.2, (2511)		nr.3, (2508)		nr.5, (2485)		nr.7, (2482)	nr.10, (2476)		nr.11, (2475)		nr.12, (2473)	
		2010	2009	2010	2009	2010	2009	2010	2010	2009	2010	2009	2010	2009	2010
Turbiditate (UNT)	≤5	1	0,5	0,5	5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5
Gust (puncte)	Accept consumatorilor	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Miros (puncte)	Accept consumatorilor	1/2 H2S	2	1/2 H2S	2	2/2 H2S	2	1/2 H2S	2/2 H2S	2	2/2 H2S	2	2/2 H2S	2	2/2 H2S
Culoare (grade)	Accept consumatorilor	5	5	5	5	5	5	5	5	5	5	5	5	5	5
pH	6,5-9,5	7,25	7,5	7,5	7,5	7,6	7,45	7,20	7,70	7,35	7,30	7,55	7,55	7,70	7,70
Amoniac şi ionii de amoniu (mg/dm3)	0,5	0,26	0,83	0,22	0,74	0,10	0,64	0,05	0,11	0,32	0,10	0,58	0,08	0,42	0,07
Nitriţi (mg/dm3)	0,5		0,02		0,14		0,13			0,13		0,14		0,60	
Nitraţi (mg/dm3)	50		<0,44		<0,44		<0,44			<0,44		<0,44		<0,44	
Cloruri (mg/dm3)	250	41,8	50	45,9	45	43,9	34	31,6	29,6	33	33,7	38	32,6	39	35,7
Sulfaţi (mg/dm3)	250	471,2	491,30	496,70	432,00	442,00	357,10	336,00	303,70	355,7	329,6	337,8	336,2	344,8	
Reziduu fix (mg/dm3)	1500	1227	1216	1233	1117	1132	941	986	893	923	934	931	871	990	955
Fier total (mg/dm3)	0,3	0,26	0,26	0,13	0,05	0,05	0,08	0,05	0,13	0,08	0,09	0,07	0,08	0,05	0,15
Duritatea totală (grad German)	> 5	37,6	37	35,9	34,8	35,1	29,7	31,1	30,7	29,4	29,4	28,6	30,0	31,4	32,0
Dureté (degré français)	> 8,9	66,9	65,9	63,9	61,9	62,5	52,9	55,4	54,6	52,3	52,3	50,9	53,4	55,9	57,0
Aluminiu rămas (µg/dm3)	200														
Fluor (mg/dm3)	1,5	0,24	0,24	0,22	0,20	0,16	0,26		0,22	0,24	0,24	0,28	0,18	0,22	0,22
Zinc (mg/dm3)	3		<0,005		<0,005		<0,005			<0,005		<0,005		<0,005	
Plumb (µg/dm3)	10		<0,5		<0,5		<0,5			<0,5		<0,5		<0,5	
Arsen (µg/dm3)	10		<5		<5		<5			<5		<5		<5	
Cupru (mg/dm3)	1		0,02		0,02		0,02			0,02		0,02		0,02	
Mangan (mg/dm3)	50		<10		<10		<10			<10		<10		<10	
Clorul rezidual: liber(mg/dm3)	0,5														
Clorul rezidual total (mg/dm3)	nu se normeaza														
Floculant rămas (µg/dm3)	0,1														
Escherichia coli (număr/100ml)	0		0		0		0			0		0		0	
Coli-fagi	0/100 ml														
Ceanuri (µg/dm3)	10														
Selen (µg/dm3)	10														
Crom (µg/dm3)	50														
Substanţe organice oxidabile (mgO/dm3)	5	1,76	1,2	1,76	1,12	1,84	1,28	1,76	1,68	1,20	1,52	0,96	1,60	0,96	1,60
Numărul total de colonii la 37 gr. C (număr/1cm3)	20/1ml	2	1	2	1	5	0	1	2	1	4	1	1	3	1
Clostridium perfingens (număr/100ml)	0														
Populatia microbiana generala (UFC/cm3)	20														
Sulfuri si hidrogen sulfurat	100 µg/l	1038		1384		1730		1038	1730		2076		1730		1730

Table 6 Quality analyses for Ghidighici wells field

We have one quality analysis for each well in 2009 and 2010. Except for wells n°4, 6, 8 and 9

Quality analyses in 2009 and 2010 show that the following parameters are above the norms:

	SO_4	NH_4^+	H_2S
	mg/l	mg/l	µg/l
Limit (norm HG nr:934)	250*	0,5	100
Average	384,9	0,32	1626
Max	496,7	0,83	2076
Min	303,7	0,05	1038
Nb of excess/nb of analyses	14/14	4/14	10/10

Rehabilitation:

Information coming from the following sources was taken into account to assess the rehabilitation works:

- Meeting of the commission for artesian wells on the 22/12/2010 and the rehabilitation plan that was approved.
- Meeting with Mr. Andronovici and Mr. Railean (operators of the well field) on the 18/08/2011 current state of artesian wells was assessed.

Rehabilitations works needed:

- Well n°9 (passport number: 2521) is stopped because it is unworkable. The pump was withdrawn from the well. The pipes on this well and the electrical alimentation are not good. Furthermore, this well is clogged from the top of the filter (during the video inspection, the camera was not able to go further than 55,8m). On a meeting of the “committee for artesian wells” on the 22/12/2010 it was decided to stop this well and to commission a study by the AGeoM in order to close permanently this well.
- Well n°4 and well n°8 are temporary stopped. They are situated close to a power line (110kV). These wells are not being operated currently. Electrical works or pump installation have to be planned with the operator of the power line.
- Install new control panel for wells n°1,5,6,7,8.
- Installation of pumps for wells n°6 and n°8
- Well casing n°6 and n°8
- According to video inspection, filters are clogged partially (about 50%) in some parts and totally in some other parts so a cleaning of the filters is mandatory for all wells.
- The operator stressed the point that the pipes are in steel and that there are not in good shape. And that there is a risk of cracks in the upper part of the pipe (causing infiltration of surface polluted water).

Flow:

Next table detailing initial and current capacity for each well in Ghidighici well field was established based on documents from Apă Canal :

- meeting of the commission for artesian wells on the 22/12/2010
- datasheet about technical and sanitary condition of artesian wells

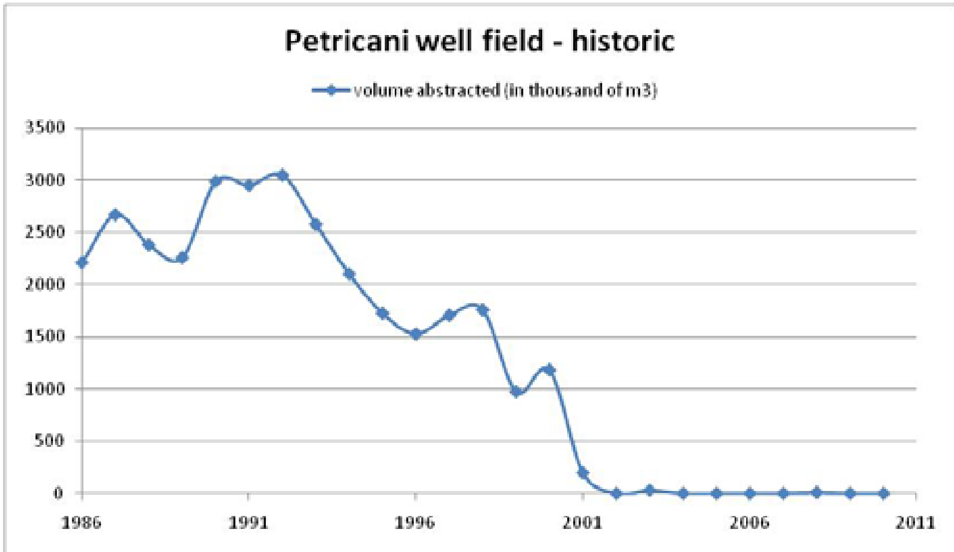
Well n°	1	2	3	4	5	6	7	8	9	10	11	12	total
Flow technical passport (m3/h)	50	60	36	40	50	50	50	30	20	36	42	42	506
Flow de facto (m3/h)	45	47	47	25	28	29	47	50	0*	52	53	53	476

* Well n°9 is stopped permanently.

Maximum capacity of the well field is 11 424 m3/d (476*24 = 11 424 m3/d).

2.3. Petricani well field

Historic:



There are 9 wells in the well field of Petricani. This well field was stopped in 2001. The reason is the drop of billed volumes. Four wells were built between 1948 and 1955. Three were built between 1964 and 1969. And the last two were built in 1979 and 1984.

The maximum production (in 1998) for the well field of Petricani was 1 755 000 m3 in a year.

Current situation:

The entire well field and pumping station has been stopped for several years. Both wells and pumping station have to be rehabilitated entirely.

Water quality

		Priza de apa Petricani																	
Nr. fîntînii arteziene (adresa)	Normativul conform HG nr.934	FA 12			FA 3953		FA 3952			FA 2242		FA 1275		FA 269		FA 268		FA 225	
		1994	1999	2003	1997	2003	1994	2000	2003	1994	1998	1994	2003	1994	2000	1994	2003	1995	2003
Turbiditate (UNT)	≤5	0,3	0,3	0,3	8,7	4,4	0,3	0,6	0,6	0,3	1,75	0,3	0,9	0,3	0,3	0,3	0,3	0,3	0,3
Miros (puncte)	Accept consumatorilor	1/1	1/1	2/3	2/2	2/2	1/1	1/2	2/2	1/2	1/2	1/2	2/2	1/2	1/1	1/2	1/2	1/2	1/2
Amoniac şi ionii de amoniu (mg/dm3)	0,5	0,7	0,69	0,85	0,86	0,81	0,5	0,41	0,55	0,7	0,8	0,4	0,51	0,8	0,59	0,7	0,82	0,7	0,67
Nitriți (mg/dm3)	0,5	ND	0,19	ND	0,02	0,03	0,02	0,15	ND	0,01	0,11	ND	ND	0,01	0,19	ND	0,03	ND	ND
Nitrați (mg/dm3)	50	ND	ND	ND	ND	ND	ND	1,99	ND	ND	ND	ND	ND	ND	1,77	ND	ND	ND	ND
Cloruri (mg/dm3)	250	45	50	43	61	42	47	45	43	40,1	43	44,5	48	55	56	41,5	47	41	42
Sulfați (mg/dm3)	250	325	362	368	430	301	390	385	364	329	392	347	355	443	413	345	370	305	292
Reziduu fix (mg/dm3)	1500	936	974	994	1216	952	1037	1045	1032	932	993	1046	986	1090	1067	904	998	916	914
Fier total (mg/dm3)	0,3	0	0	0,23	0,05	0,26	0,1	0,17	0,26	0,05	0,13	0	0,25	0	0	0	0,12	0,06	0,1
Duritatea totală (grad German)	> 5	9,9	9,9	10,7	16,1	11,3	11,2	9,5	11	9,9	10,5	11,2	11,7	11,5	10,3	9,2	11,3	10	10,2
Fluor (mg/dm3)	1,5	0,19	ND	0,23	ND	0,23	0,19	0,3	0,23	0,19	ND	0,21	0,22	0,19	0,27	0,19	0,22	0,2	0,18
Substanțe organice oxidabile (mgO/dm3)	5	1	2,5	2,64	0,9	2,88	1,5	0,64	2,56	1,9	0,64	1,1	2,32	1,1	0,64	1	2,96	1,8	2
Sulfuri si hidrogen sulfurat	100 µg/l	800	630	1780	2700	1380	800	1400	138	800	1250	1000	1070	1000	700	1100	710	1400	710

Table 7 Quality analyses Petricani well field

Since these wells were not operated in 2009 and 2010, we don’t have any quality analyses for those years. Analyses made between 1994 and 2003 were studied.

	SO_4	NH_4^+	H_2S
	mg/l	mg/l	µg/l
Limit (norm HG nr:934)	250	0,5	100
Average	362	0,67	1076
Max	443	0,86	2700
Min	292	0,4	138
Nb of excess/nb of analyses	18/18	15/18	18/18

Flow:

Next table detailing initial and current capacity for each well in Petricani well field was established based on documents from Apă Canal:

- meeting of the commission for artesian wells on the 22/12/2010
- datasheet about technical and sanitary condition of artesian wells

Well n°	1	2	4	5	6	10	11	12	13	total
Flow technical passport (m3/h)	36		42	40	36	78	27	50	42	395*
Flow de facto (m3/h)	59	62	58	50	50	25	28	25	58	415

* Sum with assessment of flow of well n°2 to be 44m3/h (average of other wells).

Maximum capacity of the well field is 9 960 m3/d (415*24 = 9 960 m3/d).

Rehabilitation:

According to the following document: *Informația priving starea tehnico-sanitară a fîntînilor arteziene*.

- 8 out of the 9 wells could be operated quickly in case of emergency (*În stare de lucru*). The pumps are still installed in the well. The reparations needed are electrical installations for 3 wells (n°5, n°12 and n°13). And externals parts of the well (pipe to collector).
- Well n°11 (passport number n°1063) is not in a good working order because of the bad state of the casing.

Another document from Apă Canal is detailing the measures to implement in order to put back in operation the well fields of Ghidighici, Petricani, Balişevsk and village Ghidighici.

Based on this document, for Petricani, the following actions have to be made:

- Mounting and commissioning 3 pumps in Petricani pumping station

State of the pumping station of Petricani is an issue. A visit is to be made to assess the reparation to be made if needed or if possible.

- Commissioning chlorination installation
- Washing reservoirs of Petricani pumping station
- Changing 3 valves
- Mounting pumps for 5 wells
- Buying and commissioning pumps for wells n°6 and n°10.
- Repairing power line for wells n°12 and n°13 and n°6 and n°10
- Changing exterior pipe of well n°6.
- Changing control panel of 5 wells
- Check quality of water abstracted from wells
- Cleaning the reservoirs

<u>Summary of video inspection in between 2000 and 2003:</u>

<u>Well n°1:</u> at 36,7m deep, the filter is clogged at 80%. At 63,4 m deep, the casing is entirely rotten and it collapse when touch by the camera. Elsewhere there are concretions (2-3 cm).

<u>Well n°2:</u> at 51,3m deep, the casing has holes

<u>Well n°5:</u> 55,7m casing partially destroyed. 56,4m deep the casing is partially rotten. 56,6m deep: beginning of the filter. The filter is clogged and rotten.

<u>Well n°6:</u> the filter is almost entirely clogged in some places. Elsewhere the filter is damaged or rotten. The camera could go deeper than 67,5 m because parts of the filter were destroyed and laid in the middle of the well.

<u>Well n°10:</u> There are some concretions on the casing. Elsewhere the filter is clogged at 90%

<u>Well n°11:</u> The filter is perforated in three places. Other inspection only talks about clogging.

<u>Well n°12:</u> Concretions (2-3 cm) on the filter.

<u>Well n°13:</u> In some place the filter is clogged at 90%. Elsewhere the case is rotten

In any case, rehabilitation of the wells is needed. For some only cleaning of casing is needed whereas for others, more complete rehabilitation is needed.

2.4. BALIŞEVSC WELL FIELD

Historic:

There are 6 wells in Balişevsc. 5 (n°5 to n°9) were built in 1976 and the n°1 was built in 2004. They currently supply zone 1 but this well field can also supply the downtown of the city (zone II).

The maximum production of Balişevsc well field was about 2 000 000 m3 from 1990 to 1992.

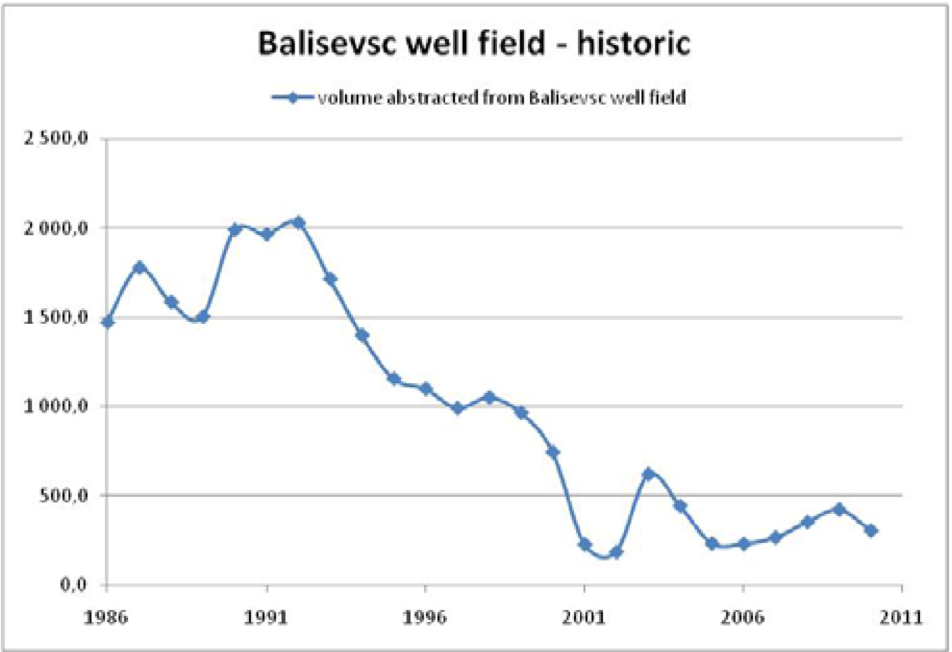


Figure 16 Volume abstracted from Balişevsc well field

Current situation:

The well field is currently being operated but volumes abstracted are low. All of wells need rehabilitation.

Water quality

		Priza de apă Balişevsc									
Nr. fintînii arteziene (adresa)	Normativul conform HG nr.934	nr.1 (219)	nr.5 (3623)		nr.6 (3624)		nr.7 (3625)		nr.8 (3626)	nr.9 (3627)	
		2009	2009	2010	2009	2010	2009	2010	2010	2009	2010
Turbiditate (UNT)	≤5	0,5	5	5	4		5			0,5	
Gust (puncte)	Accept consumatorilor	0	0	0	0		0			0	
Miros (puncte)	Accept consumatorilor	1	1	1/2 H2S	2	2/2 H2S	2	2/2 H2S	2/2 H2S	1	2/2 H2S
Culoare (grade)	Accept consumatorilor	5	20	20	15	15	20	10	5	5	5
pH	6,5-9,5	7,55	7,40	7,50	7,40		7,35		7,50	7,45	7,65
Amoniac şi ionii de amoniu (mg/dm3)	0,5	0,08	0,77	0,26	0,83	0,60	1,06	0,42	0,52	1,67	0,22
Nitriţi (mg/dm3)	0,5	0,025	0,01	<0,003	<0,003	<0,003	0,02	<0,003	0,02	<0,003	<0,003
Nitraţi (mg/dm3)	50	18,6	<0,44	<0,44	<0,44	<0,44	<0,44	<0,44	<0,44	<0,44	<0,44
Cloruri (mg/dm3)	250	94	82	77	93	93	90	86	91	80	76
Sulfaţi (mg/dm3)	250	586,7	479,7	461,7	616,5	602,8	478,1	444,8	631,7	678,1	664,6
Reziduu fix (mg/dm3)	1500	1447,5	1345	1312	1649,5	1586	1452	1457	1612	1603	1619
Fier total (mg/dm3)	0,3	0,05	0,07	0,26	0,08	0,13	0,08	0,21	0,26	0,18	0,11
Duritatea totală (grad German)	> 5	50,5	47,1	37,00	56,4	53,30	52,2	48,50	57,20	58,9	56,6
Dureté (degré français)	> 8,9	89,9	83,8	65,9	100,4	94,9	92,9	86,3	101,8	104,8	100,7
Aluminiu rămas (µg/dm3)	200										
Fluor (mg/dm3)	1,5	0,46	0,44		0,29		0,42			0,48	
Zinc (mg/dm3)	3	<0,005	<0,005		<0,005		<0,005			<0,005	
Plumb (µg/dm3)	10	<0,5	<0,5		<0,5		<0,5			<0,5	
Arsen (µg/dm3)	10	<5	<5		<5		<5			<5	
Cupru (mg/dm3)	1	0,02	0,02		0,02		0,02			0,02	
Mangan (mg/dm3)	50	<10	<10		<10		<10			<10	
Escherichia coli (număr/100ml)	0	0	0		0		0			0	
Substanţe organice oxidabile (mgO/dm3)	5	0,64	0,88	1,76	0,72		1,04			1,68	
Numărul total de colonii la 37 gr. C (număr/1cm3)	20/1ml	0	1	1,76	1	1,44	1	2,00	1,36	1	1,28
Sulfuri si hidrogen sulfurat	100 µg/l	690		1038		1380		1730	2076		1380

Table 8 Quality analyses Balişevsc well field

	SO_4	NH_4^+	H_2S	mineralization
	mg/l	mg/l	µg/l	mg/l
Limit (norm HG nr:934)	250	0,5	100	1500
Average	564,5	0,64	1382	1508
Max	678,1	1,67	2076	1649
Min	444,8	0,08	690	1312
Nb of excess/nb of analyses	10/10	6/10	6/6	5/10

More detailed quality analyses can be found in annexes in Table 8 Quality analyses Balişevsc well field

<u>Flow:</u>

Next table detailing initial and current capacity for each well in Balişevsc well field was established based on documents from Apă Canal:

- meeting of the commission for artesian wells on the 22/12/2010

- datasheet about technical and sanitary condition of artesian wells

Well n°	1	5	6	7	8	9	total
Debit technical passport (m3/h)				60			-
Debit de facto (m3/h)	140	52	52	53	58	52	407

The capacity of the well field is 407 m3/h or 9 768 m3/d.

Rehabilitation:

According to the following document: *Informația priving starea tehnico-sanitară a fîntînilor arteziene* and according to the minutes of the meeting of the *comisiei de lucru privind executarea ordinului nr.98 din 15.07.2010*.

- Well n°1 is not working because of a defect in the exterior pipe. An entrepreneur has to come to repair this. – Investigations are to be made in order to assess the real state of this well.

Video inspections (2001-2003):

Well n°5: Big concretions (3-4cm) on the casing. The camera couldn't go further than 43,8m deep because of it.

Well n°6: Big concretions (3-4cm) on the casing. The camera couldn't go further than 49,0m deep because of it.

Well n°7: ok

Well n°8: Concretions (2-3cm) on the casing. There are 2 holes of θ = 50mm at a depth of 36 and 38m. The casing is destroyed on about ¼ of the circumference at the depth of 41,7m.

Well n°9: Casing is destroyed at a depth of 26,7m (θ = 70 to 120mm).

There is a document from Apă Canal detailing the measures to implement in order to put back in operation the well fields of Ghidighici, Petricani, Balişevsk and village Ghidighici.

Based on this document, for Balişevsc, the following actions have to be made:

- Repairing the exterior pipe (250mm) of well n°1
- Mounting a pump in well n°1

2.5. NISTRU WELL FIELD

Assessment of the situation

Those 65 wells were drilled on the banks of Nistru River, between September and December 1983, in order to supply Chişinău with water while water from the river was polluted.

Apă Canal provided several documents dealing with this well field: current condition of the wells (including video inspection), quality analyses and minutes of meetings. The following assessment of the condition of this well field was made based on these documents.

Immediately after first operation the water was found to be very aggressive. Casing of wells corroded and the capacity of the wells decreased.

The initial capacity of the well field was 136 000 m3/d (49 600 000 m3/yr). A recent reevaluation (less than 10 years) brought the capacity back to 50 580 m3/d (18 500 000 m3/yr).

In fact, the well field never produced more than 10 000 000 m3 in a year.

It has been almost stopped for 20 years (production in 2010 was 11 533 m3).

Because of the aggressiveness of the water and according to video inspections, wells are not in good conditions (casing and filters are almost destroyed). Then the rehabilitation of the well field may be impossible or at least difficult and expensive.

Quality analyses:

Data from several analyses made less than 10 years ago.

	Value	Norm
Hardness (German d°)	Between 10 and 15	5
Total mineralization in mg/l	Between 800 and 1200	1500
Iron (in mg/l)	The majority of analyses are between 0,5 and 1 mg/l but some between 2,5 and 3 mg/l.	0,3
Sulfate (in mg/l)	The majority of analyses are between 220 et 390 mg/l.	250
Ammonium	50% of analyses above the quality norm, some up to 4 mg/l	0,5
free CO2	up to 52 mg/l	

The water is aggressive and is not compliant with water drinking standards. The current treatment process in SAN is unable to efficiently treat this water.

Executive Committee decision

Based on these documents, it was ascertained that the 65 wells cannot be operated in their current condition (wells are in bad shape and water abstracted is aggressive and not compliant with drinking standards). It was also stated that rehabilitation of the 65 wells and treatment of water abstracted would be complex and expensive.

Based on these conclusions the technical committee of Apă Canal recommended to stop permanently operation of Nistru well field. The well field would keep being monitored in order to prevent pollution of the aquifer.

The decision to stop operations was taken on the 15th of November 2010 by Executive Committee of Apă Canal (minutes of meeting n°31).

Conclusion

According to the decision of the executive committee, the 65 wells of the Nistru well field cannot be taken into account as an emergency resource in the emergency plan.

2.6. GRATIEŞTI

There are 4 wells in the commune of Gratieşti. They are in different part of the commune. Currently none of them is being operated.

	Passport n°	Start of operation	in operation	nominal flow (m3/h)	Depth
or.Gratieşti, str.G.Coşbuc	2932	dec.69	no	7,5	135
or.Gratieşti, str.Prieteniei	4420	avr.84	no	11	160
or.Gratieşti, str.Academiei	4047	dec.79	no	11	167
or.Gratieşti, str.I.Creangă	2873	nov.69	no	11	170

All equipments have been removed from the wells (pumps, electrical installations and exterior pipes). Nevertheless the casing and filters of the wells could be rehabilitated.

Operation:

Operation was stopped in 2002.

The maximum production was about 220 000 m3 in a year.

2.7. DURLEŞTI

There are 6 wells in the commune of Durleşti. They are in different part of the village. Currently none of them is being operated.

	passport n°	start of operation	in operation	nominal flow (m3/h)	depth
nr.1	3672	sep.76	no	16	210
nr.2	2940	dec.69	no	32	165
nr.3	2948	1970	no	8	160
nr.4	4225	nov.87	no	8	220
nr.5	4957	mai.69	no	8	207
nr.6	2809	mai.69	no	11	231

All equipments have been removed from the wells (pumps, electrical installations and exterior pipes). The location of those wells (far from network and pumping stations, separated one from another) makes their rehabilitation difficult. In addition, habitations were built in the protection perimeter of well n°6. Nevertheless casing and filter of remaining wells are in good shape.

Operation:

Production was stopped in 2005.

The maximum production was about 350 000 m3 in a year.

2.8. BURCUȚA

	passport n°	Start of operations	In operation	nominal flow (m3/h)	depth
m.Chişinău, str Munceşti S.P.Burcută	1573	nov.63	no - conservated	24	125
m.Chişinău, str Munceşti S.P.Burcută	3084	sep. 1970	no - conservated	6	131

In pumping station Burcuța, there are two artesian wells. This pumping station was dismantled about 20 years ago (every equipment was removed). The artesian wells were also dismantled and equipments removed. The presence of H_2S in the water abstracted from wells was mentioned.

3. CURRENT STATE OF EACH GROUNDWATER RESOURCE - CHIŞINĂU'S SUBURBS

3.1. INVESTIGATIONS IN CHIŞINĂU'S SUBURBS

The table below summarizes the communities included in the perimeter of the study.

Rayon / Municipality	Secteur	Commune	Village		WATER Served by	Sewerage	Who maintains the network	Connection to network	population 2009 - 2010	Visit	Proposals
CHISINAU	**Chisinau CITY** : *5 districts (present)*				yes	yes	ACC	yes	630800	-	-
	Botanica			1	yes	yes	ACC	yes	171200	-	-
	Buiucani			1	yes	yes	ACC	yes	110900	-	-
	Centru			1	yes	yes	ACC	yes	93400	-	-
	Ciocana			1	yes	yes	ACC	yes	117500	-	-
	Rascani			1	yes	yes	ACC	yes	137800	-	-
	Chisinau City : *New Territories*			1	yes	yes	ACC	yes	0	-	-
	Chisinau CITY : *TOTAL*				yes	yes	ACC	yes	630800	-	-
	Botanica	Bacioi	Bacioi Village	4	no	no	no	no	8710	visit on 07/07	ok
			Braila	4	no	no	no	no	920	visit on 07/07	ok
			Frumusica	4	no	no	no	no	467	visit on 07/07	ok
			Straisteni	4	no	no	no	no	501	visit on 07/07	ok
		Sangera	Dobruja Village	3	yes	yes	yes	yes	3247	-	-
			Revaca	3	no	no	no	no	983	visit on 05/07	ok
			Sangera City	2	yes	yes	yes	yes	7503	-	-
		Galata Village - Aeroport City			yes	yes	ACC	yes		-	-
	Buiucani	Condrita	Condrita	3	no	no	no	no	670	visit on 27/07	ok
		Durlesti	Durlesti City	2	yes	yes	ACC	yes	16206	-	-
		Ghidighici	Ghidighici Village	3	yes	yes	ACC	no	5144	visit on 06/07	ok
		Ghidighici	Pruncul	3	yes	yes	ACC	yes	-	visit on 06/07	ok
		Truseni	Dumbrava Village	4	yes	yes	ACC	yes	419	visit on 15/07	ok
			Truseni	4	no	no	no	no	7901	visit on 15/07	ok
		Vatra	Vatra City	2	yes	yes	ACC	partial	3315	visit on 06/07	ok
	Centru	Codru	Codru City	2	yes	yes	ACC	yes	14399	-	-
		Codru	Costiujeni Village	2	yes	yes	ACC	yes	-	-	-

Rayon / Municipality	Secteur	Commune	Village		WATER Served by	Sewerage	Who maintains the network	Connection to network	population 2009 - 2010	Visit	Proposals
CHISINAU	Ciocana	Bubuieci	Bac Village	4	yes	no	ACC	yes	1086	-	-
			Humulesti	4				no	234	-	ok
			Bubuieci Village	4	yes	yes	ACC	yes	5942	-	-
		Budesti	Budesti Village	4	yes	no	ACC	no	4578	visit on 09/08	ok
			Vaduleni	4	yes	yes	ACC	yes	554	visit on 30/06	ok
		Colonita	Colonita Village	3	yes	yes	ACC	yes	3385	-	-
		Cruzesti	Ceroborta	4	no	no	no	no	36	visit on 14/07	ok
			Cruzesti Village	4	yes	yes	ACC	yes	1656	visit on 14/07	ok
		Tohatin	Bunet Village	4	yes	no	no	yes	48	-	-
			Cheltuitor Village	4	yes	no	ACC	yes	335	-	-
			Tohatin de Jos Village	4	yes	yes	ACC	yes	-	-	-
			Tohatin Village	4	yes	yes	ACC	yes	2166	-	-
		Vadul lui Voda	Vadul lui Voda City	2	yes	yes	ACC	yes	4531	-	-
	Riscani	Ciorescu	Ciorescu	4	no	no	no	no	5544	visit on 12/07	ok
			Fauresti	4	no	no	no	no	469	visit on 12/07	ok
			Goian	4	no	no	no	no	1129	visit on 12/07	ok
		Cricova	Cricova	2	no	no	no	no	10185	visit on 12/07	ok
		Gratiesti	Gratiesti Village	4	yes	yes	ACC	yes	4743	-	-
			Hulboaca Village	4	yes	no	ACC	yes	1567	-	-
		Stauceni	Goianul Nou Village	4	yes	yes	ACC	yes	626	-	-
			Stauceni Village	4	yes	yes	ACC	yes	6999	-	-
Anenii Noi		Floreni	Floreni Village	6	yes	no	no	partial	3722	visit on 05/07	ok
		Maximovca	Maximovca Village	6	yes	no	no	partial	1791	visit on 11/08	ok
Criuleni		Balabanesti	Balabanesti Village	6	yes	yes	ACC	partial	3660	visit on 30/06	ok
		Cosernita	Cosernita	6	yes	no	ACC	partial	1523	visit on 12/08	ok
		Onitcani	Onitcani	6	yes	no	no	no	2066	visit on 26/07	ok
		Slobozia Dusca	Slobozia Dusca	6	yes	no	no	no	2662	visit on 26/07	ok
Ialoveni		Ialoveni	Ialoveni	5	yes	yes	ACC	yes	15233	-	-
Straseni		Straseni	Straseni	5	no	yes	no	no	18622	visit on 15/07	ok
		Cojusna	Cojusna	6	no	yes	no	no	7010	visit on 14/07	ok

3.2. DESCRIPTION OF THE CURRENT SITUATION

3.2.1. TRUŞENI

Current situation:

There are 4 artesian wells in the town of Truşeni (7 546 inhabitants). About 1 300 houses are connected to a well on about 3 000 houses in total in the town. They produce water which is not compliant with the drinking water standards (too much H_2S, NH_4, and Fluor). Other houses use shallow wells.

The network is in bad condition. There is no reservoir in Truşeni.

Quality analyses:

		Truşeni		
	Normativul conform HG nr.934	Artesian well passport	nr. 103/7* 22/04/2008	nr. 100/1 22/04/2008
Turbiditate (UNT)	≤5		6	2
pH	6,5-9,5		8,5	8,1
Amoniac şi ionii de amoniu (mg/dm3)	0,5	5,4	4,3	2,50
Nitriţi (mg/dm3)	0,5		ok	ok
Nitraţi (mg/dm3)	50	2,3	ok	ok
Cloruri (mg/dm3)	250	14	15	20
Sulfaţi (mg/dm3)	250	68	39,3	99,10
Rezidu fix (mg/dm3)	1500		911	570
Fier total (mg/dm3)	0,3		0,44	0,08
Duritatea totală (grad German)	> 5		1,4	8,7
Fluor (mg/dm3)	1,5	2,8	2,1	1,32
Substanţe organice oxidabile (mgO/dm3)	5		24	4
Populatia microbiana generala (UFC/cm3)	20		12	0
Sulfuri si hidrogen sulfurat	100 µg/l		73,6	42,96

Table 9 Quality analyses of artesian wells in Truşeni

* data from this sample is incoherent and should not be taken into account

Facies of this water is characteristic of cretaceous aquifer.

Water from artesian wells is not compliant with the drinking water standard. Concentrations in H_2S, NH_4, and Fluor are too high.

Synthesis:

Issues identified
Quality of water from artesian wells not compliant with water quality standards
Installations too small to supply the entire town
Network is not covering the entire town

3.2.2. COJUŞNA

Current situation:

This town is in the rayon (region) of Străşeni.

There are about 7 010 inhabitants in Cojuşna. Water supply is made only with shallow wells.

AGeoM built 12 artesian test wells to assess the possibility to extract potable water. But the results were not good; concentrations in Fluor and H_2S are too high.

The network was built in the fifties and is in bad condition. There is a reservoir (2x2000m3) in the city.

Synthesis:

Issues identified
Quality of water from artesian wells not compliant with water quality standards (H2S and Fluor)
Only water resource : shallow wells
Network is very partial

3.2.3. STRĂŞENI

Current situation:

This town is in the rayon (region) of Străşeni. There are 18 622 inhabitants in the town.

One year ago the town rehabilitated the aqueduct coming from Micauţsi. In Micauţsi there is a captation field with 11 artesian wells (3 only are working). This field produces good quality water and in big quantities.

The network has been rehabilitated is the last years. But the network covers only about 60% of the city. In area not connected to the network, people use shallow wells.

There is a reservoir (2x6000m3) at the elevation of 125m.

Quality: the quality of the water abstracted from artesian wells in Străşeni is not compliant with drinking water standards. The concentration in Fluor is above the norm (>1,5 mg/l).

3.2.4. COŞERNIȚA

Current situation:

This village is in the rayon (region) of Criuleni. There are 1 523 inhabitants in Coşernița.

The network is old (about 50 years) but covers the entire village. It has to be rehabilitated entirely.

Water is supplied via a bulk supply by Apă Canal through a pipe coming from the SAN (120mm). There is an old artesian well (depth 180m) but it was said water is not compliant with drinking water standards (too salty).

Synthesis:

Issues identified
Liaison pipe from SAN is old and there are many leakages
Artesian well disused
Network is old

3.2.5. ONIȚCANI:

Current situation:

This village is in the rayon (region) of Criuleni. There are 2 066 inhabitants in Onițcani

The village is supplied with water from one spring. The water from the spring is classified as technical water (because there is no chlorination). According to hypotheses (cf paragraph **Erreur ! Source du renvoi introuvable.Erreur ! Source du renvoi introuvable.**), this resource has to be abandoned. There are two disused artesian wells. They used to provide the city with water compliant with drinking standards. Their depth is 60 m and 160m. Quality analyses of water from these artesian wells can be found in annexes (in Table 10 Quality analyses of artesian wells in Onițcani)

The network has been rehabilitated with PE pipes inserted inside the old steel pipes.

Analyses

		Onitcani	
Nr. fîntînii arteziene (adresa)	**Normativul conform HG nr.934**	quality analyse 27/01/2009	technical passport
pH	6,5-9,5	6,99	7,1
Amoniac şi ionii de amoniu (mg/dm3)	0,5	0,28	0
Nitriţi (mg/dm3)	0,5	0,035	
Nitraţi (mg/dm3)	50	0,1	
Cloruri (mg/dm3)	250	86,73	
Sulfaţi (mg/dm3)	250	216,0	
Reziduu fix (mg/dm3)	1500	480	1194,8
Fier total (mg/dm3)	0,3	0,02	0,1
Duritatea totală (grad German)	> 5	3,2	
Fluor (mg/dm3)	1,5	0,70	
Substanţe organice oxidabile (mgO/dm3)	5	2,72	1,4
$Na^+ + K^+$ (mg/l)	200	131	161

Table 10 Quality analyses of artesian wells in Oniţcani

Synthesis:

Issues identified
Current water resources are vulnerable (spring and shallow wells)
Existing artesian wells are disused

3.2.6. SLOBOZIA DUSCA

Current situation:

This village is in the rayon (region) of Criuleni. There are 2 662 inhabitants in Slobozia Dusca.

The village is currently supplied with water from two springs. The water is free. There is no billing or even metering.There is not enough water to supply the entire population in the village. According to hypotheses (cf paragraph **Erreur ! Source du renvoi introuvable.Erreur ! Source du renvoi introuvable.**), this resource has to be abandoned.

People also use shallow wells.

There are 4 old artesian wells. One is still working but only supplies the kindergarten.

The network is in bad condition, made in asbestos cement. It has to be rehabilitated entirely

Synthesis:

Issues identified
Current water resources are vulnerable (spring and shallow wells)
Existing artesian wells are disused

3.2.7. BĂLĂBĂNEŞTI

Current situation:

This village is in the rayon (region) of Criuleni. In the commune of Bălăbăneşti there are 3 660 inhabitants (in Bălăbăneşti; Mălăieşti and Mălăieştii Noi).

100 houses are supplied by Apă Canal; the rest of the population is supplied by 4 artesian wells. There are shortages of water in summer.

Synthesis:

Issues identified
Current installations are not enough to supply the entire village

3.2.8. FLORENI

Current situation:

This village is in the rayon (region) of Anenii Noi. There are 3 722 inhabitants in Floreni.

Currently Floreni is supplied by 3 artesian wells (70% of volumes) and a pipe (= 150mm) from Apă Canal (30% of volumes). Because of the bad economic balance, the municipality decided to build 2 new wells to supply the village without using water coming from Apă Canal. They are currently under construction (end of works scheduled in fall 2011).

The network covers the entire village and is interconnected.

Quality analyses:

		Floreni			
Nr. fîntînii arteziene (adresa)	**Normativul conform HG nr.934**	factory well	factory well - apeduct in the well's room	nr. 956	nr. 957
		10/03/2011	10/03/2011	10/03/2011	10/03/2011
pH	6,5-9,5	8,8	8,8	8,8	8,8
Amoniac şi ionii de amoniu (mg/dm3)	0,5	2,41	1,21	2,80	2,22
Nitriți (mg/dm3)	0,5	ok	0,01	ok	ok
Nitrați (mg/dm3)	50	0,4	0,8	ok	ok
Cloruri (mg/dm3)	250	21,4		22,4	22,4
Sulfați (mg/dm3)	250	119,70		174,50	150,80
Reziduu fix (mg/dm3)	1500	318,4		621	522,2
Fier total (mg/dm3)	0,3		0,05	0,26	0,05
Duritatea totală (grad German)	> 5	2,1		1,40	2,0
Fluor (mg/dm3)	1,5	1,05		0,99	1,38
Sulfuri si hidrogen sulfurat	100 μg/l	364,2		387,2	193,4
$Na^+ + K^+$ (mg/l)	200	234,3		260,5	244

Table 11 Quality analyses of artesian wells in Floreni

Water abstracted from artesian wells is not compliant with water drinking standards. The average concentration in NH4 is about 2 mg/l. Concentration in Na+ and K+ is above norms. H2S is also exceeding norms (average concentration is 250 μg/l).

More detailed quality analyses can be found in annexes in Table 11 Quality analyses of artesian wells in Floreni

<u>Synthesis:</u>

Issues identified
Water abstracted from artesian wells is not compliant with drinking standards

3.2.9. BĂCIOI COMMUNE

The commune of Băcioi is composed of Băcioi village and 3 hamlets (Brăila, Frumuşica Străisteni).

	population
Bacioi Village	8 710.
Braila	905
Frumusica	555.
Straisteni	514.

3.2.10. BĂCIOI VILLAGE

<u>Current situation:</u>

The main part of Băcioi has a proper network and is supplied by 6 wells. The network doesn't serve all streets or all houses in streets connected. The network is gravitational. In summertime there are shortages of water.

<u>Quality analyses:</u>

		Bacioi				
Nr. fintînii arteziene (adresa)	**Normativul conform HG nr.934**	nr.40/290	nr.1/10	nr.4/12 Bazin Apa Potabile	nr.4874	nr.19 Braila
		18/05/2010	23/06/2010	23/06/2010	18/05/2010	18/05/2010
pH	6,5-9,5	7,60	7,90	7,85	8,10	8,00
Amoniac şi ionii de amoniu (mg/dm3)	0,5	0,05	0,86	0,86	1,76	0,05
Nitriţi (mg/dm3)	0,5	0,003	0,003	0,03	0,003	0,015
Nitraţi (mg/dm3)	50	0,01	0,01	0,01	0,01	14
Cloruri (mg/dm3)	250	70	55	55	20	20
Sulfaţi (mg/dm3)	250	557,80	117,1	118,90	48,5	102,2
Reziduu fix (mg/dm3)	1500	1394	515	543	374,5	602
Fier total (mg/dm3)	0,3	0,41	0,04	0,06	0,19	0,1
Duritatea totală (grad German)	> 5	44,9	19,9	20,5	10,9	18,5
Fluor (mg/dm3)	1,5	0,52	0,3	0,28	0,58	0,48
Substanţe organice oxidabile (mgO/dm3)	5	0,68	1,56	1,64	0,76	
Sulfuri si hidrogen sulfurat	100 µg/l	33,5	35,5	30,7	30,1	36,8

Table 12 Quality analyses for Bacioi commune

Quality of water abstracted from the artesian wells varies from one well to another.

Overall the main issue is NH4 which exceeds norms most of the time. Nevertheless NH4 concentration remains moderate (0,05 mg/l to 1,8 mg/l)

Detailed quality analyses can be found in annexes in Table 12 Quality analyses for Bacioi commune

Synthesis:

Issues identified
Water abstracted from artesian wells is not compliant with drinking standards
Water shortages
Network does not cover the entire town

3.2.11. BRĂILA

Current situation:

Brăila is supplied by a well. The network serves the entire hamlet and it is independent from Băcioi network. According to the director of operations 90% of pipes need to be changed because they are 50 years old and made of steel. The well needs also to be rehabilitated.

Highest point in the village: 70m

Quality analyses:

Quality of water abstracted from the artesian well is compliant with water quality standards.

Detailed quality analyses can be found in annexes in Table 12 Quality analyses for Bacioi commune

3.2.12. FRUMUŞICA

Current situation:

Frumuşica is supplied by a well. The network covers the entire hamlet and is independent from Băcioi.

Highest point in the village is 110m.

3.2.13. STRĂISTENI

Current situation:

20 houses (eastern part) of Străisteni are supplied by Frumuşica network. The rest is supplied by an individual well. Network covers the entire hamlet.

Highest point of the village: 83m

3.2.14. CRICOVA

Current situation:

Cricova is a town of 10 600 inhabitants.

The town is supplied by 3 artesian wells. All these wells are connected to 2 reservoirs. Chlorination is made before entering in the reservoirs. Another artesian well is under construction to solve quantity problems. In 2010, volume of water abstracted from the 3 wells was 414 000 m3. The wells are working 24h a day (ie there is not enough water to supply the entire town). Each well products an average of 15 m3/h.

Quality:

		Cricova			
Nr. fîntînii arteziene (adresa)	**Normativul conform HG nr.934**	nr.3	nr.1	nr.2	BAP
		28/10/2010	28/10/2010	28/10/2010	28/10/2010
pH	6,5-9,5	7,40	7,65	7,90	7,75
Amoniac şi ionii de amoniu (mg/dm3)	0,5	0,00	0,00	0,00	0,00
Nitriți (mg/dm3)	0,5	0,00	0,00	0,00	0,00
Nitrați (mg/dm3)	50	0	0	0	0
Cloruri (mg/dm3)	250			35	35
Sulfați (mg/dm3)	250	246,1	164,0	182,5	162,5
Reziduu fix (mg/dm3)	1500		563	674	556
Fier total (mg/dm3)	0,3	0,09	0,09	0,30	0,14
Duritatea totală (grad German)	> 5	29,7	25,8	23,8	24,4
Fluor (mg/dm3)	1,5	0,66	0,86	0,61	
Substanțe organice oxidabile (mgO/dm3)	5	1,24	1,40	1,24	

Table 13 Quality analyses of artesian wells in Cricova

Water abstracted from artesian wells is compliant with drinking standards.

Detailed quality analyses can be found in annexes in Table 13 Quality analyses of artesian wells in Cricova

Synthesis:

Issues identified
Water shortages

3.2.15. CIORESCU COMMUNE

The composition of the commune of Ciorescu is described in the following table

Commune	Village	Population
Ciorescu	Ciorescu	5 525
	Fauresti	466
	Goian	1 105

3.2.16. CIORESCU

Current situation:

The village of Ciorescu is currently supplied by 3 artesian wells. About 80% of the population is connected to the network.

Needs: the hourly peak flow is 31l/s and the daily peak flow is 15,5/s

Quality analyses:

Nr. Fîntînii arteziene (adresa)	**Normativul conform HG nr.934**	**Ciorescu**			
		technical passport nr.3688 (1976)	technical passport nr.4158 (1980)	technical passport nr.4159 (1980)	analyse BAP 20/10/2005
Turbiditate (UNT)	≤5				0,58
pH	6,5-9,5	7,1	7,4	7,4	7,8
Amoniac şi ionii de amoniu (mg/dm3)	0,5	0	7	0,2	0,4
Nitriți (mg/dm3)	0,5				0,003
Nitrați (mg/dm3)	50	3,4		4,8	0,01
Cloruri (mg/dm3)	250	43,9	35,4	35,4	49,5
Sulfați (mg/dm3)	250	247,7	332	334	286,4
Reziduu fix (mg/dm3)	1500	730	912	908	892
Fier total (mg/dm3)	0,3	0	0,1	0	0,18
Fluor (mg/dm3)	1,5	0,43			
Clorul 59esidual: liber(mg/dm3)	0,5				0,3
Substanțe organice oxidabile (mgO/dm3)	5	2,1	3,4	2,7	
$Na^+ + K^+$ (mg/l)	200	103,7	117,8	118,7	

Table 14 Quality analyses from artesian wells in Ciorescu commune

Concentration in sulfate in water abstracted from artesian well in the commune of Ciorescu is most of the time exceeding 250 mg/l.

Synthesis:

Issues identified
About 80% of the population is supplied with water from artesian wells
Quality of water not compliant with drinking standards
Network to be extended

3.2.17. Goian

Current situation:

Population: 1 105.

In the village of Goian, the network and the well are new. But the well is not yet in operation.

3.2.18. FAUREŞTI

Current situation:

Population: 466

Fauresti is not supplied with water, people use shallow wells. There is a old well that needs rehabilitation.

Highest point in the village is 88m.

Synthesis:

Issues identified
Current water resource is vulnerable
Quality of water not compliant with drinking standards
Network to be rehabilitated

3.2.19. Goian Noi

Current situation:

There is an artesian well is this village, ran by Apă Canal. About 20 000 m3 were abstracted every year until 2010. The well was closed when the village was connected to the central network of Apă Canal. The well was affected by a landslide and reparation was made, inserting a smaller pipe inside the casing.

Nominal flow is 10 m3/h.

Quality analyses:

		Goeinii Noi
Nr. fîntînii arteziene (adresa)	Normativul conform HG nr.934	2422
		2009
Turbiditate (UNT)	≤5	1
Gust (puncte)	Accept consumatorilor	0/Accept consumatorilor
Miros (puncte)	Accept consumatorilor	1H2S
Culoare (grade)	Accept consumatorilor	15/Accept consumatorilor
pH	6,5-9,5	7,35
Amoniac şi ionii de amoniu (mg/dm3)	0,5	1,02
Nitriți (mg/dm3)	0,5	<0,003
Fier total (mg/dm3)	0,3	0,52
Escherichia coli (număr/100ml)	0	0
Substanțe organice oxidabile (mgO/dm3)	5	2,08

Table 15 Quality analyses artesian wells Goian Noi

Concentrations in Iron (Fe) and in ammonium (NH4) are above drinking norms.

3.2.20. Condrița

Current situation:

There are 658 inhabitants in the village (pop in 2004) and 280 houses.

The village isn't currently supplied with water. There are 30 shallow wells but only three provide potable water. According to hypotheses, these wells are vulnerable and should be abandoned.

There is a project of building an artesian well to supply the school first and then some houses when the water and wastewater network will have been done.

The hole has been drilled and the two reservoirs (20 m3 each) were bought but nothing else was done.

Based on quality analyses on private artesian wells elsewhere in the village, (cf Table 16 Quality parameters in the vicinity of Condrița) the technical study concludes that the water abstracted from this well will not be compliant with quality standards because of too high level of NH4, Iron and Fluor. And that a treatment will be needed. The forecasted flow is 20 to 50 m3/24h (maybe 100).

	Well #1 (mg/l)	Well #2 (mg/l)	Norm (mg/l)
Iron	0,63	1,03	0,3
Fluor	5	0,35	1,5
NH_4^+	4,5	1,39	0,5

Table 16 Quality parameters in the vicinity of Condrița

Synthesis:

Issues identified
Current water resource is vulnerable
Quality of water in future artesian well is not compliant with drinking standards
Network to be built

3.2.21. BUDEŞTI

Current situation:

There are about 4 500 inhabitants in the village. There is no central network.

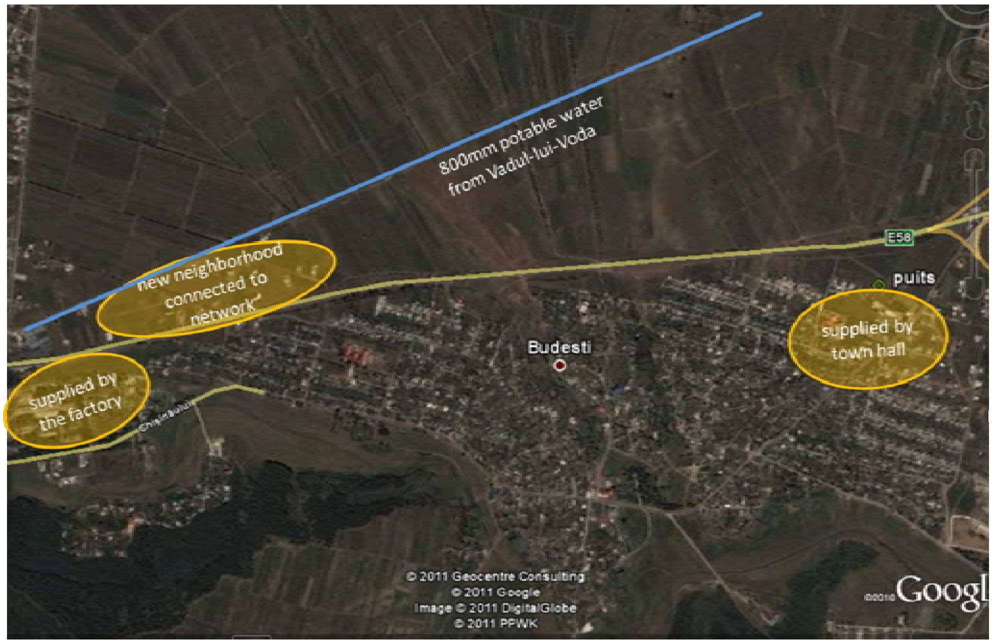


Figure 17 Water supply in Budesti

- The 800mm going from SAN (WTP in Vadul-lui-Voda) to the reservoirs of Tohatin is close to the village but Budeşti is not connected to it.
- 20 houses in a new neighborhood are connected to Apă Canal network. People are building themselves the network.
- There is one artesian well (depth 170m) owned by the town hall. Its production is 5500 – 6000 m3 per year. Almost of this water supplies the kindergarten but 100 houses are connected to this network. The pump of the well is working automatically. The price of this water is 8lei/m3.
- There is another artesian well owned by a private company that supplies building on the West side of Budeşti but the quality of water is not good (technical water).

To sum up, about 10% of people are connected to a network.

Ammonium levels are above norms is the public artesian well (1mg/l and 2,8mg/l).

Synthesis:

Issues identified
Network has to be extended - About 10 % of people are connected to network
Most of water resources (swallow wells for 90% population) are vulnerable
Water from artesian wells not compliant with drinking standards

3.2.22. MAXIMOVCA

Current situation:

This village is in the rayon (region) of Anenii Noi.

Maximovca is connected to Apă Canal network via bulk supply. The network of the village is being built (already about 50% has been done).

Synthesis:

Issues identified
Network has to be extended

3.2.23. REVACA

Main pipes has been laid in every street of the village and connected to Apă Canal network in Singera; only connection to houses is missing.

Synthesis:

Issues identified
Connection to network no yet made

3.2.24. GHIDIGHICI VILLAGE

Current situation:

There are 5 144 inhabitants in the village. About 1/3 of the houses are connected to water network. 6 wells supply water in the village. According to the operator capacity of wells is not big enough to supply the entire village. Network doesn't cover the entire village and has to be extended.

These wells were built between 1958 and 1967 (except well n°4431 built in 1984).

Figure 18 Geographical location wells in Ghidighici village and Vatra

A visit was made on the 6th of July and the situation of each of these wells was assessed.

Video inspections of those wells were made from 2000 to 2008. Filters were found partially corroded and clogged in some places but the general state of those wells was found to be ok.

In the well n°2, the camera was stopped by concretions.

Concretions were also found in well n°4.Clogging is more important in the filters of well n°5.

In 2010, the production of the 7 wells (including the one in Vatra) was 137 200 m3, (19 600 m3/well/year). The maximum production was about 180 000m3/yr in 1998.

<u>Quality analyses:</u>

Nr. fîntînii arteziene (adresa)	**Normativul conform HG nr.934**	com.Ghidighici (1154)	com.Ghidighici (4785)	com.Ghidighici (4431)	com.Ghidighici (1009)	com.Ghidighici (993)	com.Ghidighici (2492)
Turbiditate (UNT)	?5	0,5	0,5	1,5	0,5	0,5	0,5
Gust (puncte)	Accept consumatorilor	0	0	0	0	0	0
Miros (puncte)	Accept consumatorilor	1H2S	1H2S	1H2S	2H2S	2H2S	1H2S
Culoare (grade)	Accept consumatorilor	5	5	5	5	5	5
pH	6,5-9,5	7,85	7,75	7,65	7,8	7,65	7,9
Amoniac şi ionii de amoniu (mg/dm3)	0,5	1,18	0,59	0,36	0,91	0,2	0,59
Nitriţi (mg/dm3)	0,5	<0,003	<0,003	<0,003	<0,003	<0,003	<0,003
Nitraţi (mg/dm3)	50	<0,44	<0,44	<0,44	<0,44	<0,44	<0,44
Cloruri (mg/dm3)	250	37	50	22	26	37	41
Sulfaţi (mg/dm3)	250	387,60	507,3	322,2	261,1	400,8	460,0
Reziduu fix (mg/dm3)	1500	1037	1227	888	829	1027	1129
Fier total (mg/dm3)	0,3	0,31	0,25	0,33	0,18	0,21	0,15
Duritatea totală (grad German)	> 5	33,6	37	32,2	29,2	34,5	35,9
Fluor (mg/dm3)	1,5	0,4	0,15	0,31	0,42	0,3	0,25
Zinc (mg/dm3)	3	0,005	0,005	0,005	0,005	0,005	0,005
Plumb (μg/dm3)	10	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5
Arsen (μg/dm3)	10	<5	<5	<5	<5	<5	<5
Cupru (mg/dm3)	1	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02
Mangan (mg/dm3)	50	<10	<10	<10	<10	<10	<10
Escherichia coli (număr/100ml)	0	0	0	0	0	0	0
Substanţe organice oxidabile (mgO/dm3)	5	1,6	1,36	1,2	1,12	1,2	1,36
Sulfuri si hidrogen sulfurat	100 μg/l	1384	1040	1380	1730	2075	1380

Table 17 Quality analyses for artesian wells in Ghidighici village

Water abstracted from artesian wells in Ghidighici village is not compliant with drinking water standards. Concentrations in NH4, H2S and in SO4 are above norms. Fe is also sometimes slightly above 0,3 mg/l

.

Synthesis:

Issues identified
Water from artesian wells not compliant with quality standards
Network is partial (about 50% of the village)
Artesian wells cannot supply the entire village

3.2.25. PRUNCUL

This industrial area is connected to the network of Apă Canal Chişinău.

3.2.26. VATRA

The main part of the village is connected to the network of Apă Canal. The other part is supplied by an artesian well. The well is situated NW of the village. It supplies the part of Vatra situated on the north of the railroad. The well supplies some houses (74 or 76) and several factories. In 2010, 10 000 m3 were abstracted from this well.

Quality analyses:

	Normativul conform HG nr.934	Vatra		Normativul conform HG nr.934	Vatra
Turbiditate (UNT)	≤5	0,5	Fier total (mg/dm3)	0,3	0,36
Gust (puncte)	Accept consumatorilor	0	Duritatea totală (grad German)	> 5	33,4
Miros (puncte)	Accept consumatorilor	1H2S	Fluor (mg/dm3)	1,5	0,33
Culoare (grade)	Accept consumatorilor	5	Zinc (mg/dm3)	3	<0,005
pH	6,5-9,5	7,85	Plumb (μg/dm3)	10	<0,5
Amoniac şi ionii de amoniu (mg/dm3)	0,5	0,26	Arsen (μg/dm3)	10	<5
Nitriți (mg/dm3)	0,5	0,01	Cupru (mg/dm3)	1	<0,02
Nitrați (mg/dm3)	50	<0,44	Mangan (mg/dm3)	50	<10
Cloruri (mg/dm3)	250	55	Escherichia coli (număr/100ml)	0	0
Sulfați (mg/dm3)	250	346,0	Substanțe organice oxidabile (mgO/dm3)	5	1,52
Reziduu fix (mg/dm3)	1500	972	Sulfuri si hidrogen sulfurat	100 μg/l	1040

Table 18 Quality analyses for artesian well in Vatra

Water abstracted from artesian wells in Vatra is not compliant with drinking water standards. Concentrations in H2S and in SO4 are above norms. Fe is also slightly above 0,3 mg/l.

.

Synthesis:

Issues identified
Water from artesian wells not compliant with quality standards
The railroad makes it difficult to connect the two parts of the town

3.2.27. DUMBRAVA

This area is connected to the network of Apă Canal Chişinău.

3.2.28. VADULENI

This small village is supplied by Apă Canal via bulk supply.

3.2.29. HUMULEŞTI

This hamlet is supplied with water by shallow wells. There are 234 inhabitants in Humuleşti.

Synthesis:

Issues identified
Current water resource (swallow wells) is vulnerable

3.2.30. CRUZEŞTI

The water in Cruzeşti is supplied by Apă Canal. A 200mm pipe enters the village to a pumping station. This pumping station then supplies the village. The delivery pressure is 6.5 bars and the suction pressure 2 bars.

The network need to be extended to neighborhoods not yet supplied (for example one neighborhood in a distance of 1.4 km).

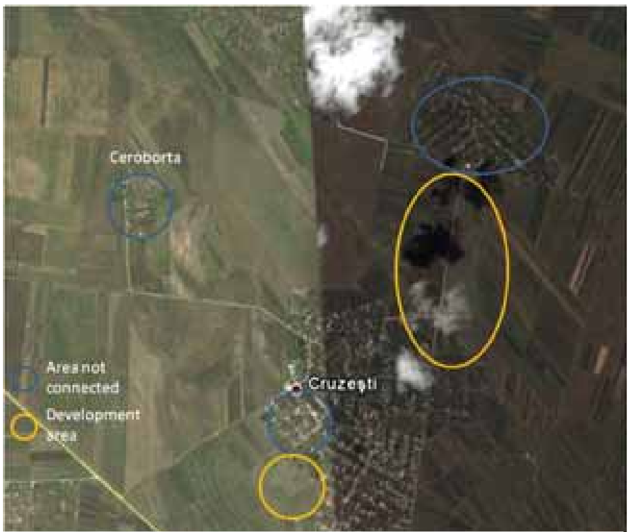


Figure 19 Non connected neighborhoods in Cruzeşti

Synthesis:

Issues identified
Network doesn't cover the entire town

3.2.31. CEROBORTA

This hamlet of 30 people is not connected to the network. People use 3 shallow wells, whose quality is not good.

Highest point in Ceroborta: 170m.

Synthesis:

Issues identified
Current water resource (swallow wells) is vulnerable

3.2.32. SINGERA

There are about 7300 inhabitants in Singera. The main part of Singera is connected to the network of Apă Canal but one neighborhood is supplied by an artesian well. In 2010, the production of this well (situated str. Cantemir) was 12976 m3.

There are 3 artesian wells in Singera, but only the one in str. Cantemir is currently operated (cf Table 19). It is in good working order, but as it is old, cleaning of casing is necessary.

According to the operator, the 2 other wells are not in good working order, pumps, pipes and electrical equipments are missing. But it is possible to rehabilitate them; the inside of the well is quite good (cleaning of casing is necessary).

Localisation of the well	Passport n°	Start of operations	In operation	nominal flow (m3/h)
or.Sînjera, str.Aeroport,26	2625	nov.68	no	9
or.Sânjera, str.Cantemir	4403	mar.84	yes	9
or.Aeroport	827	1963	no	12

Table 19 Artesian wells in Singera

Quality analysis:

		Singera
Nr. fintînii arteziene (adresa)	Normativul conform HG nr.934	4403
		2009
Turbiditate (UNT)	≤5	0,5
Gust (puncte)	Accept consumatorilor	0/Accept consumatorilor
Miros (puncte)	Accept consumatorilor	1H2S
Culoare (grade)	Accept consumatorilor	5/Accept consumatorilor
pH	6,5-9,5	8,05
Amoniac şi ionii de amoniu (mg/dm3)	0,5	1,8
Nitriţi (mg/dm3)	0,5	<0,003
Fier total (mg/dm3)	0,3	0,15
Clorul rezidual total (mg/dm3)	nu se normeaza	0
Substanţe organice oxidabile (mgO/dm3)	5	2,16

Table 20 Quality analyse artesian well Singera

NH4 concentration is 1,8 mg/l in the well str. Cantemir.

Synthesis:

Issues identified
Water from artesian wells not compliant with quality standards

4. ANNEX 4 METHODOLOGY - DESIGN CRITERIA

4.1. WELL

The newly built wells are assumed to have a productivity of 15m3/h or 4,2l/s. This is the average of the nominal flow of wells seen in the villages around Chişinău.

Cost of a well: The diameter is supposed to be 10'' (this is the diameter of almost every wells in Moldova). According to the AGeoM prices for drilling a well and installing casing and filter are detailed below

Depth in m	Cost (MDL)
100	350 000
150	525 000
200	700 000
250	875 000

Equipment of the well:

The cost of all the equipments for the well (pump, electrical cabinet, manhole and pipes) is assessed to be: 330 000 MDL

As a consequence the total price of a new well is given in the following table.

Depth in m	Cost with equipement (MDL)
100	680 000
150	855 000
200	1 030 000
250	1 205 000

4.2. TREATMENT OF WATER ABSTRACTED FROM WELLS.

Chlorination:

In any case, it is proposed to install chlorination on every working well.

Small chlorination units can be installed on each well. The capacity of the chlorination units must be 30 g/h of chlorine (for a 15m3/h well). They can use either solution of sodium hypochlorite or 50 kg gas chlorine bottles with a chlorometer.

The cost of such unit is about 5 k€ or 80000 MDL.

Ammonium (NH_4^+) :

There are two ways for removing dissolved ammonia:

- Break point chlorination
- Biological nitrification

Break point chlorination is much simple and reliable; but, as it consumes nearly 10 mg of chlorine for 1 mg of NH4, it requires huge doses of chlorine when the NH4 concentration is high. Then, it cannot be considered for NH4 concentration above 0.8 to 1.0 mg/l.

The biological nitrification consists in an aeration followed by a sand filtration, in which the nitrifying naturally biomass grows. This process has very low operation cost, and may be efficient; its limits are:

Temperature: the development of the biomass is very slow at low temperature. It may work above a temperature of 5°C, but is really efficient only when the water temperature is higher than 10 °C.

Oxygen: as the nitrification of 1 mg of NH4 consumes 3.3 mg of O2, the process requires a permanent aeration in the bulk of the filtration media if the amount of NH4 to be treated is above 2.5 to 2.8 mg/L (depending of the temperature); under these concentration, a natural aeration before the filtration (bringing the O2 concentration to the saturation) is enough. This aeration step also allows stripping and oxidation of H2S.

Finally the biological nitrification also requires mineral carbon (alkalinity), but this would not be limiting factor in the case of Chişinău.

The cost of a biological treatment of ammonia (including aeration tower and sand filters) may be assessed about 250 €/m3/d installed. So for a well with a nominal flow of 15 m3/h the cost would be around 90 000€ or 1 440 000 MDL.

If the content of NH_4^+ is above 2,8 mg/l, with a need for a forced aeration in the filters, the cost of it can be estimated to 300 €/m3/d installed .

Iron: Iron can be removed either biologically or chemically; in both cases, the water must be aerated and then filtered. The choice of a biological of chemical way depends on the pH and on the oxidation/reduction potential. For pH>7,2, a chemical treatment is necessary, and the investment cost is about 220 €/m3/d installed. The cost for a 15m/h well would be 79200€ or 1267000 MDL.

For pH<7,2, a biological treatment is possible and the cost is around 180€/m3/d. The cost for a 15m/h well is 64 800€ or 1 036 800 MDL.

Iron + Ammonium: In this case, the treatment is complex, and not suitable with small installations.

Fluor: Within Veolia group there is no experience of such treatment. Possible solutions are the use of calcium carbonate and aluminium hydroxide flocs or ion-exchange resin but these are complex method not suited for small installations.

Sulfates: It is impossible to treat the sulfates ($S0_4^{2-}$) at reasonable cost for small capacities.

Synthesis:

Cost of treatment for 15m3/h (or 360m3/d)

		Cost (MDL) / feasibility
Chlorination		80 000
NH4+	< 1 mg/l	break point chlorination
	1< < 2,8 mg/l	1 440 000
	> 2,8 mg/l	1 728 000
Iron	if pH >7,2	1 267 000
	if pH <7,2	1 036 800
NH4 + Iron		too expensive and complex
Fluor		too expensive and complex
Sulfate		too expensive and complex

4.3. Connection to the network

Diameter of the pipe needed to supply a village:

The first step is to determine the maximum flow in the pipe.

- In the case the village to supply has no reservoir, the maximum flow correspond to the hourly peak flow which is computed as follow:

$$maximum\ flow = \frac{population * average\ consumption * \frac{1}{network's\ efficiency} * daily\ peak *}{(24 * 3600)}$$

Maximum flow in l/s

Population: total population of the village

Average consumption: average consumption per capita. Equals 100 l/day/capita

Network's efficiency: Equals to 50%

$$Daily\ peak = \frac{maximum\ volume\ consumed\ in\ one\ day}{average\ volume\ consumed\ in\ one\ day} = 1{,}2$$

$$Hourly\ peak = \frac{maximum\ flow\ in\ one\ day}{average\ flow\ in\ one\ day} = 2$$

- In the case the village to supply has a reservoir, the maximum flow correspond to the daily peak flow because the reservoir can absorb the hourly variation. The daily peak flow is computed as follow:

$$maximum\ flow = \frac{population * average\ consumption * \frac{1}{network's\ efficiency} * daily\ peak}{(24 * 3600)}$$

With the maximum flow and the acceptable linear head losses (about 3 m/km) we determine the diameter of the pipe needed.

The results of this work can be summarized in the following table:

Diameter (mm)	Maximum flow (l/s) (3 m/km head losses)	Inhabitants (if reservoir)	Inhabitants (if no reservoir)
100	3	1080	540
150	10	3600	1800
200	25	9000	4500
300	70	25200	12600
400	140	50400	25200

The cost of laying new pipes has been estimated based on Apă Canal's information on rehabilitation of pipes. The following cost includes purchase of the pipe but also the cost of the works.

Diameter mm	Cost (per meter) in MDL
100	500
150	750
200	1 000
300	2 000
400	4 000

4.4. Cost of a pumping station

The first step is to determine whether there is a need of a pumping station.

The piezometric head at the connection point has to meet the following condition:

$$Piezometric\ head\ at\ connection\ point > Elevation\ of\ highest\ point + 20 + Linear\ head\ los$$

We need at least 20m of pressure at the highest point of the village.

If the piezometric head is lower, we can determine the Total Dynamic Head needed for the pump.

With the TDH and the expected flow, it is possible to determine the power of the pump and its price.

The total cost of a pumping station is computed as follow (in MDL):

$$Cost = Cost_{pump} * \alpha_{VFD} * \alpha_{hydraulic} + Cost_{civil\ works}$$

$$Cost = Cost_{pump} * 1,5 * 1,5 + 160000$$

With:

α_VFD: coefficient for variable frequency of the pump

α_hydraulic: coefficient for all the hydraulic equipment needed for the pump.

Cost of civil works includes building the manhole protecting the pump. It is assumed to be 10000 €

4.5. Other resources (shallow wells, springs)

Shallow wells and springs are sometimes used by the population to supply with water.

Analyses of such resources showed that they were polluted by human activities or agriculture (for example nitrates concentration is always above norms). Those resources are vulnerable: infiltration of pollutants is possible because the aquifer is close to the ground and there is usually no protection perimeter.

As a consequence, in any case, it was prescribed to abandon water supply from shallow wells or spring.

4.6. Exchange rate

The exchange rate was assessed to be 16 MDL = 1 €

4.7. Other Criteria

Only technical and economical criteria are taken into account in order to recommend an option. The engineering consultant doesn't consider in this study political or administrative criteria.

5. ALIMENATION DES VILLES ET VILLAGES

5.1.1. TRUSENI, COJUSNA, STRASENI

5.1.1.1. Truşeni

Needs: As there is no reservoir in Truşeni, the maximum flow going through the supply pipe will be 44 l/s (the hourly peak). Therefore a 300mm pipe is needed to supply Truşeni. If the town is supplied by artesian wells, as it is possible to use the reservoirs of the wells, the maximum flow is the daily peak (=22l/s) and not the hourly peak.

Option 1: build new wells and treatment facilities for water (H_2S, NH_4^+ and Fluor)

5 artesian wells are needed in order to abstract the maximum daily flow of 22 l/s – given the hypothesis of a production of 4,2l/s per well).

The study of quality analyses of artesian wells in Truşeni showed that Fluor's concentration is above the norm. As explained above (cf **Erreur ! Source du renvoi introuvable.Erreur ! Source du renvoi introuvable.**), treatment of Fluor is too complex and too expensive for small installations.

For this reason, this option is considered as not feasible.

Option 2: Connect to Apă Canal network (Ghidighici wells or in University Agrara)

	Diameter of the liaison pipe	Distance from network	Need of a pumping station	Cost (MDL)
Truşeni	300mm	Ghidighici: 6 km	Yes*	12 664 000
Truşeni	300mm	Univ. Agrara 9,3 km	Yes**	19 192 000

*in the case of a connection to Ghidighici pumping station, piezometric head is 110m. Elevation is 50m and TDH is 60m. Half of the village of Truşeni is above 150m high

**Piezometric head in Universitat Agrara is 150m. Half of the village of Truşeni is above 150m high

Option 3: Connection to the pipe supplying Străşeni from Micauţsi

There is a transit pipe going from a well field in Micauţsi to Străşeni. There is project to connect Cojuşna and Truşeni to this transit pipe.

Figure 20: project to supply Cojuşna (and Truşeni) via the well field in Micauțsi

From the connection point North-East to Străşeni to Truşeni downtown, the distance is 11,6 km. At least two wells need to be rehabilitated in Micauțsi, in order to abstract the water needed to supply Truşeni.

	Nb of wells to rehabilitate in Micauțsi	Diameter of the liaison pipe	Distance from network	Need of a pumping station	Cost (MDL)
Truşeni	2	300mm	11,6 km	yes*	25 852 000

* as we don't have information about pressure in the transit pipe going to Străşeni we assumed that there is a need of a pumping station to supply Truşeni from this point. The cost is assumed to be the same as for the connection to Universitat Agrara.

Solution proposée : raccordement à Ghidighici

5.1.1.2. Cojuşna

Needs: As there is a reservoir in Cojuşna, the maximum flow going through the supply pipe is the will be 19 l/s. Therefore a 200mm pipe is needed to supply Cojuşna.

Options:

Option 1: Build new wells and treatment facilities for water (H2S and Fluor).

5 artesian wells are needed in order to abstract the maximum daily flow of 22 l/s – given the hypothesis of a production of 4,2l/s per well.

However, the concentration of Fluor is above the norm in Cojuşna and the water abstracted from artesian wells cannot be treated at reasonable price.

For this reason, this option is considered as not feasible

Option 2: Connect to Apă Canal network (Ghidighici wells or in University Agrara)

	Diameter of the liaison pipe	Distance to the network	Need of a pumping station	Cost (MDL)
Cojuşna	200mm	Ghidighici PS: 8,7km	Yes*	9 068 800
Cojuşna	200mm	Univ. Agrara PS: 12,2 km	Yes**	12 532 800

*Piezometric head in Ghidighici pumping station is 110m (50m + 60m TDH). Altitude of reservoirs in Cojuşna is 150m

**Piezometric head in Universitat Agrara is 150m. Altitude of reservoirs in Cojuşna is 150m. Because of linear head losses, a pumping station is mandatory

Option 3: Connection to the pipe supplying Străşeni from Micauțsi

There is a transit pipe going from a well field in Micauțsi to Străşeni. There is project to connect Cojuşna and Truşeni to this transit pipe (cf Figure 20: project to supply Cojuşna (and Truşeni) via the well field in).

At least two wells need to be rehabilitated in Micauțsi, in order to abstract the water needed to supply Cojuşna.

Local authorities in Cojuşna seemed to prefer this option.

	Nb of wells to rehabilitate in Micauți	Diameter of the liaison pipe	Distance from network	Need of a pumping station	Cost (MDL)
Cojuşna	2	200mm	7,8 km	yes*	10 192 800

* as we don't have information about pressure in the transit pipe going to Străşeni we assumed that there is a need of a pumping station to supply Truşeni from this point. The cost is assumed to be the same as for the connection to Universitat Agrara.

Solution propose : raccordement à Ghidighici

5.1.1.3. Străşeni

<u>Needs:</u> Străşeni needs 52 l/s on a daily peak. Therefore a 300mm pipe is needed to supply Străşeni.

<u>Options:</u>

Option 1: Build new wells and treatment facilities for water (H2S and fluor).

With a production of 15 m3/h, 13 artesian wells are needed to supply the entire town.

Fluor cannot be treated at reasonable cost (cf (cf **Erreur ! Source du renvoi introuvable.Erreur ! Source du renvoi introuvable.**)).

For this reason, this option is considered as not feasible.

Option 2: Connect to Apă Canal network (Ghidighici wells or in University Agrara)

Network	Liaison pipe	Distance to reservoirs 2x6000m3 (km)	Pumping station	Cost (MDL)
	300mm	17,5 km from Universitat Agrara PS	Yes	29 062 400
	300 mm	14,3 km from Ghidighici PS.	Yes	35 347 200

Option 3: Keep connection to Micauțsi artesian wells and rehabilitate new wells of Micauțsi well field.

The current connection to Micauțsi artesian wells is satisfactory. However, more wells may need to be rehabilitated in order to supply the entire town. As 3 wells supply 60% of the town, 2 more need to be rehabilitated. The cost of the rehabilitation can be assumed to be the same of the cost of building a new artesian well.

Cost: 2 060 000 MDL

Solution propose ; raccordement à Ghidighici

5.1.1.4. Option for Truşeni, Cojuşna and Străşeni

Connect the 3 villages to the network of Apă Canal.

Connection point can be either in Ghidighici pumping station, or in Universitat Agrara pumping station.

Network	Population	Liaison pipe	Distance from the network (km)	Need of a pumping station	Cost (MDL)
Truşeni Cojuşna-Străşeni	33 533	400mm and 300mm	14,2 km from Ghidighici PS (for the 3 towns)	Yes	46 016 000
			17,6 km from Univ. Agrara PS(for the 3 towns)	Yes	60 537 000

The maximum flow (the hourly peak) is 115 l/s. To obtain this value we take the hourly peak flow for Truşeni (44 l/s) and the daily peak flow for Cojuşna and Străşeni because there are reservoirs that can absorb the hourly variations (19 l/s and 52l/s). Hence we forecast to use a 400mm pipe at the beginning.

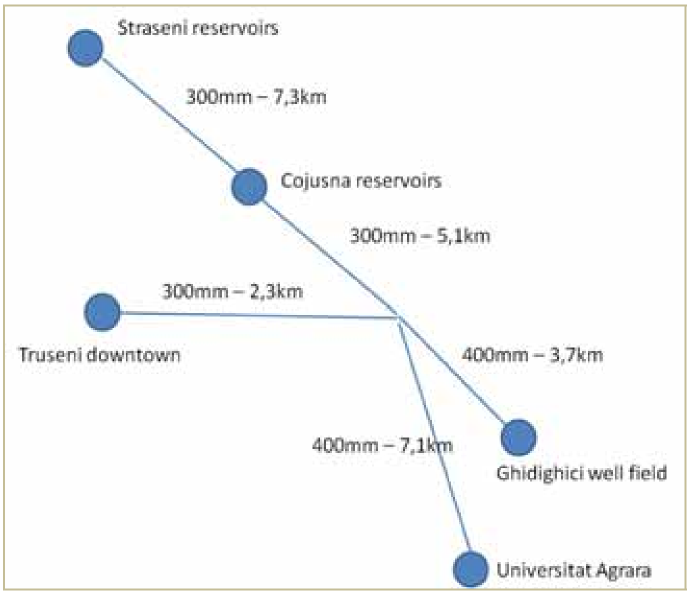


Figure 21: supply scenario of Truşeni, Cojuşna and Străşeni

5.1.2. ONIȚCANI, SLOBOZIA-DUSCA ET COŞERNIȚA

5.1.2.1. Coşernița

Needs: the hourly peak flow is 8,5 l/s and the daily peak flow is 4,3l/s

Option 1: Build 1 new well

Given that we are in a zone of high permeability, wells will produce more than 15 m3/h (or 4,2 l/s). Hence we need only one artesian well with a reservoir to supply the entire village.

Based on quality analyses of Onițcani artesian well, it can be assessed that water abstracted from this well will be compliant with water quality standards.

A chlorination unit will be installed.

Cost: 760 000 MDL

Option 2: Keep the current connection to SAN – install a pumping station

The pipe is 120 mm (external diameter). This solution will cause high linear head losses (about 9m/km for a pipe =125mm and flow = 8,5 l/s) through transit. In addition, even if the state of this pipe cannot be assessed precisely, it is old, in bad condition and important leakages may occur.

For the main part of the year, the lower reservoir in SAN (elevation 80m) is used to supply Coşernița. Only during summer, the upper reservoir is used (elevation 134m). Therefore pressure is not high enough the supply the upper parts of the village during the main part of the year. There is a thus a need of a pumping station.

Cost: 318 400 MDL

Option 3: Lay a new pipe for connection to SAN – install a pumping station

Laying a new pipe, =150mm can also be considered.

This option will cause lower linear head losses (about 2 m/km) and reduce leakage losses.

The distance from SAN is 1,4 km.

For the main part of the year, the lower reservoir in SAN (elevation 80m) is used to supply Coşernița. Only during summer, the upper reservoir is used (elevation 134m). Therefore pressure is not high enough the supply the upper parts of the village during the main part of the year. There is a thus a need of a pumping station.

Cost: 1 368 000 MDL

5.1.2.2. Oniţcani

Option 1: Build 2 new well

Given that on an average, wells will produce about 15 m3/h (or 4,2 l/s), we need to build two artesian well with reservoirs to supply the entire village.

According to quality analyses in 2009, the water abstracted from artesian well is compliant with drinking water standards except for total hardness which is slightly lower than the minimum. Chlorination will be installed on every working well. No other treatments are required.

	Nb of wells in operation	Nb of well to be built	Depth m	Treatment	Cost (MDL)
Oniţcani	2 not good	2	100	Chlorination	1 520 000

Option 2: Connect to Apă Canal network (in SAN)

Network	Liaison pipe	Distance (km)	Pumping station	Cost (MDL)
	200mm	4,7 km from SAN	Yes*	5 018 400

*Oniţcani will be supplied during the main part of the year by the lower reservoir of the SAN (elevation 80m) and the highest point of the village is 91m.

5.1.2.3. Slobozia Dusca

Needs: the hourly peak flow is 14,8 l/s and the daily peak flow is 7,4/s. Hence we need a 200mm pipe to supply the village.

Option 1: Build 2 new wells

Given the age and the poor condition of existing wells it is better to build new wells rather than rehabilitating the existing ones. On an average, wells will produce about 15 m3/h (or 4,2 l/s), it is needed to build two artesian wells with reservoirs to supply the entire village. According to quality analyses in 2009 in Oniţcani (5km between the two villages), the water abstracted from artesian well is compliant with water drinking standards without treatment. Chlorination will be installed on every working well.

	Nb of wells in operation	Nb of well to be built	Depth m	Treatment	Cost (MDL)
Slobozia Dusca	1 (3 more not good)	2	100	Chlorination	1 520 000

Option 2: Connect to Apă Canal network (in SAN)

Network	Liaison pipe	Distance (km)	Pumping station	Cost (MDL)
	150mm	9,1 km from SAN	Yes*	9 418 400

* Highest point of the village 50m.But given linear head losses and that there should be at least 2 bars in the network; a pump with an TDH of 10m is needed.

5.1.2.4. Option for Oniţcani, Slobozia Dusca and Coşerniţa

Connect the 3 villages to the network of Apă Canal.

Another option is to connect the three villages in the same time to the SAN. The total population to supply is 6251 inhabitants; hence we need a 300mm for the first part, then it is possible to use a 200mm pipe.

The distances are detailed below:

- 1,8km from SAN to Coşerniţa
- 3,4km from Coşerniţa to Oniţcani
- 4,3km from Oniţcani to Slobozia-Dusca

A pumping station is needed. Those villages will be supplied by the lower reservoir of the SAN (elevation 80m) and the highest elevation is 91m (in Oniţcani).

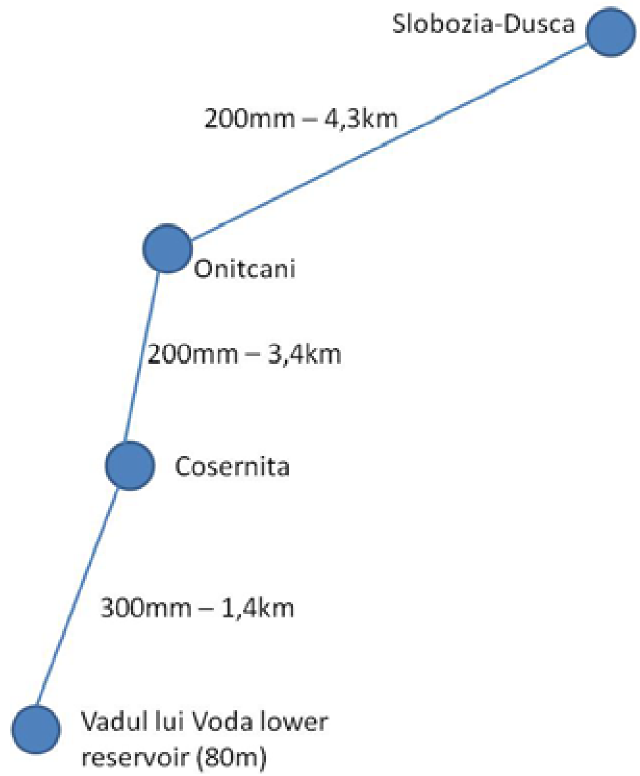


Figure 22 supply scenario for Cosernita, Onitcani and

Cost: 10 847 000 MDL

5.1.3. BĂLĂBĂNEŞTI

Option 1: Build 1 new well to solve shortages – install chlorination

	Nb of wells in operation	Nb of well to be built	Depth m	Treatment	Cost (MDL)
Bălăbăneşti	4	1	150	Chlorination in every well.	1 255 000

Option 2: Connection to the network of Apă Canal

	Liaison pipe	Distance (km)	Pumping station	Cost (MDL)
Bălăbăneşti	200mm	0,8 from WWTP	Yes	1 168 000

A 300 mm pipe from SAN comes to the WWTP of Vadul lui Voda Measurement campaign showed us that the average pressure is about 40m. The logger elevation there is 20,83m.

The highest point of the commune is 114 high.

Figure 23 Location of Bălăbăneşti, WWTP of Apă Canal and contour lines

5.1.4. FLORENI

Option 1: Supply entirely with artesian wells – treatment facilities for NH_4^+:

Over the 3 wells currently working, only one (the factory owned well) has a good productivity. We suggest keeping this well together with the 2 new wells. There will be enough water for the entire village. The three wells will produce about 1 080 m3/d (flow is 15 m3/h).

Biological nitrification to eliminate NH_4^+ (cost: 250 €/ m3/d installed) can be installed (cost: 4 320 000 MDL). Treatment of Na^+ + K^+ (with reverse osmosis) is too expensive for small installations and is not considered.

Chlorination will also be installed on every working well (cost: 80 000 MDL / well).

Total cost of treatment (MDL): 4 560 000 MDL

However this solution is not recommended because water will not be compliant with drinking water norms (Na^+ + K^+ won't be treated).

Option 2: Supply the entire village with water from Apă Canal:

The maximum flow for Floreni is 10 l/s given that there are reservoirs (2x150m3). This flow can transit in a 150mm pipe but will cause head losses slightly higher than 3 m/km. Nevertheless, it is possible to supply Floreni this way.

Cost: 0 MDL

Option 3: Blending the two sources of water

Because the treatment of water abstracted from wells is expensive, one option is to mix water from the artesian wells and water from Apă Canal in the reservoirs. If we assume that the mean concentration of NH_4^+ is 2,5 mg/l, there should be 4 volumes of water from Apă Canal for 1 volume of water from the wells in the reservoirs.

This solution could be envisaged on a temporary basis while another option (option 1 or option 2) is chosen.

Cost: 0 MDL

5.1.5. BĂCIOI COMMUNE

5.1.5.1. *Băcioi*

Option 1: Build 3 new wells - install chlorination on every well.

Over the 6 wells currently operated, wells nr. 40/290 and nr.4874 will be stopped (quality of water is not compatible with quality standard). Quality analyses for the four other wells are alike well nr 1/10; concentration in NH4 is lower than 1 mg/l. To maintain operation of those wells, ammonia will be treated by breakpoint chlorination.

Rehabilitation of wells (cleaning of casing and filters) is to be scheduled.

Three new wells need to be build in order to stop the water shortages in summer and allow supplying new consumers (only 50% of the population is connected).

Hence 7 chlorination units need to be installed.

Cost: 3 125 000 MDL

Option 2: Build 6 new wells with chlorination

According to hypotheses, a newly built well will provide about 4,2l/s. To supply the entire village on the peak day (24 l/s) we need 6 wells. This is enough to supply the entire population of Băcioi. Chlorination will be installed on every newly built well.

Cost: 5 610 000 MDL

Option 3: Connection to Apă Canal via Ialoveni (10km) or Codru pumping station (6km)

The population of the municipality of Băcioi is 8710 so it must be supplied it with a pipe of diameter 300mm.Connection can be made from Ialoveni pumping station or from Codru pumping station (pipes coming to Aeroport pumping station are not big enough to connect a 300mm pipe).

Highest point in Băcioi is 115m.

Codru pumping station: elevation of pumps is 42,6m and according to measurement campaign n°3 the delivery pressure is 90m. So the piezometric head is 132,6m at the outlet of Codru pumping station.

Ialoveni pumping station: elevation of pumps is 83,4m and according to measurement campaign n°3 the delivery pressure is 100m. So the piezometric head is 183,4m at the outlet of Ialoveni pumping station.

	Liaison pipe	Distance (km)	Need of a pumping station	Cost (MDL)
Băcioi	300mm	10,8 km from Ialoveni PS	No	21 600 000
		6 km from Codru PS	Yes	12 318 400

5.1.5.2. Brăila

Option 1: Keep current supply by well - install chlorination.

Réhabilitation du puits et installation d'une chloration

Cost: 127 500 MDL + 80 000 MDL = 207 500 MDL

Option 2: Connection to Băcioi network

	Liaison pipe	Distance (km)	Pumping station	Cost (MDL)
Brăila	150mm	3,4 km from Băcioi	No*	2 550 000

* If Băcioi is connected to Apă Canal network, pressure is high enough to supply entirely Brăila. Piezometric head in Băcioi downtown is bigger than 142m. Head losses in the pipe transiting to Brăila are about 6,8m (2m/km). So piezometric head in Brăila is about 135,2m

5.1.5.3. Frumuşica

Option 1: Keep current supply by well - install chlorination.

Cost: 80 000 MDL

Option 2: Connection to Băcioi network

	Liaison pipe	Distance (km)	Pumping station	Cost (MDL)
Frumuşica	100mm	2 km from Băcioi	No*	1 000 000

* If Băcioi is connected to Apă Canal network, pressure is high enough to supply entirely Frumuşica. Piezometric head in Băcioi downtown is bigger than 142m. Head losses in the pipe transiting to Frumuşica are about 4m (2m/km). So piezometric head in Frumuşica is about 138m

5.1.5.4. Străisteni

Options:

Option 1: Keep current supply by well - install chlorination.

Cost: 80 000 MDL

Option 2: Connection to Băcioi network

	Liaison pipe	Distance (km)	Pumping station	Cost (MDL)
Străisteni	100mm	2,2 km from Băcioi	No	1 100 000

If Băcioi is connected to Apă Canal network, pressure is high enough to supply entirely Străisteni. Piezometric head in Băcioi downtown is greater than 142m. Head losses in the pipe transiting to Străisteni are about 4,4m (2m/km). So piezometric head in Străisteni is about 137,6m. So there is no need of a pumping station.

5.1.6. CRICOVA

Needs: Given the number of inhabitants, the hourly peak flow is 57 l/s and the daily peak flow is 28,5 l/s. Since Cricova has 2 reservoirs able to absorb hourly peak, a 300mm pipe would be needed to supply the commune.

Options:

Option 1: Build three new wells – Install chlorination

According to hypotheses, the daily peak flow is 28,5 l/s. Hence 7 wells (with a flow of 15m3/h) are needed.

One new well is already under construction. Then this option is to build 3 new wells together with 3 chlorination units. Quality analyses show that the water is compliant with water drinking standards. No other treatments than chlorination are forecasted from Cricova.

Cost: 2 805 000 MDL

Option 2: Connect to Apă Canal network

The town cannot be connected to Apă Canal network in Goian Noi because the diameter of the pipe entering in Goian Noi is too low.

	Liaison pipe	Distance (km)	Pumping station	Cost (MDL)
Cricova	300mm	5 km	No*	11 000 000

* Stauceni PS 180m + TDH pumps 62m. Linear head losses in a distance of 5 km are about 4,5m.

The highest point in Cricova (at the entrance of the town) is about 170m

5.1.7. CIORESCU COMMUNE

5.1.7.1. Ciorescu

Needs: the hourly peak flow is 31l/s and the daily peak flow is 15,5/s

Options:

Option 1: Build one new well - install chlorination on every well.

To supply the entire village we need 15,5l/s so 4 wells (each well can produce 4,2l/s). So one more well needs to be built.

According to the Moldavian quality norms, it is allowed to supply until 2015 water with 500 mg/l of sulfates (if the water is not aggressive). As a consequence it can be proposed not to treat the sulfate in Ciorescu's water.

In order to meet the quality standard of 250 mg/l of SO4, dilution can be used, mixing water with high concentration of SO4 and water with low concentration of SO4.

4 chlorination units need to be installed.

Ciorescu	Nb of wells in operation	Nb of well to be built	Depth m	Treatment	Cost (MDL)
	3	1	200	Chlorination	1 350 000

Option 2: Build one new well - install chlorination on every well – treatment facilities for sulfate.

This option is the same as the last one with the addition of sulfate treatment.

One well will be built.

SO_4^{2-} can be treated by reverse osmosis. The cost is about 500 €/ m3/d installed. The total production capacity will be 1080 m3/d, but only 30% of the flow needs to be treated. Then, the blending of the treated water and non-treated water would meet the quality standards.

The cost of such sulfate treatment is 2 880 000 MDL.

4 chlorination units need to be installed.

Cost: 4 230 000 MDL

Option 3: Connect to Apă Canal network

The town cannot be connected to Apă Canal network in Goian Noi because the diameter of the pipe entering in Goian Noi is too low.

Ciorescu	Liaison pipe	Distance (km)	Pumping station	Cost (MDL)
	300mm	5 km	No*	10 000 000

* Stauceni PS 180m + TDH pumps 62m. Linear head losses in a distance of 5 km are about 4,5m.

The highest point in Ciorescu (at the entrance of the village) is about 170m

5.1.7.2. Goian

Needs: the hourly peak flow is 6,3l/s and the daily peak flow is 3,1/s. With a reservoir, one well producing 4,2 l/s is enough to supply the entire village.

Options:

Option 1: Install chlorination on the new well.

Cost: 80 000 MDL

5.1.7.3. Faureşti

Needs: the hourly peak flow is 2,6/s and the daily peak flow is 1,3/s

Options:

Option 1: Build one new well - install chlorination

It is preferable to build a new well, instead of rehabilitating the current one. Based on quality analyses from artesian wells in Ciorescu, it can be assessed that no other treatment than chlorination will be needed in order to use the water from the new well.

Faureşti	Nb of wells in operation	Nb of well to be built	Depth m	Treatment	Cost (MDL)
	0	1	200	Chlorination	1 110 000

Option 2: Connection to Ciorescu's network

Connection to Goian's network is impossible because the well will not be able to produce enough water.

Instead, it is possible to connect Fauresti to Ciorescu's network.

Fauresti	Network provenance	Liaison pipe	Distance (km)	Pumping station	Cost (MDL)
	Ciorescu	100mm	2 km	No*	1 000 000

* Well's reservoirs are at the elevation of 160m in Ciorescu (and in the case Ciorescu is connected to Apă Canal's network, piezometric head will be above 130m). The highest elevation is Fauresti is 88m. So there is no need of a pumping station.

5.1.8. GOIAN NOI

Options:

Operate again artesian well

Quality of water abstracted from this artesian well is not compliant with water quality standards. Furthermore, NH_4^+ and Fe are difficult to treat when they are together (cf hypotheses). Then treatment of water would be too complex and expensive for such small installation.

Furthermore current supply via Apă Canal network is satisfactory.

Putting this well back in operation is then not recommended.

Supply via Apă Canal network

The village is currently supplied by this mean and it is satisfactory.

5.1.9. CONDRIȚA

Needs: daily peak is 3,7l/s and hourly peak is 1,85l/s

Options:

Option 1: Treatment for water purification

According to hypotheses (cf paragraph **Erreur ! Source du renvoi introuvable.**), Fluor cannot be treated at reasonable cost in small installation. The statement is the same for the compounds Iron and Ammonium. When they are together it is difficult to eliminate them.

As a result it is not considered as feasible to treat water abstracted from this artesian well.

Option 2: Connection to Apă Canal network

Condrița	Liaison pipe	Distance (km)	Pumping station	Cost (MDL)
	150mm	17km (following the road)	No*	12 750 000

* Linear head losses of about 0,5m per km for a 150mm pipe and for a flow of 3,7l/s. Outlet of Cartuşa pumping station is about 252m (elevation: 232m and outlet pressure is 20m). And highest point in the village 200m

Option 3: Connection to the network of a closer village (Ulmu, Scoreni, Malcoci…).

Further investigations have to be made in order to assess whether it is possible or not to connect Condrița to one of the surrounding villages. Those villages are situated from 3 to 5km from Condrița.

<u>Cost:</u> 4 068 000 MDL. This is the maximum cost of this option. It has been computed with a 150mm pipe, a distance of 5 km and a pumping station.

Option 4: Build new well in a zone where quality of water is good

Further investigations have to be made in order to find a zone where it is possible to drill well producing water whose quality is compliant with the standards.

According to topography, the depth of the well will be 150m in the area around Condrița. In the well is situated farther than 3,86 km from Condrița, then option 3 is recommended (if possible) because is cost less.

<u>Cost:</u> 4 068 000 MDL. This is the maximum cost of this option. It has been computed with a 150m deep well, chlorination unit, 150mm pipe, a distance of 3,86 km and a pumping station.

Option 5: Temporary use of water abstracted from the artesian well

It can be envisaged to install only chlorination on the artesian well.

Water abstracted won't be compliant with quality standards but can temporary be consumed if after chlorination, the following limits are respected:

- $NH_4^+ < 1$ mg/l
- Fe < 1 mg/l
- F < 2,5 mg/l

This solution should be envisaged on a temporary basis (for several months) while another option (option 2, 3 or 4) is chosen.

Cost: 80 000 MDL

5.1.10. BUDEŞTI

Needs: daily peak is 25 l/s and hourly peak is 12,5 l/s

Options:

Option 1: Connection to the 800mm pipe

Budeşti	Liaison pipe	Distance (km)	Pumping station	Cost (MDL)
	300mm	0,5	No* Top of the village 100m	1 000 000

*There is no need of a pumping station in Budeşti. The highest point in the village is 120m (cf geoportal.md). Piezometric head is 180m at the outlet of the WTP in Vadul lui Voda (cf measurement campaign n°6) and linear head losses are lower than 2m/km (which are the linear head losses for a 400mm pipe) so on 5km they are lower than 10m.

Option 2: Build new wells – install chlorination – treatment facilities for NH4

3 wells are needed to supply the entire village. Treatment of ammonium is to be forecasted based on analyses of existing artesian wells. For this treatment, biological nitrification without external aeration can be used (cost is 250 €/ m3/d installed).

Budeşti	Nb of wells in operation	Nb of well to be built	Depth m	Treatment	Cost (MDL)
	0	3	150	Chlorination and ammonium treatment	7 125 000

5.1.11. MAXIMOVCA

Options:

Option 1: Bulk supply by Apă Canal

Current supply is ok. The network has to be finished.

5.1.12. REVACA

Options:

Option 1: Supply by Apă Canal network

Current supply is ok. Houses have to be connected to main pipes.

5.1.13. GHIDIGHICI VILLAGE

Options:

Option 1: Build/ rehabilitate four artesian wells – water purification.

Enough water to supply the entire village can be abstracted with the building of 4 new wells or with the rehabilitation of 4 existing wells. The rehabilitation cost is assumed to be half the construction cost of a new well.

H_2S, SO_4^{2-} and NH_4^+ and sometimes Fe exceed the norm in Ghidighici village. In order to treat those chemical compounds, the following process can be proposed:

Aeration (stripping of H_2S and precipitation of Fe), filtration (biological treatment of NH_4^+) and finally ion exchange on 50% of the flow (decrease of the concentration of SO_4^{2-} but increase of Cl^-).

This process is complex and delicate to operate.

The cost of such a process can be estimated to 300 to 400 €/ m3/d installed.

It is also foreseen to install chlorination on every well built/rehabilitated.

	Nb of wells in operation	Nb of well to be built	Depth m	Treatment	Cost (MDL) rehabilitation/construction
Ghidighici village	6	4	150	Chlorination H_2S, SO_4^{2-} ,NH_4^+ and Fe	8 942 000 / 10 652 000

Because the process is complex, this option is not recommended.

Option 2: Connection to network (Ghidighici PS)

Ghidighici	Liaison pipe	Distance (km)	Pumping station	Cost (MDL)
	300mm	2,4 km	Yes*	5 168 800

Ghidighici PS: piezometric head at the outlet is 110m (according to measurement campaign). And highest elevation in Ghidighici village is 145 m

5.1.14. PRUNCUL

Options: No further studies are needed – current supply is satisfactory.

5.1.15. VATRA

Options:

Option 1: Keep current supply with artesian well – install chlorination – change reservoir:

According to the Moldavian quality norms, it is allowed to supply until 2015 water with 500 mg/l of sulfates (if the water is not aggressive). As a consequence it can be proposed not to treat the sulfate in Vatra's water. Furthermore the iron in the analysis can be a consequence of the corrosion of the reservoir. A new reservoir may solve the iron exceed.

It can be proposed to install chlorination on this well and also to change the reservoir (the cost of a new reservoir can be estimated to 10 000€)

Cost: 240 000 MDL

Option 2: Connect the neighborhood to Apă Canal network.

Connection can be made with the main part of Vatra. Nevertheless pipes have to be laid under the railway and the cost of this work will be greater than normal prices (in a first approximation they are estimated to be twice as expensive as the normal price). About 500m of 100mm have to be laid (according to the 2010 production of the artesian well).

Cost: 500 000 MDL

5.1.16. DUMBRAVA

Options: No further studies are needed – current supply is satisfactory.

5.1.17. VADULENI

Options: No further studies are needed – current supply is satisfactory.

5.1.18. HUMULEŞTI

The daily peak flow is 0,7 l/s and the hourly peak flow is 1,3 l/s.

Options:

Option 1: Build one artesian well – install chlorination.

One artesian well is enough the supply the entire hamlet.

Humuleşti	Nb of wells in operation	Nb of well to be built	Depth m	Treatment	Cost (MDL)
	0	1	150	Chlorination	935 000

Option 2: Connection to network

It can be proposed to connect Humuleşti to Apă Canal network in Bubuieci. The distance is 3,0 km.

Humuleşti	Network	Population	Liaison pipe	Distance (km)	Pumping station	Cost (MDL)
		230	100mm	3,0km	No*	1 500 000

Piezometric head in Bubuieci is at least 160m (elevation of the ground) and the highest point in Humulesti is 120m.

5.1.19. CRUZEŞTI

Options: Current supply via Apă Canal is satisfactory. The network has to be extended.

5.1.20. CEROBORTA

Options:

Option 1: Build one artesian well.

One artesian well is enough the supply the entire hamlet. Quality of in the newly built well is unknown.

If concentration in NH4 is between 0,5 mg/l and 1 mg/l, then water will be treated with chlorination. But there is a risk that water could not be treated with chlorination only (high concentration of NH4 or presence of SO4 or Fe). In this case cost of treatment will be much higher.

In case only chlorination is required, cost of this option is 1 110 000 MDL.

Ceroborta	Nb of wells in operation	Nb of well to be built	Depth m	Treatment	Cost (MDL)
	0	1	200	Chlorination	1 110 000

Option 2: Connection to network of Cruzeşti

Ceroborta	Liaison pipe	Distance (km)	Pumping station	Cost (MDL)
	100mm	2,8 km	No*	1 400 000

* Delivery pressure is 6,5bar from the pumping station of Cruzesti and elevation of pumps is about 150m.

Conclusion:

Whereas option 1 is slightly cheaper than option 2, option 2 is recommended because there are risks the quality of water in the newly built artesian well require more treatment than chlorination.

5.1.21. SINGERA

Options:

Option 1: Rehabilitation of well n°4403 - Treatment facilities for NH_4^+ and chlorination:

It is possible to keep the supply of a small part of Singera with artesian well n°4403. Nevertheless the water abstracted from this well must be treated (high concentration of NH_4^+).

According to hypotheses, the appropriate treatment of NH_4^+, biological nitrification without external aeration, for small installations cost 250 €/m3/d installed. Well n°4403 in Singera can deliver 10 m3/h or 240 m3/d. Hence the cost of NH_4^+ treatment is therefore: 960 000 MDL.

Including the chlorination, the total cost of this option is 1 040 000 MDL.

Option 2: Supply of Singera by artesian wells only

This option includes the rehabilitation of the three artesian wells and the construction of 3 new wells.

In addition because of the quality of water in this area, all the wells need NH_4^+ treatment and chlorination.

Cost: 4 830 000 MDL

This option is not recommended because it is expensive (construction of 3 new wells + treatment of NH_4^+) and doesn't provide any benefits compared to a supply with water from Apă Canal given that Singera is already connected to the network of Chişinău.

Option 3: Connection to the network of Apă Canal

This option is to supply the entire town with water coming from Chişinău's network (and from SAN or STA). This option includes stop operation of well n°4403.

No network is to be built, because according to the map of network, the neighborhood supplied by well n°4403 is already connected to the water network of Singera.

Cost: 0 MDL