CONSIDERATIONS REGARDING WATER SUPPLY IN DOLHASCA TOWN, SUCEAVA COUNTY

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Abstract. Geomorphologically, Dolhasca town is located in the east-southeastern part of Suceava county, in the contact area of Suceava Plateau with terraces from the right part of Siret river at the confluence of the Siret and Şomuzul Mare rivers. Geologically, the studied area is located on the Moldavian Platform and is characterized by the presence of Sarmatian and Quaternary deposits. Hydrogeologically, on the basis of data provided by wells located in this area, two types of aquifers: shallow and confined were separated. Shallow aquifer has been intercepted in the meadows of the Siret and Şomuzul Mare rivers and consists of one or two porous-permeable layers, in the range of approximately 3-16 m depth. This aquifer has been identified in four wells belonging to the National Hydrogeological Network. Confined aquifer is accumulated in the Lower Sarmatian (Volhynian) deposits, in a depth range of about 20-250 m. Drinkable water sources that supply the Dolhasca town are made from two production wells: Poiana production wells constituted by six wells and Budeni production wells constituded by two wells. For delimitation of the sanitary protection areas for Budeni and Poiana production wells, the Wyssling analytical method was used. The hydrogeological protection perimeter boundary of two production wells was drawn taking into account the geomorphological conditions, the hydrographic network but also the regeneration area of groundwater resources.

Key words: shallow, confined, aquifer, well, production wells

1. INTRODUCTION

Dolhasca town, made of eight villages (Dolhasca, Budeni, Gulia, Poiana, Poienari, Probota Silişteа Nouă and Poiana Valley) is located in the east-south-eastern part of Suceava county, on the contact area between Suceava Plateau and the terraces from the right part of Siret river, at the confluence of the Siret and Şomuzul Mare rivers.

Water supply of this town is provided by two production well fields : Poiana, with 6 wells and Budeni, with 2 wells.

2. GEOMORPHOLOGICAL CONSIDERATIONS

Geomorphologically, Dolhasca town is located within the contact area between Suceava Plateau (Fălticeni Plateau subunit) with the terraces of the right part of Siret river, at the confluence of Siret river with Şomuzul Mare river (Fig. 1).

Fălticeni Plateau, having a north-west - south-east orientation and a maximum width of 20-22 km, lies in the southern part of Moldova-Suceava interstream. It starts at an altitude of 528 m near its northern edge and to the south Fălticeni Plateau, reaching Paşcani town, where Falticeni Plateau narrows because of the common terrace area of Moldova and Siret rivers.

A feature of the Suceava Plateau is the large extent of the structural Şomuzul Mare and Somuzul Mic plateaus, which are fragmented by deep valleys of 100-150 m relative depth.

Siret Valley is a broad valley having a system of five large terraces on all its course in Suceava county (almost 100km).

In the Suceava county, the Siret Valley is 6-8 km wide, and in the area of confluence with Suceava transforms it in an alluvial plain with over 12 km width.

In the confluence area of the two rivers, four terraces of Siret river (180, 130, 50 and 25 m above the river) are the same as those of Suceava river. The age of the terraces is Quaternary and the most extensive terrace is that one of 25 m (Pascani).

Hydrologically, Dolhasca town is located in the Siret river basin which is managed by the Water Basinal Administration of Siret, headquartered in Bacău.

3. GEOLOGICAL CONSIDERATIONS

The studied area is part of the great geological unit of the Moldavian Platform and is characterized by the presence of Sarmatian and Quaternary age deposits. In the following the main characteristics of these deposits are described.

Lower Sarmatian (Volhynian)

Volhynian deposits have a largest development and presents lithological monotony, being made mostly of clays and sands, in which thin levels of sandstones, calcareous sandstones and oolitic limestones are distinguished. Nearby Fălticeni town there is a coal complex consisting of clays with thin intercalations of coal.

At Arghira (about 15 km northwest of Dolhasca town), on the profile of Muscalului Valley (Ionesi, 1968) these deposits are represented by compact clays and sandy clays, containing numerous fauna, constituting lumachelle levels, which abound both in bivalves and gastropods, on which there is a package of sandstones with thin intercalations of sand, and on the top it consists of calcareous sandstones which pertains to the Arghira I lumachellic sandstone horizon.

At Lespezi (12 km south of Dolhasca town), from an altitude of 200 meters, Upper Volhynian deposits consist of quartz sands followed by a level of fossiliferous sandstone covered with medium grain sands. Towards the top part of Volhynian deposits two levels of quartziferous sandstones occur (Ștefan, 1997).

The thickness of the Volhynian deposits increases gradually from east to west, so that in the contact area of these deposits with Carpathian orogenetic this thickness reaches arround 2000 m.

Middle Sarmatian (Bessarabian)

Bessarabian deposits outcrop only on small areas at the southern border of the region. They form interfluves' peaks, with the greatest development in the Dealul Mare massif, situated east of Siret river and south of Boroaia village; at the edge of the Subcarpathian area these deposits appear as a narrow band.

The Bessarabian deposits overlay conformably the Volhynian ones as it can be seen in Dealul Mare area and Tătăruşi region and consists of sandy clays and sands, with rare intercalations of sandstones and oolithic limestones.

West of Siret Valley there was identified only the lower part of Bessarabian deposits in dominantly sandy facies. Friable and poorly oolithic sandstones intercalate into the sands from the upper part of peaks located north of Tătăruşi locality situated about 9 km south of Dolhasca town.The thickness of Bessarabian deposits is about 200m at the east of Siret Valley and increases to the west, towards the Subcarpathian area.

Quaternary deposits

Quaternary deposits are ascribed to the Pleistocene (old colluvia and terraces), Upper Pleistocene-Holocene (deluvial deposits) and Holocene (actual and subactual alluvia). Pleistocene deposits enter within the composition of the Siret river terraces and are represented by alluvial formations.

Siret terraces, four in number in the surroundings of Dolhasca locality were highlighted by Sîrcu (1955). Thus, Siret upper terrace (100 m) appears at Tudora (10 km north of Dolhasca) and Lespezi. Lithologically, in the composition of this terrace occur gravels with Carpathian origin elements.

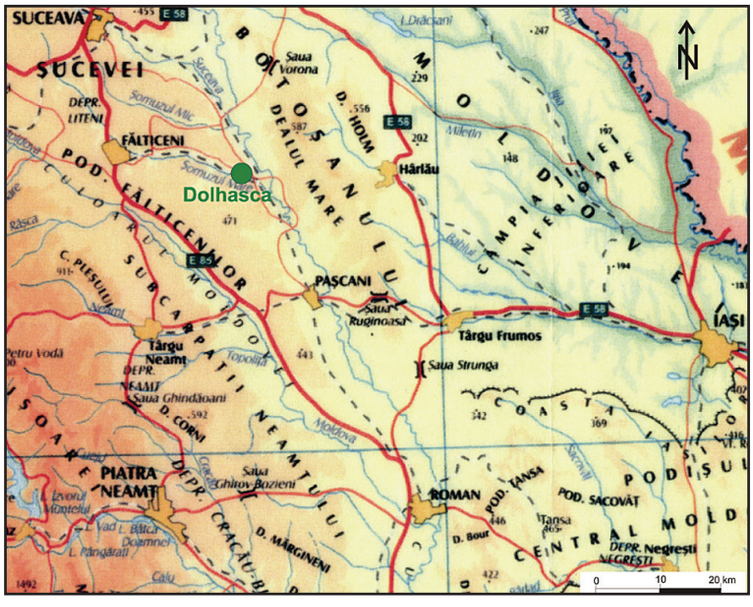

Fig.1 Geomorphological map of the studied area

Middle terrace (60 m) has a large development, also, at Tudora and Lespezi. Lower terrace (20 m) has in its composition gravels and loess and is developed at Lespezi. Low terrace (7-8 m) consists of gravels and it formed as a result of alluvial processes.

Upper Pleistocene-Holocene deposits are represented by slope deluvial deposits (silts, clays, sands and gravels).

Holocene deposits with the largest spread are represented by alluvial deposits which form the Siret river valleys and its tributaries.

4. HYDROGEOLOGICAL CONSIDERATIONS

Based on data from wells carried out in Dolhasca and its surroundings two types of aquifers were separated: shallow and confined.

In the meadow area of Siret river and Şomuzul Mare right tributary of Siret, at the base of deluvial deposits and sometimes at the upper part of the Sarmatian deposits, the wells intercepted the shallow aquifer, represented by one or two porous-permeable layers, within a depth interval of about 3 -16 m.

The confined aquifer is located in the Lower Sarmatian (Volhynian) deposits within a interval of about 20 - 250 m depth.

In the following the main characteristics of wells drilled for tapping of the shallow and confined aquifers in the investigated area are presented.

Shallow aquifer

The analysis of the existing groundwater data for Dolhasca area have identified both wells belonging National Hydrogeological Network (4 monitoring wells) as well as production wells (4 wells).

The four observation wells (F1-F4), which were drilled in 1970, have the following characteristics:

- F1, with a depth of 21 m, provided a yield of 1.9 l/sec (for 0.26 m draw-down). In this well a single porous-permeable layer was screened at 13.7-18.7 m depth;
- F2 yielded 2.3 l/sec, for 1.0 m draw-down and it has screened the aquifer layer developed between 8.3 -10.1 m;
- F3, with the final depth of 15 m achieved yield of 0.71 l/sec (for 0.43 m draw-down);
- F4 (with the yield of 1.9 l/sec, for 0.57m draw-down) crossed the aquifer layer situated at a depth interval of 3.2m to 6.6m.

The production wells, drilled in 1978, have a depth of 8.5 m. These wells intercepted a single porous-permeable layer of gravels and sands with a thickness of around 3-4 m and the yields that were obtained ranged from 1.5 to 1.7 l/sec for draw-downs ranging from 1 to 3.6 m. These wells are not used at present as they are scrapped.

The shallow aquifer was highlighted by wells of water supply as well, wells belonging to Budeni and Poiana production well fields.

Budeni F1 well, with a 15.0 m depth, screened the interval between 8.0-10.5 m (sand and gravels), with a yield of 1.6 l/sec, for a 0.40 m draw-down. Budeni F 2 well with a 15 m total depth opened the porous-permeable layer (sandy gravel) situated at a depth 8-11 m . At the testing moment F2 had a yield of 2.0 l/sec, for a 0.5 m draw-down.

The shallow aquifer was highlighted by six wells of Poiana production wells, wells with depths ranging from 13.0 to 16.0 m. The screening intervals were at depths ranging from 6.20 to 10.80 m. Lithologically, shallow aquifer is represented by gravels and boulders (fig.2).

Water recharge of the shallow aquifer developed in the Siret meadow is done both by the rainfall and directly from river.

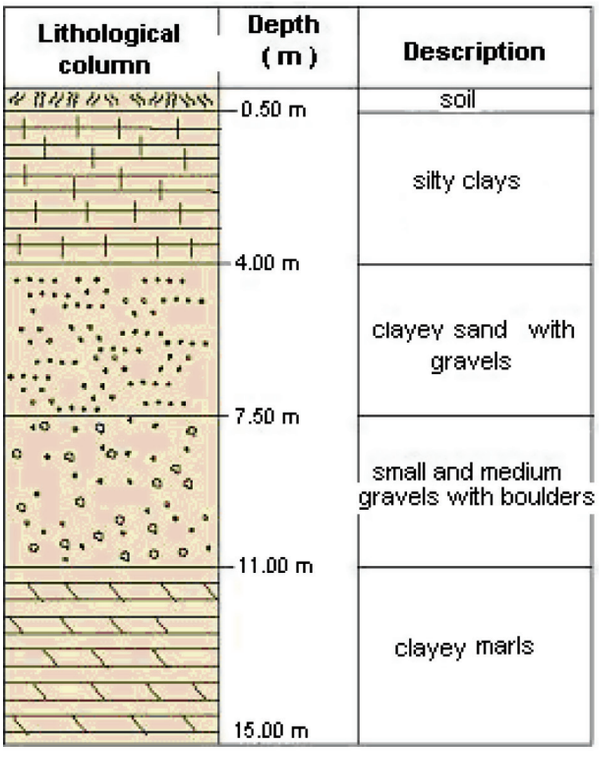

Fig.2 Lithological column in Budeni production wells (0-15 m depth interval)

Confined aquifer

This aquifer is accumulated in the Lower Sarmatian (Volhynian) deposits which develops at a 20- 250 m depth interval.

Dolhasca H11 well was drilled in 1992, at a total depth of 100 m and has screened a single porous-permeable level located in the Volhynian deposits (92-95 m depth). At the pumping test moment, the yield was 0.5 l/sec, and the piezometric level was artesian (+1 m). The water sampled analyzed in 1992 exceeded the maximum admissible concentration

under Law no. 458/2002 regarding drinkable water quality, modified and completed by Law no. 311/2004, at the total dissolved solids, so being declared non-drinkable from the chemical point of view, but drinkable from bacteriological point of view. In Vereşti town, situated approx. 20 km northwest of Dolhasca town, the hydrogeological well was drilled (H9), with a total depth of 200 m, which intercepted four deep layers (156.3 - 157.3 m, 170 -171.2 m; 172.4 – 173.5 m and 175.8-177.8 m) located in Volhynian deposits. At pumping test, the yield was 0.4 l /sec, for a 25.11 m draw-down, and the piezometric level was artesian (+ 2.8 m). The water samples taken and analyzed in 1992 had exceeded the maximum admissible concentration of total dissolved solids as stated under Law no. 458/2002 regarding drinkable water quality, modified and completed by Law no. 311/2004.

The well drilled in Fălticeni town, with total depth of 230 m, intercepted four deep layers accumulated in Volhynian deposits (156.3-157.3 m, 170 -171 m ,172.4 -173.7 m and 175.8 - 177.8 m). At pumping test, the yield was 0.4 l/sec, for a 39 m draw-down.

5. DATA REGARDING WATER SUPPLY OF DOLHASCA TOWN

Budeni production wells

Located on the left bank of the Siret River (Fig. 3) those production wells supplies with drinking water the Budeni and eastern part of Dolhasca town and consists of two wells F1 and F2, 15 m deep each, arranged on an alignment of about 120 m length, oriented from northwest to southeast. The distance between the two wells is approximately 75 m. The area in which the production wells are located is enclosed by a fence made of concrete pillars and wire mesh. In this area there are the pumping and chlorination stations. Production wells was given in use in 2008.

The water from the two wells is pumped into the storage tank having a 200 cubic meter capacity. From the reservoir, by free fall the water enters the distribution network which has a length of about 7 km, supplying about 300 households in Budeni village.

The water samples taken from the water treatment plant and analysed from physical-chemical and microbiological point of view in February 2009, did not exceed the maximum admissible concentrations for drinking water as stated by Law no. 458/2002, as amended by Law no. 311/2004 .

In Budeni area, the hydrogeological parameters have the following values: the hydraulic conductivity (K) 55.29 m/day, the radius of influence between 10 and 11 m, and the permissible velocity are 0.0016 m/s.

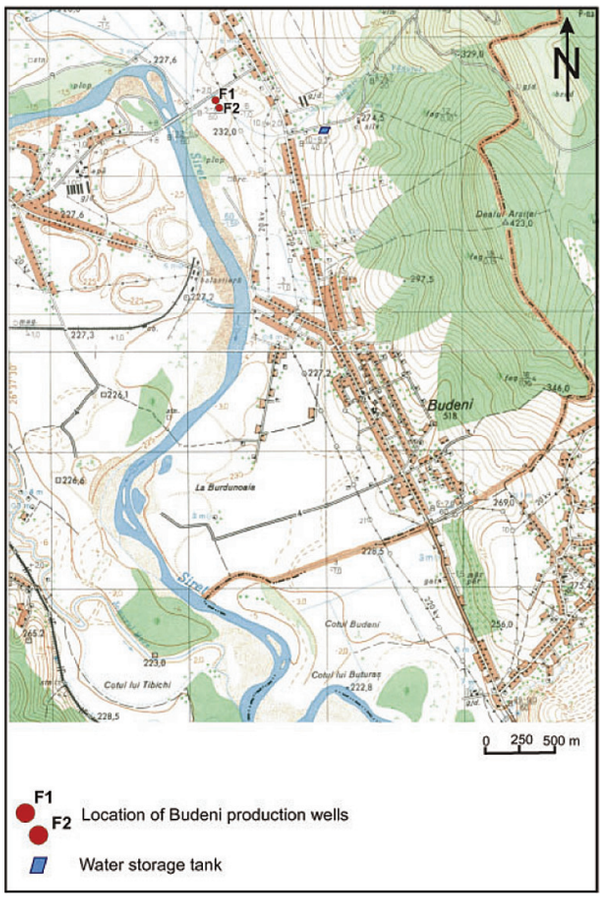

Fig. 3 Framing plan in Budeni area

Wells are equipped with sludge and bottom piece, and have compacted clay concrete ring between 2 - to 4 m depth. The filter column consists of gravel with 3-7 mm grain size. Casing column is made of PVC and has a diameter of 225 mm.

Main hydrological characteristics of the two wells that form Budeni production wells, are presented in table1.

The shallow aquifer is located in Quaternary deposits consisted of gravels and boulders which compose the Siret river's terrace.

Poiana production wells

Drinking water source that supplies Dolhasca town is ensured by Poiana production wells, situated about 3 km northwest from Dolhasca, namely on the right bank of the Siret River (Fig. 4). The production well field comprises six wells, with depths of 13 to 16 m, arranged on an alignment with length of about 350 m, oriented from north-northwest to south-southeast. The distance between wells is about 70 m. The area of the production wells is enclosed by a fence consisting of concrete pillars and wire mesh. Inside the perimeter area there are the pumping and chlorination stations. Poiana production wells was given in use in 2008, replacing the old catchment which was left due to aging of wells and deterioration of distribution pipes.

Table 1 Characteristics of the wells from Budeni production wells

Well	Depth (m)	Ground level elevation (m)	Screens interval (m)	Level of water table (m)	Yield (l/s)	Draw-down (m)
F 1 Budeni	15.0	230.00	8 – 10.5	6.50	1.60	0.40
F 2 Budeni	15.0	230,00	8 – 11	7.00	2.00	0.50

Table 2 Characteristics of the wells from Poiana production wells

Well	Depth (m)	Ground level elevation (m)	Screens interval (m)	Level of water table (m)	Yield (l/s)	Draw-down (m)
F 1 Poiana	16.00	232.0	6.20-9.50	4.50	3.0	1.00
F 2 Poiana	13.00	232.5	6.20-9.00	3.40	2.0	1.60
F 3 Poiana	13.00	233.0	6.80-9.70	3.95	2.0	0.40
F 4 Poiana	14.00	233.0	8.90-10.30	4.30	1.5	0.30
F 5 Poiana	14.50	232.8	6.80-10.80	3.85	3.0	1.80
F 6 Poiana	14.00	233.8	7.90-9.80	4.50	2.5	1.40

Sizing the sanitary protection areas and establishing the hydrogeolgical protection perimeter for Budeni and Poiana production wells

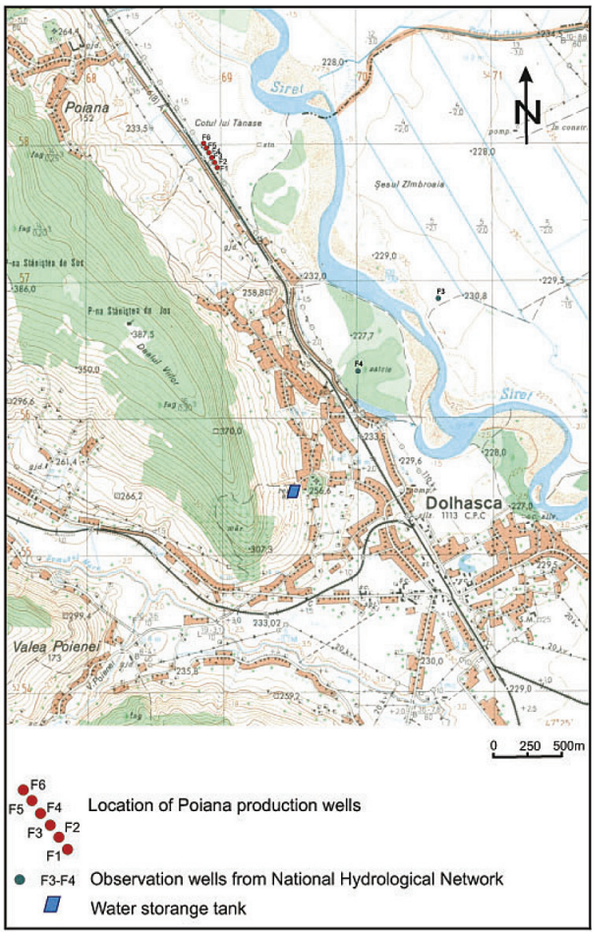

Fig. 4 Framing plan in Poiana area

The water that comes from the six wells is pumped into the semi-buried storage tank, which has a capacity of 600 cubic meters. From the reservoir by free fall the water enters the distribution network, supplying about 250 households in the north - west of Dolhasca town.

The water sample taken from the tap of the water treatment plant of production wells was analyzed from a physical-chemical and microbiological point of view in February 2009 and has not exceeded the admissible concentrations for drinkable water quality as stated by Law no. 458/2002, amended by Law no. 311/2004.

In Poiana production wells, the hydrogeological parameters have the following values: hydraulic conductivity (K) 118.36 m/day, transmissivity (T) 838.08 m^2/day, radius of influence between 14 and 88 m, and the permissible velocity between 0.0006 and 0.0057 m/s.

Wells are equipped with sludge and bottom piece, and have compacted clay concrete ring between 2 - to 4 m depth. The filter column consists of gravel of 3-7 mm grain size. Casing column is made of PVC and has a diameter of 220 mm.

Main hydrological characteristics of the six wells that form Poiana production well field, are presented in table 2.

The protection of groundwater refers to all measures intended to preserve water quality in terms of achieving a rational exploitation, which involves maintaining a balance between exploited water volume and the recharge of groundwater resources.

An over-exploitation of an aquifer can have immediate uncontrolled negative effects by collecting lower quality water resources from adjacent structures or vertical drainage.

The concept of „groundwater quality „means all physical, chemical, biological and bacteriological properties, which will be maintained in their natural limits, in order to maintain a ecological balance. Given the above it is required that the delineation of protection areas to be done so that designated authorities can effectively manage water resources, in order to preserve their qualitative and quantitative status.

For delineation of the sanitary protection areas of Budeni production wells it was used the Wyssling analytical method entitled "hydrodynamic spectrum dimensions calculation" (under Methodological guideline for calculation of the sanitary protection zones for groundwater abstractions, developed by the INHGA, 1998). We note that the two wells of Budeni are located on a line having a length of 120 m and the distance between wells is 75 m (Fig. 5).

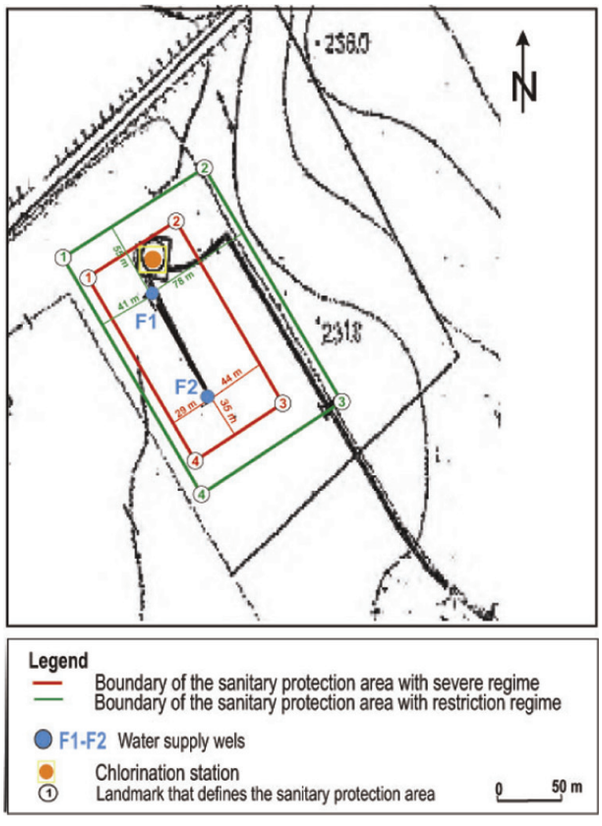

Fig. 5 Sketch plan with sanitary protection areas of Budeni production wells

This method allows to calculate the recharge area of the tapping as well as the distances (upstream and downstream) corresponding to a transit time for any particle of supposed contaminated groundwater flowing toward the water wells of 20 days or 50 days (Bretotean & Pandele,1998), based on complex formulas that take into account the following characteristics of aquifer: yield, hydraulic conductivity, thickness of water layer, hydraulic gradient,supply radius downstream of well, effective speed of the underground flow, porosity etc.

The sanitary protection areas with severe regime and with restriction regime are embodied by isochronous drawn based on the distances upstream and downstream corresponding to an underground transit time of 20 days and 50 days.

In order to establish the sanitary protection areas of Poiana production wells there was used, as in the case of Budeni production wells, Wyssling analytical method, because F1 - F6 wells are located on an alignment of 350 m length, the distance between wells is about 70 m (Fig. 6).

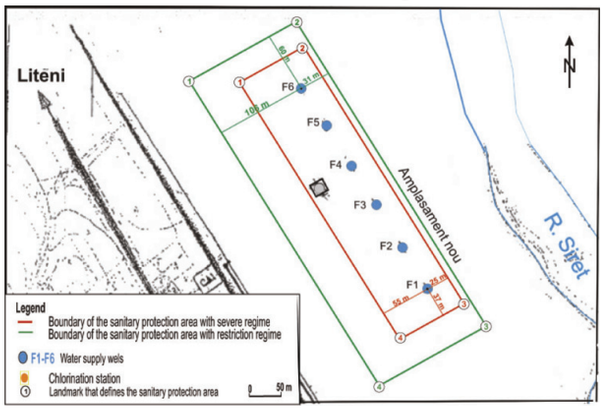

Fig. 6 Situation plan with of sanitary protection areas of Poiana production wells

The hydrogeological protection perimeter boundary of Budeni and Poiana production wells was drawn taking into account the geomorphological conditions, hydrographic network but also the regeneration area of groundwater resource.

For delimitation of sanitary protection areas for Budeni production wells, Wyssling analytical method was used. Sanitary protection areas with a severe and restriction regime are embodied by isochronous, drawn by an appropriate upstream and downstream distances corresponding to a transit time of 20 days and 50 days. Upstream distances from the tapping front (Dups), downstream distances from the tapping front (Ddow) and lateral distances (Dlat) regarding the sanitary protection areas with severe regime (20 days) and restriction regime (50 days) have the following values:

- Dups (20) = 44 m, Ddow (20) = 29 m Dlat (20) = 35 m;
- Dups (50) = 78 m, Ddow (50) = 41 m Dlat (50) = 55 m;

For Poiana production wells, the local flow direction of groundwater is from west-southwest to east-northeast, and for Budeni production wells the local flow direction is from east-northeast to west- southwest.

For Poiana production wells the delimitation of sanitary protection areas with severe regime (20 days) and with restriction regime (50 days) was done using the same analytical method and the upstream distance (Dup), downstream distance (Ddow) and lateral distance (D lat) have the following values:

- Dups (20) = 55 m, Ddow (20) = 25 m Dlat (20) = 37 m;

The boundary of the two hydrogeological protection perimeters corresponding to the production wells was drawn taking into account the geomorphological conditions, hydrographic network and the area of groundwater resource regeneration.

Establishing the sanitary protection areas is one of the current issues of great importance to protect the environment and from this derives the need for vigorous action by rational management of groundwater, from a quantitative and qualitative point of view.

6. CONCLUSIONS

Dolhasca town is located in the east-southeast part of Suceava county, at the contact area of the Suceava Plateau with terraces of the right side of Siret river, at the confluence of Siret with its right tributary, Şomuzul Mare river.

Geologically, the studied area is situated on the Moldavian Platform and is characterized by the presence of Sarmatian and Quaternary deposits.

Hydrogeologically, based on data from wells carried out in Dolhasca town and its surroundings there were separated two types of aquifers: shallow and confined. Shallow aquifer has been intercepted in the meadow area of Siret and Şomuzul Mare rivers, at the base of delluvial deposits and sometimes at the top part of the Sarmatian deposits and it consists of one or two porous-permeable layers, in a depth range of about 3 -16 m.

Confined aquifer is accumulated in the Lower Sarmatian (Volhynian) deposits in a depth range of about 20-250 m

For delineation of sanitary protection areas for Budeni and Poiana production wells, Wyssling analytical method was used.

To protect the groundwater, the most important step is to delineate specific areas with a special regime of use. In these areas only nonpolluting activities would be permitted so that to ensure the qualitative protection of resources. After their establishment in each of these areas there will be taken the measures stipulated by Government Decision no. 930/2005.

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