Water catchment modeling system in the city of Oradea, Romania

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Abstract: - The Paper present unconfined groundwater flow modeling for water catchment system Oradea, Romania. Water supply system is complex Oradea organized in 5 water. Plants 1,2,3, and 4 are obtained from the water drains through the water table which in turn are fed from the enriched pools of infiltration. Works 5 is surface water source Crisul Repede River is intended basically as a backup solution can provide drinking water. The companion software Processing Modflow for Windows (PMWIN) offer a totally integrated simulation system for modeling groundwater flow and transport processes with MODFLOW-88, MODFLOW-96, PMPATH, MT3D, MT3DMS, MOC3D, PEST and UCODE.

Key-Words: - groundwater, flow, catchment, water plant, calibration

1 Introduction

Oradea Water Company, is an economic unit which has the object of capturing the raw water, treat it and pumping water in the supply of Oradea city. These goals are achieved through the five water stations located on both sides of Crisul Repede River, in the north-east of the city, which has a total capacity of installed pumping 2,100 l /s, as show in figure 1.

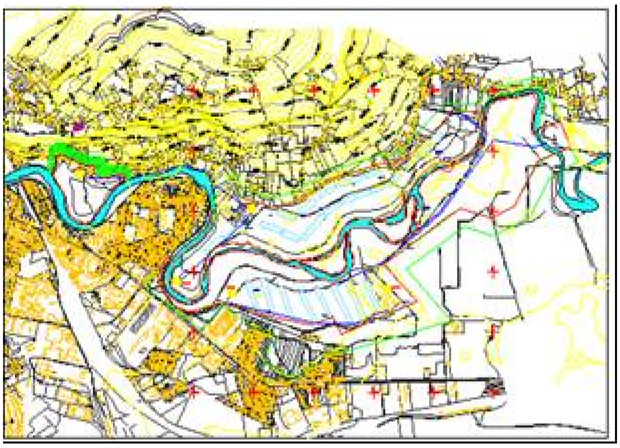

Fig. 1. Plan view capture area.

Raw water is abstracted from aquifers through drainage network located in the vicinity of Repede River. To enrich underground water layer using a total of 23 wells (15 on the right and 8 left banks of river) Crisul Repede fed through a culvert system from two catchments located upstream shore plants water in the dam Fughiu.

Existing technology allows the use of surface water abstracted Crisul Repede river and then treated accordingly (Water Plant 5). Usually this is a backup solution, preferring groundwater, which is better quality and cheaper, requiring that only chlorination treatment.

The entire water supply system consists of Oradea catchments, water connection pools enrichment field's infiltration, water plants is within a protection zone with a total area of approx. 280 ha [5].

1.1 Water plant 1

On the right bank of surface water abstraction through two pipelines from Ø1000 mm socket capture caisson type. Through these pipes, water abstracted is directed through a desilting on two longitudinal concrete clarifiers (140 m x 40 m) provided with inlet baffle.

After passing through clarifiers, water reaches the 13 groundwater basins enrichment layer, placed on two parallel rows (8 + 5 pools) with Crişului bed. The tanks have dimensions of 200 mx 40 m water depth is approximately 1.5 m between the two rows of basins and between basins and Cris two drains are placed to capture groundwater that feeds SP1.

Drains have a total length of 4200 m, are pictured at a depth of about 6 m and diameters that increase progressively with proximity to plant one (Ø400 - Ø1000 mm). Through these drains, water from aquifers is captured and directed toward gravity caisson to plant one. There are a total of 27 of these

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drainage manholes located on their route, visible in the field.
If the amount of water captured by drains would not meet the needs for SP1, you can use and surface water, filtered using filters slow situated near SP1.
Power filters are made with raw water directly from capture, through a pipeline Ø 600 mm, the water turbidity is low and if water has high turbidity, the last pool enrichment, after previously passing through desilting , decanters and pools, just ordered the coarse dirt trail in the water to settle by gravity[5].

1.2 Water plant 3

SP3 is still on the right is located downstream of the plant 1 and is designed pumping capacity of 150 l/s. The supply of water through a drain from a Ø300 mm, a length of 560 m and with a Ø250 mm caisson pipe SP1.
The discharge pipe 3 feeds 2x10.000 m3 to 2,000 m3 tank located at a higher rate of 2,000 m3 tank provides water in the area surrounding the tanks of 10,000 m3, and the water escapes through the pipe from the pump SP 1 the city [5].

1.3 Water plant 2

The plant is physically located on the right, but pumping network on the left bank of Crisul repede River a rate of 250 l/s. It uses only groundwater abstracted via a drain (Ø600 mm, l = 960 m). Enriching layer drain groundwater supply is via two pools fed by the river enrichment of SP1. Cheson the plant 2 is cylindrical, with a diameter of 3 m and a depth of 9 m [5].

1.4 Water plant 4

It is located on the left bank of River Crisul Repede with design capacity of 500 l / s. It uses only groundwater abstracted through drain. To enrich the phreatic layer there are 8 pools rich with dimensions of approx. 40 mx 300 m, water depth is about 1.5 m water supply watershed is Crisul Repede gravity of the two pipes.
The 8 pools enrichment are located approximately perpendicular Crisul Repede bed. These basins are located side drains that feed mainly dren disposed between bed Crişului and 8 pools, 6-7 m depth. The drain water main leading collector caisson to SP4 [5].

1.5 Water plant 5

Water Plant no. 5 is located on the left bank of Crişul Repede River has design capacity of 600 l / s and uses only surface water. Water is abstracted Crisul Repede, upstream of the city and get into a pool desanding through two pipelines with diameters of 1200 mm and 1000 mm and a length of about 1.5 km.
The basin shall be desanding larger solid particles contained in the water, after which it is pumped to the mixing chamber, which inject the solution of aluminum sulphate, acting as a coagulant, then decanted and filtered [5].

2 Problem Formulation

For the study was necessary to achieve numerical model alluvial aquifer are located Crişului Repede River significant components of the water supply system in Oradea, in the five water plants (dams, infiltration basins, drains).
Making numerical models required a topographic database and hydrogeological setting enabling elements for constructing models.
Based on these studies could lead to the following underlying numerical modeling:

2.1 Perimeter

The plant is physicall Perimeter area hydraulically significant for analysis and modeling of pollutant transport taking into account the operating conditions characteristic. This area represents the active part of the numerical model. This analysis led to the determination of the area of the modeling shown in Figure 2. On this site plan are the typical objects with role in groundwater regime, elements of water supply system: capture on Repede river, infiltration basins, primary and secondary drains, Crisul Repede as the active element penetrate the aquifer.

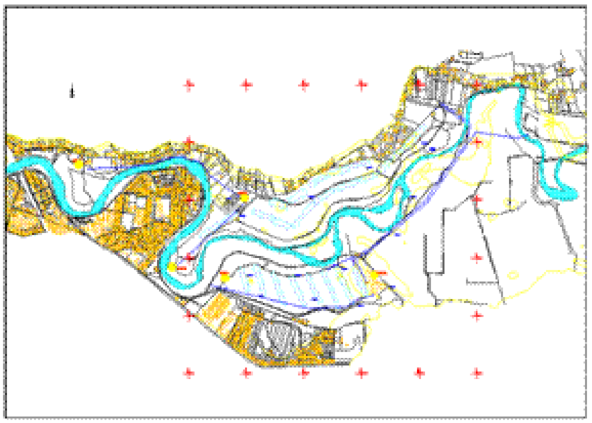

Fig. 2. Modeling area.

2.2 The boundary conditions

These conditions determine essentially conduct groundwater movement and hence the movement of pollutants in the aquifer, are the result of natural conditions and that conditions forced the operation to capture drains. These conditions are:

- Hydraulic load imposed on Crisul Repede values between 137 m to 125 m east boundary respectively NV;

- Limit the model on the right was modeled as a line current because aquifer disappears with increasing rates north slopes with a structure based on predominantly clay;

- Limit the model on the left, to the south, is made all the edge-type hydraulic load imposed by between 145 m east, 125 m west respectively.

Principal or secondary collector drains were modeled in various tasks hydraulic imposed under field trial. Enrichment in the ground pools also were modeled version hydraulic load imposed. In Figure 3 is presented model meshing and boundary conditions.

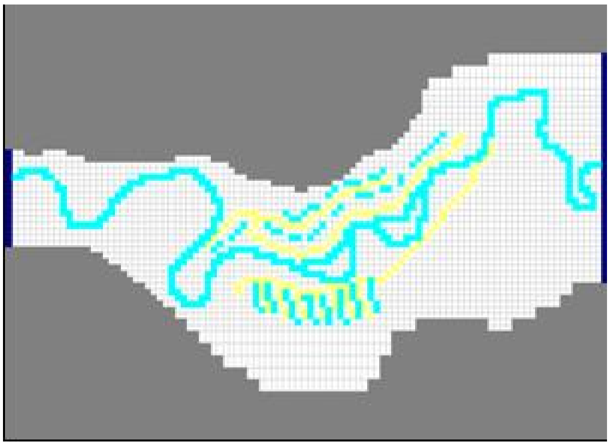

Fig. 3. Meshing the domain and boundary conditions.

2.3 Aquifer characteristics

Hydrogeological studies indicate aquifer of 5-8 m in area with variable permeability zones (filtrate coefficients kf = 30 m / day in the south and 120 m / day in the north, with intermediate values between the two limits in the remaining value territory). Figure 4 are shown in detail on areas filtrate coefficients. Based on studies and hydrogeological characteristics of alluvial aquifers contained in specialized studies was considered a low vertical permeability (report kfvertical / kflongitudinal = 1/10). Carrying out the vertical / horizontal been also represented in the model is shown in Figure 5 (odss).

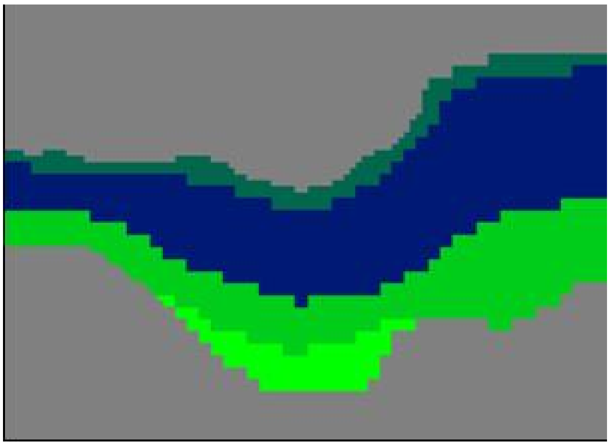

Fig. 4. Permeability zones.

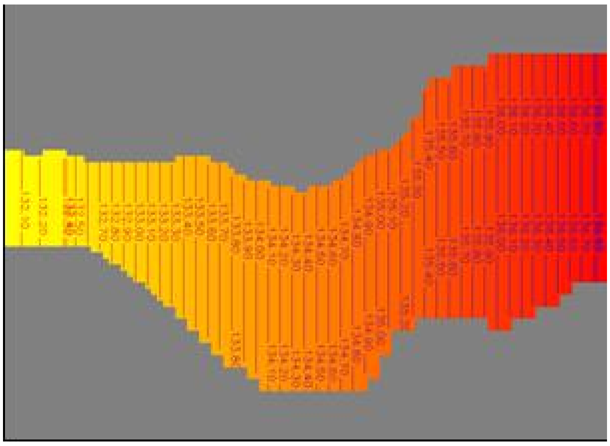

Fig. 5. Odss.

3 Problem Solution

The numerical method and the software that formed the basis of numerical modeling is PMWIN software package based on finite difference method. This program includes an interactive presentation of programs MODFLOW, MOC 3D MT3D MT3DMS [1],[2],[3].

Modeling is powerful, three-dimensional, thus allowing to model the movement and transport plane in neighboring areas Crisul Repede river, that drains and infiltration basins.

Data can be entered interactively, possibly relatively easy to modify certain parameters such as permeability mesh eg, odds base layer granularity.

Perimeter of the hydraulically significant was included in the core of the numerical model, adjacent areas were eliminated. Horizontally using meshing dx = dy = 50 - 100 m, size of 100 m was used in relatively uniform areas and the size 50 m in areas that were to be positioned modeling elements (basins, drains, the Crişul Repede River).

Vertical discretization used three vertical structures. This allows the mesh corresponding vertical locations of inter modeled objects at different rates,

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different zoning permeability of the aquifer and different thicknesses in the center which has a greater thickness (6-7 m) and decreases towards the northern and southern extremities. For each layer were set upper and lower quotas corresponding topographic data.

3.1 Version 1

The purpose of these options is to obtain a numerical model to faithfully reproduce the groundwater flow conditions consistent with the available studies.

Objectives included in the modeling in this embodiment are those existing water supply system in Oradea at the time of the Survey ie task type boundary conditions reign eastern and western extremes of the pattern, odd task Crisul Repede River, a enrichment of all wells on the right and a single drain.

Model calibration is to adjust the data reasonably domain (permeability), boundary conditions and levels required enrichment drains and basins so that by running the model and obtain the head contour they overlap control levels of study.

Finally, a control element drain flow model was included. Head contour obtained from Version1 are shown in Figure 6.

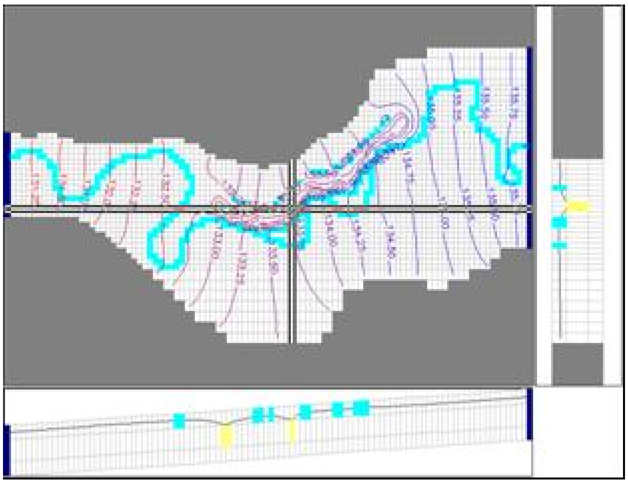

Fig. 6. Head contour version 1.

3.2 Version 2

Version 2 includes in addition to the numerical model Version 1 - Calibration additional objects that replicate the current situation in the field with the fully equipped as follows:

- Two rows of wells (8 15 pieces) on the right bank of water plant 1;
- Two rows of drainage from the right bank, the first located between the river and the second enrichment cycle through first Crisul Repede river basins and;
- Enriched ponds on the left bank (8 pieces) Water Plant 4;
- On the left side drains located between the basins mentioned above and drain it collects;
- A drain for the capture water plant 3;
- Drained 2 capture from the water plant 2;
- Crisul Repede River odds imposed thresholds considering barring modeled area.

With these elements to run the model variant V2 gaining head contours shown in Figure 7.

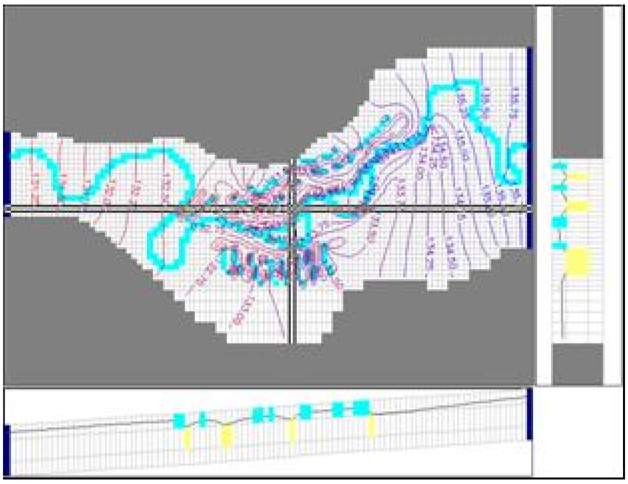

Fig. 7. Head contour version 2.

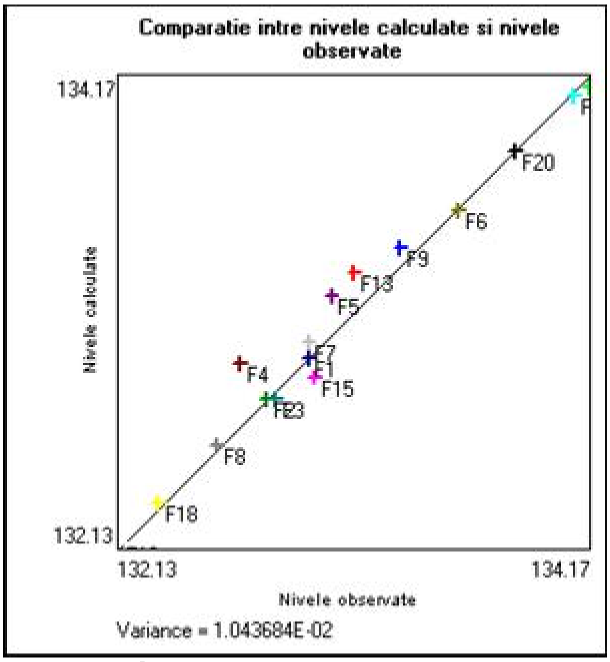

Fig. 8. Head contour version 1.

Besides head contours obtained software allows extracting data type water balance which allows the comparison of related drains and streams flow in

different directions in order to compare them with data mining.
For better performance modeling hidroizoipsele obtained in variant V2 were confronted with hydrogeological levels recorded recently completed wells. The data obtained from a comparison between the levels of hydrostatic forming, and the version V2 are recorded in the land shown in figure 8 and demonstrates the correct modeling.

4 Conclusion

Water supply system is complex Oradea organized in 5 water. Plants 1,2,3, and 4 are obtained from the water drains through the water table which in turn are fed from the enriched pools of infiltration. Works 5 is surface water source Crisul Repede River is intended basically as a backup solution can provide drinking water. This system completes the construction and specific objects (food pipe, manholes, valves, flow management). Actual plants are equipped with pumping equipment, flowmeter instrumentation and automated treatment plants.
The numerical model has been stalled in the reproductive V1 true of groundwater flow regime, the objects contained in the period for which they were available hydrogeological studies.
In variant V2 modeling baseline was set with objects that replicate situation of the existing complex system (tanks, drains). To confront the results obtained in variant V2 and in accordance with the beneficiary's network was conducted hydrogeological wells (16 pcs) representative from objects placed in the system.
We obtained a good agreement between hydrostatic levels obtained from modeling and registered to the network of wells.

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