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Regulations of Underground Water Usage in Armavir Region

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ABSTRACT

In this article justifications of using underground water for irrigation purposes of lands in the landscape of Armavir region are introduced: water intake has been implemented from low pressurized aquifer by repairing existing boreholes and by drilling new ones. Research on hydrogeological conditions of the selected area, its analysis and schematization has been performed. Hydrogeological calculations of boreholes with actual discharges are presented as an example, taking into account the permissible drop rate of piezometric level. As a result, the groundwater level drawdown of an aquifer has been obtained under possible discharges, considering the hydraulic connections between the aquifers.

The obtained results will enable to regulate working regimes of both new drilled and already operating boreholes in the region, as well as those under construction.

Introduction

The development and implementation of complex water engineering measures (land melioration) in the field of water management and agriculture in Ararat Valley are associated with the use of large amounts of underground water (mostly low pressurized). However, the use of underground water for irrigation and water supply purposes requires justification in engineering and scientific approaches.

Justification of engineering approaches is based on hydrogeological sections of the area, lithological composition of the rocks, borehole parameters in consistent with filtration characteristics, type of filters and correct location of the deep pump.

Justification of scientific approaches is based on the forecast of water level fluctuations of aquifers when boreholes are operated and determination of the permissible maximum water level drawdown excluding water resource consumption.

The basis for hydrodynamic calculations is the actual baseline data of existing boreholes in the abovementioned area operating in low pressurized horizons with a depth of 60-250*m*.

It should be noted, that underground water's hydrodynamic indices are classified as confined and unconfined types in Armavir region. Moreover, the confined aquifer is presented as low- (I) and high-pressurized (II). Currently, there is a tight hydraulic connection between the aquifers. The water from boreholes for irrigation purposes in the Ararat Valley is mainly taken from the low pressurized aquifer by using deep pumps. Consequently, when presenting parameters of a new drilled borehole, the hydrodynamic indicator of a filtering environment should be primarily taken into account, particularly, in order to maintain the piezometric level in boreholes when water is taken, that is, to exclude water resource consumption (Mkrtchyan, 1974).

Materials and methods

In order to efficiently use underground water resources for irrigation purposes in the Armavir region, the research of hydrogeological conditions of the area has been carried out and the filtering environment has been prepared in cases when water is taken from perfect and imperfect boreholes, which is as follows (pic. 1).

In consistent to the schemes a hydrodynamic calculation has been carried out.

Considering hydraulic connection between aquifers (water inflow from bottom and top aquifers to the observed one) and taking into account the condition of unlimited expansion of an aquifer, underground water flow to the vertical perfect borehole in a pressurized aquifer can be determined by the following equation (Khachatryan, 1993, Klimentov, 1985).

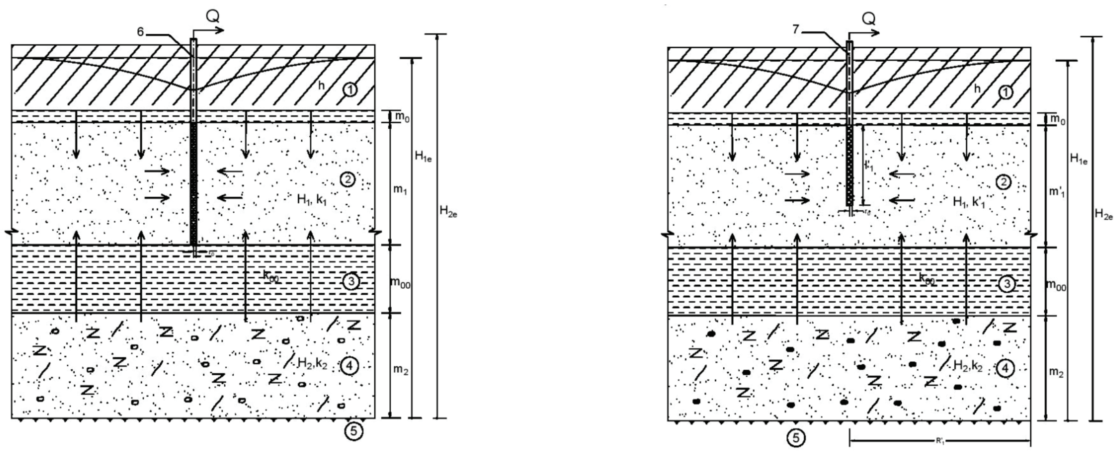
$$S_0^n = \frac{Q}{2\pi (km)_1} \ln \frac{1.12B}{r_0} \qquad (1)$$

where r_o is a diameter of a borehole, Q is a discharge from the borehole, $(km)_1$ is a coefficient of water conductivity of a low pressurized aquifer, B is the water inflow parameter of an observed aquifer, the size of which depends on the filtering properties of the low permeable and effective horizon and can be determined as follows (Klimentov, 1985).

$$B = \sqrt{\frac{(km)_1 m_0 m_{00}}{k_0 m_{00} + m_0 k_{00}}} \qquad (2)$$

Where k_0, k_{00} are filtration coefficients of low permeable horizons, m_0, m_{00} are their thicknesses.

a) Borehole N1, village Margara, b) Borehole N1, village Vardanashen



Pic.1. Hydrogeological calculation scheme
1- unconfined aquifer, 2, 4- low and high-pressurized aquifers, 3- low permeable layer, 5- impermeable rocks, 6- perfect borehole, 7- imperfect borehole

In cases, when water is taken from the imperfect borehole, (1) equation can be presented as follows (Klimentov, 1985, Maksimova, 1979):

$$S_1' = \frac{Q}{2\pi (km)_1'} \left[\ln \frac{R_1'}{r_0} + \zeta_1' \right] \qquad (3)$$

Where R_1' is the radius of the borehole impact, ζ_1' is the additional resistance, which depends on $\frac{l_1'}{m_1'}, \frac{m_1'}{r_0}$ parameters. Here l_1' is the length of the water intake part of the borehole, m_1' is the thickness of an aquifer. The value of ζ_1' parameter is presented in the table 1 (Verigin et al., 1977).

Table 1 The value of addition resistance based on $\frac{l_1'}{m_1'}, \frac{m_1'}{r_0}$ parameters

$\frac{l_1'}{m_1'}$	$\frac{m_1'}{r_0}$									
	0.5	1	3	10	30	100	200	500	1000	2000
0.1	0.04	0.122	2.04	10.4	24.3	42.8	53.8	69.5	79.6	90.9
0.3	0.03	0.09	1.29	4.79	9.2	14.5	17.7	21.8	24.9	28.3
0.5	0.016	0.05	0.66	2.26	4.21	6.5	7.86	9.64	11.0	12.4
0.7	0.0005	0.017	0.24	0.88	1.69	2.67	3.24	4.01	4.58	5.3
0.9	0.00004	0.0015	0.02	0.13	0.3	0.53	0.66	0.85	0.98	1.12

According to the abovementioned schemes, calculations of piezometric levels' drawdown in aquifers have been performed with (1) and (3) equations, which are based on the following actual baseline characteristics (borehole N1, village Margara and borehole N1, village Vardanashen): $r_0 = 0.16m$, $k_1 = 10.3\ m/day$, $m_1 = 68m$. The characteristics of an upper low permeable layer are as follows: $k_0 = 0.1m/day$, $m_0 = 4m$. The characteristics of a low permeable layer below are as follows: $k_{00} = 0.01m/day$, $m_{00} = 15m$, $k'_1 = 13.6m/day$, $m'_1 = 80m$, $l'_1 = 47m$, $R'_1 = 600m$. The drawdowns of levels have been determined for $Q=40,60,80l/s$ borehole discharges. According to the table 1 from $\frac{l'_1}{m'_1}=\frac{47}{80}=0.6$ and $\frac{m'_1}{r_0}=\frac{80}{0.16}=500$, $\zeta'_1 = 6.825$ is derived. The calculation results are summarized in Table 2.

Table 2 The drawdown of piezometric levels in Armavir region when water is taken from perfect and imperfect boreholes

r, m	$Q, l/s$	$\frac{Q}{2\pi(km)}$	$\frac{Q}{2\pi(km)'_1}$	$\ln\frac{R'_1}{r_0}+\zeta'_1$	B	$\ln\frac{1.12B}{r_0}$	S_0^n, m	S'_1, m
0.16	40	0.79	0.51	15.05	165	7.05	5.5	7.6
	60	1.18	0.76				8.3	11.4
	80	1.57	1.01				11.1	15.2

The maximum permissible drawdown of piezometric levels for vertical perfect borehole can be determined by the following equation: (Maksimova, 1979, Bochever, 1976)

$$S_{mad} = H_{le} - (0.4m_1 + \Delta H_p + \Delta H_f): \quad (4)$$

Where H_{le} is the initial size of the pressure, ΔH_p is the maximum depth of the bottom of the pump in the well, ΔH_f is the loss of pressure at the borehole entrance. In our situation the abovementioned parameters are as follows: $H_{le} = 80.2m$, $m_1 = 68m$, $\Delta H_p = 5m$, $\Delta H_f = 6m$. By placing these parameters in the equation (4), the maximum acceptable drawdown will be $S_{mad} = 42m$.

In cases when there is an imperfect borehole, (4) equation can be written as follows (Maksimova, 1979).

$$S'_{1mad} = (0.5 \ldots 0.7)(M_1 + H_1) \quad (5)$$

Where H_1 is the initial size of the pressure, M_1 is the thickness of the observed aquifer. In this situation these two parameters are as follows: $H_1 = 28m$, $M_1 = 47m$. By placing these parameters in the equation (5), the maximum acceptable drawdown will be $S'_{1mad} = 37.5m$.

Results and discussions

The calculation results show that in Armavir region the maximum drawdown in boreholes takes place when water is taken from the imperfect borehole with the possible maximum discharge ($Q = 80l/s$) and it is $15.2m$ (table 2), which is less than the maximum acceptable drawdown: $S'_{1mad} = 37.5m$.

Conclusion

Hydrodynamic calculations show that the irrigation of a part of landscapes in Armavir region can be done by using underground water resources without disrupting the maximum acceptable piezometric level drawdown in boreholes. Similar calculations have been performed for 20 new and 14 operating boreholes in Armavir region, which show that in appropriate discharge conditions the piezometric level drawdowns in boreholes are 7-22*m*, which is always less than maximum acceptable drawdown.

The calculations enable to irrigate the existing land areas and to expand their sizes.

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