Groundwater Monitoring Program at Al-Tuwaitha Nuclear Research Center, Iraq

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INTRODUCTION

The Al-Tuwaitha Nuclear Research Center is the largest, most complex and most radiological contaminated site in Iraq. Located about 20 km to the south of Baghdad, the Center has separate and distinct nuclear facilities which were destroyed during the Gulf Wars. Radioactive material onsite has an increased potential to be disperse and contaminate the environment.

Therefore, in the year 2002, the former Iraqi Atomic Energy Commission began monitoring the groundwater to determine whether the main destroyed nuclear radioactive facilities have contaminated the groundwater [1]. This paper presents current information concerning the characterization and quality of the groundwater and outlines the proposed groundwater monitoring program at Al-Tuwaitha Nuclear Research Center, which will be performed in close cooperation between Radiation Protection Center (RPC) of Iraq's Ministry of Environment (MoEN) and the International Atomic Energy Agency (IAEA), as well as Sandia National Laboratories (SNL).

DESCRIPTION OF FIELD OPERATION

To study the hydrogeological conditions and the characteristics of the ground water, six boreholes (3 shallow with depth of 15 meter and 3 deeper boreholes with depth ranging between 26-45 meters) were drilled in the area. Five of the boreholes are situated near the main destroyed nuclear radioactive facilities and one deep borehole is used for background measurement. Fig. 1 shows the locations of these boreholes and Fig. 2 and Fig. 3 show example of boreholes design with the geological vertical section. Water samples were taken for laboratory analyses.

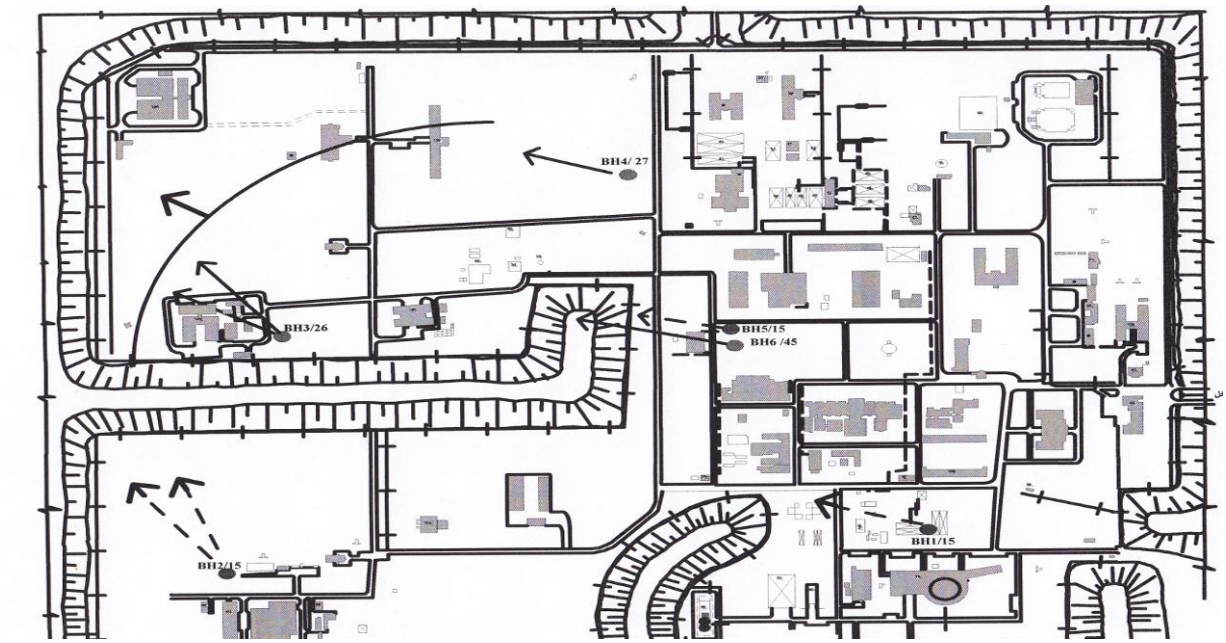

Fig.1. Map of Boreholes Locations with Directional Movement of Ground Water

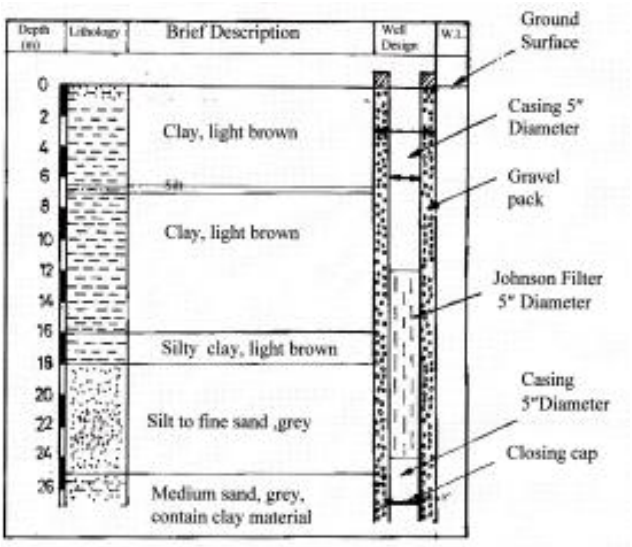

Fig.2. Design of Borehole No.4 with geological section

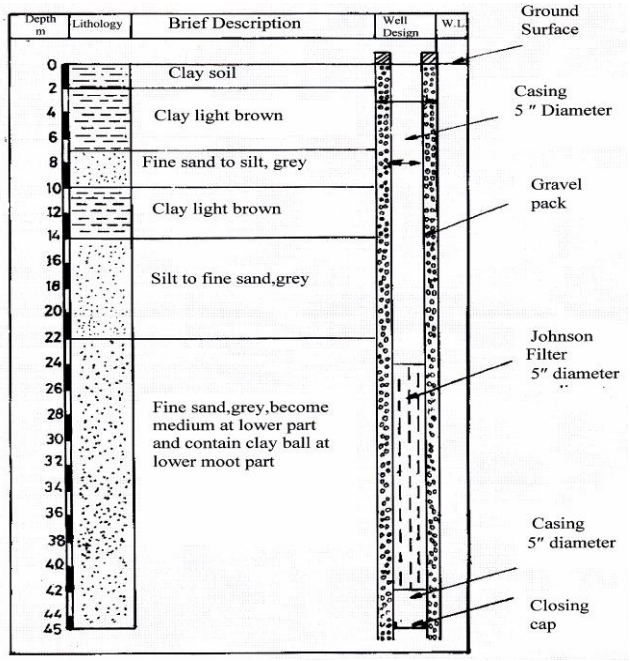

Fig.3. Design of Borehole No.6 with geological section

RESULTS

The results found that ground water exists in two aquifers. The first aquifer exists at the depth between 4-8 meters and represents confined perched water. The thickness of such water lenses is about 4 meters. The second aquifer represents the main water body in the area. The depth of the aquifer lies between 14-18 meters. The thickness of the aquifer is greater than 31 meters. The low gradient movement of the ground water is towards the Tigris River, which exists about 2.5 km from the site (see Fig.1).

Table I provides the results of the sample analyses which show great differences in the concentrations of solid substances and dissolved ions between the two water storages. This proved that there is no connection between the two water storages. This is due to the present of clay strata between 14-18 meters which separates the two aquifers from each other.

The analyses of water samples, using gamma spectrum analyzer, show no significant radioactive contaminations in the ground water except traces of Bi-214 with maximum contamination equal to (12±2) Bq/l and Pb-214 with maximum contamination values (11±2) Bq/l.

FUTURE GROUNDWATER MONITORING PROGRAME

In addition, additional ground water monitoring is planned. The monitoring program will include but not limited to the following:

- establishing program goals, objectives and procedures;
- helping organize the groundwater monitoring program within the Radiation Protection Center;
- identifying training requirements for staff;
- developing a preliminary hydrogeology conceptual model;
- establishing a monitoring well inspection and evaluation process;

Table I. Results of the Physicochemical Analyses of Water Samples from Monitoring Boreholes

BH. No.	PH	EC/ µmoose/cm	TDS/ mg/l	Ca^{++}/ mg/l	Mg^{++}/ mg/l	Na^{+}/ mg/l	$K^{+/}$ Mg/l	Cl^{-}/ Mg/l	CO_3^{-2}/ mg/l	HCO_3^{-1}/ mg/l	SO_4^{-2}/ mg/l	NO_3^{-3}/ mg/l	Depth/ m
BH.1	7.75	10660	6864	720	626	2050	15	2004	0.0	380	1030	0.7	15
BH.2	7.80	13000	8364	680	726	2730	23	2624	0.0	448	1092	0.75	15
BH.5	7.70	6960	4492	600	447.7	1173	6.3	1098	0.0	344	789	0.4	15
BH.3	7.42	4610	2985	160	275.8	1043	4.7	828	0.0	144	506.40	0.37	26
BH.4	7.35	3040	1977	120	153	695	3.5	583	0.0	85	307	0.37	27
BH.6	7.30	2820	1830	112	101.6	686	2.6	576	0.0	77	252	0.5	45

- determining the sufficiency of the existing monitoring well network;
- determining analytical parameters, and frequency of sampling;
- planning studies to determine if prior operations have impacted ground water quality; and
- planning studies to monitoring ongoing decommissioning activities.

ENDNOTES

1. The water levels of the ground water in boreholes nearly equal and exist between 27.61-28.07 meters. The differences between them will not exceed 0.5 meter (i.e., there exists a very low gradient for the water to flow towards the Tigris River from east to west). The low gradient movement of the ground water will charge the Tigris River during the summer time, while the Tigris River will recharge the main aquifer during period of flooding when the water level of the Tigris River rises.
2. The static level of the ground water from the ground surface lays between 3.52-4.22 meters.
3. The great differences in the concentrations of solid dissolved substances and ions between the first aquifer (shallow) and the second aquifer (deep) proved that there is no connection between them. This is due to the present of clay strata with thickness between 14-18 meters, which separate them.
4. The low concentration of solid dissolved substances and ions in the second aquifer is due to the existing connection of this water horizon with the Tigris River, since they are nearly at the same level.
5. The first aquifer cannot be considered as a ground water horizon but represents water lenses not connected to each others. The ground water comes from filtrations of rain water, agricultural irrigation and water sewages. As a result, the concentrations of dissolved substances and ions are much higher than the deeper aquifer.
6. The very low radionuclide values Pb-214 and Bi-214, which were observed in a few water samples (only three of the eighteen samples for Pb-214 and two of the eighteen samples for Bi-214) need to be verified and most probably is a natural occurrence.
7. Due to the ongoing decommissioning activities and the existing destroyed radioactive nuclear facilities, the proposed detailed ground water program at Al-Tuwaitha Nuclear Research Center is essential to verify any contamination of ground water.

REFERENCES

1. Abbas, M. J.; Al-Mubarek, M. A.; Aboud, H. S.: Underground Water Conditions Inside the Berm of Tuwaitha, Environmental Research Directorate, Siting Section, Internal Report No. EN-SI-RN129-2002, IAEC, 2002 (In Arabic).