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A Case Study on Design and Field Application by Evaluation of Artificial Recharge Performance

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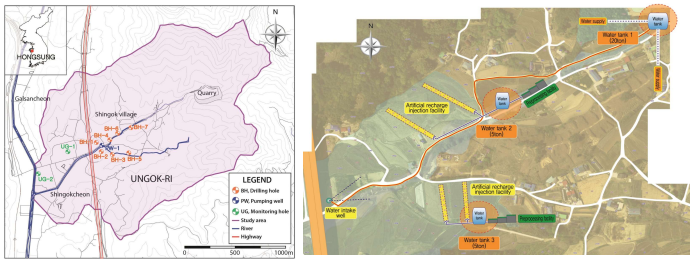
Introduction :

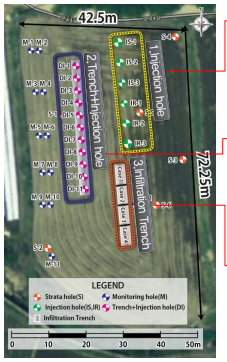
In recent years, due to the impact of global climate change, drought continues to occur every year in Korea, and affected areas are also appearing in various ways. Accordingly, artificial injection facilities are installed in the alluvial layer in the middle and upper regions of small flat lands in regular drought areas that can actively cope with drought and secure groundwater resources, and water intake facilities using horizontal collection wells are installed in downstream areas with good aquifer development. Therefore, the final goal is to establish an integrated artificial injection and collection system with a continuous circulation method of intake and supply. The study was conducted by focusing on the calculation of the design elements of artificial recharge and the construction cases reflecting the calculation results. The study area was targeted at the Ungok-ri area, Hongseong-gun, Chungcheongnam-do, Republic of Korea, where limited water supply was conducted due to drought and unsupplied areas of water. The area consists of silty gravel, showing good hydraulic characteristics as a ground for artificial recharge. The hydraulic property of the aquifer is $3.79\times10^{-4}\sim7.71\times10^{-3}$ (average 3.13×10^{-5})m/sec as a result of pumping and recovery tests. Determination of the design factors of artificial recharge is calculated by taking into account the hydrogeological characteristics of the aquifer. After performing the injection test step by step for each injection type (vertical crystal, pitch and mixed type) built in the test site of the research area, the optimal design factors for artificial recharge were derived, and the artificial recharge facility is currently under construction by applying the design elements to the site construction and operation. Through a full-fledged test operation for about one year, problems and security matters will be checked and water will be secured in the water shortage area at all times during continuous operation

1. Study Area

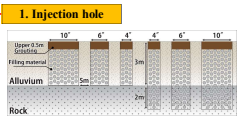


Location: Ungok-ri, Galsan-myeon, Hongseong-gun, Chungnam-do, Korea
Geology: Composed of Precambrian schist and gneiss, Mesozoic intrusive igneous rock, and metamorphic or sedimentary rock of unknown age and a Quaternary alluvial deposits at the top.
Activity: Based on the results of drilling, geological and hydrogeological investigation and in-situ test analysis in the area, the optimal artificial recharge and water intake system plan was established.

2. Field Tests for design

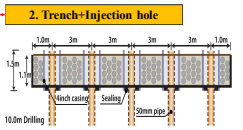


1. Injection hole



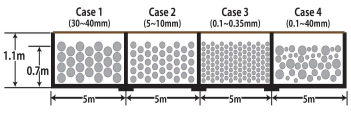
Objective:
Determining hole size and depth of vertical injection wells in artificial recharge facilities:
- Evaluation on Injection volumes of alluvial layer and alluvial + bedrock
- Evaluation of injection rate by injection hole size

2. Trench+Injection hole



Objective:
Determination of installation spacing of vertical injection wells in the infiltration trench
- Evaluate the amount of injection through injection tests at intervals of 3, 6, 9, and 12m
- Determination of the distance for each vertical injection well in the trench.

3. Infiltration Trench

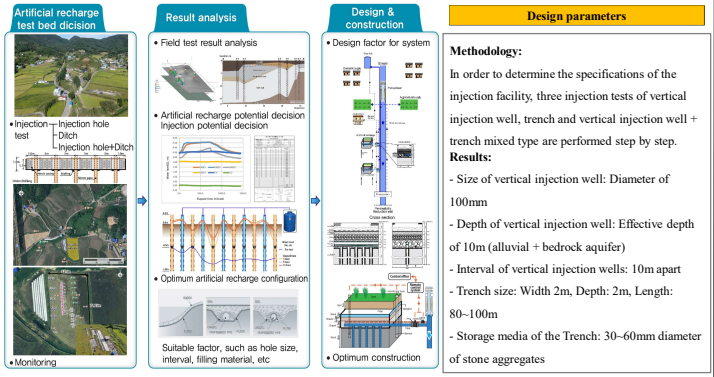


Objective:
Determination of the type and size of storage media (stone aggregates) in the trench
- Evaluation of injection amount according to filling media size
- Evaluation of injection amount of single media and mixed media

4. Monitoring

Objective:
- Real-time monitoring and evaluation of artificial recharge results during field tests
- Utilized for on-site monitoring such as average water level in the study area and water level during rainfall through long-term monitoring

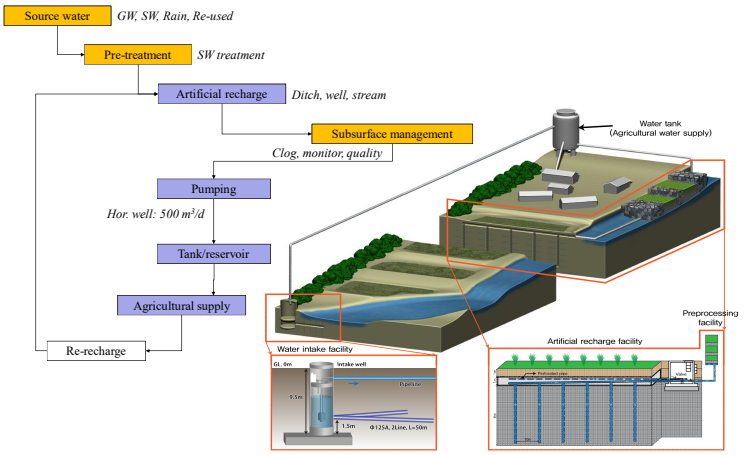
3. Design parameters for artificial recharge system



Design parameters

Methodology:
In order to determine the specifications of the injection facility, three injection tests of vertical injection well, trench and vertical injection well + trench mixed type are performed step by step.
Results:
- Size of vertical injection well: Diameter of 100mm
- Depth of vertical injection well: Effective depth of 10m (alluvial + bedrock aquifer)
- Interval of vertical injection wells: 10m apart
- Trench size: Width 2m, Depth: 2m, Length: 80~100m
- Storage media of the Trench: 30~60mm diameter of stone aggregates

4. Conceptual diagram of artificial recharge and water intake system



Artificial recharge facility : 2 trench lines on the right side of the recharge area (80m), 2 trench lines on the left side of the recharge area (100m)
→ Water supply system installation to trench lines and vertical injection well
Water intake facility : 2 horizontal intake well lines (about 50m)
→ Supply groundwater from the horizontal intake well to the water tank through the vertical collection well and the supply pipes
Water tank : Buried and installed pipelines to use groundwater supplied from water intake facility to agricultural and other domestic waters
- Continuous circulation type artificial recharge facility of Groundwater, Surface water, Rain, Re-used → Artificial Recharge → Pumping → Tank/reservoir → supply → Re-recharge
- Control and operation through remote monitoring

5. Construction milestone at the site

- Currently, the supply pipelines and artificial recharge facility are under construction, and horizontal intake and collection wells are scheduled to be completed in July 2021.
- The construction of the entire artificial recharge and water intake system is scheduled to be completed in September 2021, and trial operation is planned from October.
- Through the test operation, the system will be supplemented and improved to build an optimal artificial recharge system.
- Finally, by combining remote monitoring and remote control system, we intend to build a system suitable for the situation in the research area

Conclusion :

- After on-site construction, on-site research on the residence time and flow paths according to continuous recharge operation is required, and more precise verification of the effect of artificial recharge will be carried out in parallel. This study suggests a method necessary for preliminary experiments and analysis for the design and construction of an artificial groundwater enrichment system in the future. Through continuous research, it is expected to contribute to the expansion of artificial groundwater enrichment technology to secure water in areas with constant water shortage

Acknowledgements :

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References :

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