Union Hill Water Association

Proposed Lake Washington STEM School Project

ROTH HILL
Engineering Report

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GROUNDWATER & ENVIRONMENTAL SCIENTISTS

September 19, 2011

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Union Hill Water Association

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INTRODUCTION

On behalf of the Union Hill Water Association, our team conducted a review of selected elements of the construction drawings and technical support documents for the proposed Lake Washington School District's Science, Technology, Engineering and Math (STEM) School. Our review was focused on the impact that the construction and operation of the school might have on the Association's aquifer, specifically its water supply wells 1, 1S and 2, and for conformance to the Association's Policies for connection to the system and membership requirements.

The review was completed by Gregory G. Hill, PE, Association Engineer, Doug Dow L.GH., Hydrogeologist for the Association, Rich Aramburu, Legal Counsel for the Association, and Richard D. Melton, PE, Acting Association General Manager.

The School District has provided construction drawings, reports and technical memorandums for the teams' review and information. The following is a summary of the issues reviewed and subsequent conclusions.

PROJECT DESCRIPTION

Storm Water Management System

The site is approximately 21.58 acres, undeveloped with second growth forest and heavy vegetation. The STEM School building and associated facilities result in a projected disturbance of approximately 7.23 acres.

The storm water management of the STEM School site is under the jurisdiction of King County and regulated by the County's Surface Water Design Manual, 2009 edition (KCSWDM). The KCSWDM provides regulations and guidelines for storm water management, specifically treatment protocol for pollution generating surfaces and runoff management. The KCSWDM treatment and runoff control protocols are very stringent and provide highly effective results to properly designed and maintained systems. The project is located within a Conservation Flow Control Area and required to meet Basic Water Quality Treatment criteria.

The School District's Engineer prepared storm water plans and a Technical Information Report (TIR) for the project. The storm water plans and TIR will be reviewed and subject to approval by King County engineering staff. In our experience, the reviews conducted by County staff for storm water projects are very thorough and final approval issued by the County is only issued after the applicant's proposal meets all of the guidelines of the KCSWDM. The School District has designed their storm water facilities such that all storm water collected from the impervious surfaces is either infiltrated onsite or used for non-potable uses. The KCSWDM and County codes encourage and support onsite storm water infiltration when feasible. Underground infiltration galleries are the proposed method of storm water disposal for this project.

The impervious storm water generating surfaces added to the site consist of both pollution generating and non-pollution generating surfaces.

The non-pollution generating surfaces include the building roof, sidewalks and emergency vehicle access surfaces. The storm water from the building is planned to be collected in 50,000 gallon cistern. The School District intends to use the water collected from the cistern for non-potable uses such as toilet flushing and irrigation... The storm water from the sidewalks and emergency vehicle access surfaces will be infiltrated into the site via pervious pavement over a gravel infiltration gallery.

The pollution generating surfaces include a School bus loop and vehicle parking areas. The storm water from these surfaces is planned to be collected and treated to the KCSWDM's Basic Water Quality Treatment Standards. The treatment process for the bus loop is a sand filter system and underground infiltration. The parking lots are treated by a biofilter system and underground infiltration. All pollution generating surfaces include spill control tees.

A Storm Water Pollution and Spill Plan (SWPSP) was prepared by the School's Engineer as part of the TIR. The SWPSP will be reviewed by King County Engineering Staff for conformance to KCSWDM requirements. The SWPSP provides protection to the site and aquifer during construction; it is thorough and appears complete.

The project requires a commercial building permit, and as such is required to provide water treatment in accordance with the KCWSDM's Enhanced Basic Water Quality Menu. However, the KCWSDM allows an exemption from the Enhanced process.

ANALYSIS

There are several issues about the storm water management and infiltration that are of significance to the Association.

1. The site is located near the Association's Wells, 1, 1S and 2. The Association's Well Head Protection Plan identified the 1 year, 5 year and 10 year aquifer recharge zones for the wells. The site is located within the projected 1 year aquifer recharge zone and is a recharge area for the primary aquifer.
2. The site is located within the immediate cone if influence of the Association's Wells 1, 1S, and 2. The cone of influence of the Association's primary source, Well 1S, has a measured and recorded draw down of 14 feet during pumping. The significance of this relationship is that the predominately southward hydraulic gradient of the primary aquifer is locally redirected northward toward the Association's wells during pumping. This drawdown directly affects the rate and volume of shallow ground water infiltration downward through the aquitards and into the primary aquifer.
3. The site's surface geology is characterized as a highly pervious Vashon recessional outwash deposit of sands and gravels about 10 to 35 feet in thickness(AESI MW-1). This outwash generally drains southward to discharge into Evans Creek Valley. However, the underlying aquitard of silt and clay has an irregular surface that likely causes infiltrated water to follow the subsurface contours as it reaches the Evan's Creek discharge area.

The aquitards of silt and clay vary in thickness and elevation within the local area. The Subsurface geology at Well 1 and 1S shows 15 feet of coarse brown gravel with cobbles(recessional outwash) overlying 15 feet of glacial till (15 to 30 feet). Six feet of sand with some gravel between 30 and 36 feet overlies a thick sequence of low permeability sediments. The aquitard consists of gray clay and silt with some sand and gravel between 36 and 156 feet. The aquitard is water bearing below 145 feet. The primary aquifer becomes coarser with depth between 156 and 232 feet. However, at Well 2, the recessional outwash is found from ground surface to a depth of 21 feet. The silt aquitard has a greater content of sand and gravel and shows two layers of clean, water bearing, sand and gravel between 73 and 76 feet and again from 97 to 109 feet. The primary aquifer (123 to 212 feet) is predominately sand and less permeable than at Wells 1 and 1S.

The critical observation about these hydro geologic descriptions is how they differ significantly over a small area. Although an aquitard is present under the site that does restrict the vertical path and direction of water flow, it does not stop the infiltration of water from the surface, or subsurface down into the primary aquifer. Because the water table in the recessional outwash sediments is at a higher elevation than the elevation of the water in the primary aquifer, we know that this is a recharge area. Robinson Noble reviewed the storm water infiltration mounding analysis completed by AESI. AESI suggests that mounding of infiltrated storm water will be five feet under the infiltration basin reducing to zero three hundred feet away. Robinson Noble calculates that if the average mound height is one foot of water, this increase in hydraulic head will recharge an additional 70 to 6,900 cubic feet of water per day down to the primary aquifer. Although this is relatively small amount of water in a small area, the capture zone for the Association's Well 2 does extend under the site and some of the recharge from the infiltration basins would therefore be captured by Well 2.

4. The storm water will be infiltrated into the highly pervious sands and gravels located near the surface. Our primary objective is that water infiltrated into the site be treated to the highest regulatory standard prior to entering the underground infiltration galleries.

RECOMMENDATIONS

Water Quality Treatment

The School District's hydrogeologist presented an argument that only Basic Water Quality Treatment is necessary due to the presence of the low permeable aquitard layer. The basic premise of the argument being that the presence of the aquitard provides additional treatment of water before it enters the water bearing aquifer. In addition they argued that the topography of the underlying impervious soils are such that storm water infiltrated near the surface will flow to the south and west and away from the cone of influence of the Association's water supply wells. While the Association's consulting team recognizes this aspect of the School District's technical argument, we remain concerned about the quality of the water that is introduced for infiltration. While we recognize the presence of the aquitard and the characteristics of low permeable soils, we do not know conclusively that the aquitard is uniform in depth or if it is in fact continuous over the aquifer. We cannot conclude with any certainty that there is not direct communication between the highly permeable soils near the surface and the Association's

aquifer. Accordingly, we are not comfortable accepting the assertion by the School District's hydrogeologist that Basic Water Quality Treatment is sufficient.

- **Recommendation**: The Association require Enhanced Water Quality Treatment for water infiltrated on the site.

- **Recommendation**: Conduct monitoring of the storm water treatment every 6 months to ensure the Enhanced Water Quality Treatment Facilities are functioning according to the requirements of the KCWSDM. Require the installation of shallow monitoring wells near the infiltration galleries to facilitate the sampling and monitoring process. Develop a monitoring protocol for the treated storm water.

- **Recommendation**: Monitoring wells be installed on the site and be monitored every 6 months. We further recommend that these wells be located as follows: One well at both the west and east end of the geothermal recovery system, and one well at the Northeast corner of the building site.

- **Recommendation**: The Association monitor the construction site at least weekly to ensure that the elements of the Storm Water Pollution and Spill Plan are installed and maintained during construction.

Our team discussed the use of the proposed cistern. Our research concludes that cisterns and diversion of rain water for non-potable uses are allowed. Our primary concern is that the water system that uses the water from the cistern be in absolutely no way connected to the plumbing or water system that delivers potable water. The Association's cross connection policy requires back flow prevention systems be provided for any potential cross connection. The Uniform Plumbing Code will not allow the connection of non-potable and potable water systems. The Association's Cross Connection Policy is very restrictive and does not allow the connection of private wells or other water sources to the Association's system.

The Association should confirm that separate systems have been constructed by the School District and in accordance with the UPC and Association's Policy. Further recommended is that the Association confirm that the School District's non-potable water system has absolutely no physical connection to the Association's water system, plumbing inside of the School building or landscape irrigation piping that is connected to the Association's system.

Water System Extension

On behalf of the Association, RH2 Engineering conducted a hydraulic analysis and concluded that the Association can plan to deliver 2,500 gpm fire flow protection at 20 psi residual to the site. Roth Hill, LLC reviewed the proposed water main extension requirements for the project, the Association's Policy Manual and the Association's Water Comprehensive Plan. Roth Hill, LLC developed the final requirements for onsite and offsite water line extension for the project.

- **Recommendation**: The Association require the School District to extend a 10 inch waterline along 228th Avenue NE from the south property line northerly to the intersection of 228th Avenue NE and NE 46th Street. Further recommended is an onsite 8 inch diameter water main loop connecting to

the proposed 10 inch waterline within 228th Avenue NE and the existing 8 inch waterline located on the Alcott School site. It is our professional opinion that constructing the water lines as recommended will provide long term benefit to the LWSD's project, and improve the overall hydraulics and reliability of the Association's system for existing facilities such as the Alcott School. It is also our opinion that constructing these facilities will support the Association's long term Water Comprehensive Plan. Further recommended is that all waterlines 6 inches and larger, and water system facilities such as meters, hydrants and fire department connection ports onsite be owned and operated by the Association. Accordingly, all water facilities intended to be owned by the Association shall be designed and constructed in accordance with Association policy and standards.

Geothermal Recovery System

The School District proposes a buried geothermal loop heat recovery system. The system is intended to collect heat stored naturally in the ground and extract that energy to provide heat for the school building. The system is a closed loop system buried approximately 15 to 30 feet below finished grade using fresh water circulated through the geothermal transfer gallery and heat exchanger. The geothermal gallery is designed to be buried in the highly permeable outwash layer, but may encounter shallow aquitard sediments.

AESI's test pits and two monitoring wells have shown that the surface of the silt aquitard varies in depth throughout the site. AESI reported layers of silt within the recessional outwash at three locations near the center of the parking area. Monitoring Well 1 was drilled at the same location and confirmed that silty layers, that are not significant aquitards, occurred within the outwash. The bottom of the outwash was found at a depth of 35 feet in MW-1. Monitoring Well 2, at the west end of the geothermal loop system, encountered aquitard materials at a depth of 21 feet, the same depth as found in the Associations Well 2. Installation of the geothermal loop system between depths of 15 and 30 feet below finished grade is likely to encounter layers of silt within the outwash sands and gravels. If the drilling encounters the top of the silt aquitard in areas where the aquitard is at a higher elevation, it will not pose an increased threat to the Association's primary aquifer.

Our team reviewed several issues about the geothermal system. The method of construction will be by trenchless directional boring. The proposed method will not use drilling fluids that present a threat to the aquifer. The elevation of the geothermal loops is proposed to be within the highly pervious sands and gravels and mostly above the aquitard. The Association requested, and the School District conducted additional soil log studies in order to confirm the elevation and depth of the aquitard in order to support the design of the elevation of the geothermal loops. The pump system and piping are designed such that the pipe will not burst from the hydraulic pressure even if the system inadvertently becomes closed. The system will be used to extract heat from the ground and is not expected to impact the temperature of the soil near the aquifer.

- **Recommendation**: Monitoring be completed during construction to ensure that the geothermal loop is constructed at the proposed design elevation. Further recommended is that the Association meet on a six month basis with the School District in order to ensure that only water is used in the heat transfer system.

Pesticide Free Facility

The School District does have a policy for Pesticide Free Facilities.

- **Recommendation**: The Association should require that no herbicides, pesticides or fertilizers be allowed to be used on the site.

Chemical Storage on the Site

The School will keep an inventory of chemicals for use in their classroom laboratories. An inventory and proposed quantity of chemicals to be stored on the site has been submitted.

- **Recommendation**: The Association meet every six months with the School District in order to ensure that additional chemicals are not being stored on the site.

Sanitary Sewer Facilities

The School will be connected to the public sanitary sewer system. All materials required by the Northeast Sammamish Sewer and Water District for this project are state of the art municipal grade materials and standards.

- **Recommendation**: The Association meet every six months with the School District in order to ensure that the concrete manholes on the site remain competent and do not leak. The inspection of the manholes on site should be conducted by personnel trained and certified by the Manhole Assessment Certification Program (MACP).

Hux Howard Well

Our research produced a well log that indicates the presence of a well on the site. The well, if it exists should be found and it should be established if the well was de-commissioned properly. The well, if it exists should be found and it should be established if the well was decommissioned properly. Should the well be located, it must be decommissioned per Washington State requirements. This well, if left onsite and not decommissioned according to the Washington State requirements, poses a potential conduit for surface contamination to directly impact the primary aquifer where the Association obtains its water.

We have conducted non-invasive investigation on the site using a metal detector. The well has not been found.

- **Recommendation**: The Association and School District coordinate site work construction efforts such that the Association is allowed access to the site upon completion of the site clearing and grading. Additionally recommended is that the Association procure professional geotechnical investigative services to search for this well. The investigation should be limited to the area that is described on the well log's meets and bounds legal description. This should conclusively establish the existence of the well or not. The Association can then make arrangements to coordinate the inspection of the well and coordinate decommissioning if necessary.