June 1, 2018

Mr. Edward Peters
Edmonds School District #15
20420 68th Avenue West
Lynnwood, WA 98036

Re: Madrona School Stormwater Management System Assessment

Dear Edward:

PGG has been contracted by the Edmonds School District No. 15 (the District) in Edmonds, WA to perform technical evaluation of selected aspects of the Madrona School stormwater management system (the Project). ESD requested that PGG address the six questions presented below. Each question is followed by a summary of our response as presented in the rest of the document.

1. Whether the use of UIC's in this instance is consistent with current water treatment and monitoring process.

   The use of UIC wells, as proposed, is consistent with best management practices. The Project's monitoring plan adds additional protection and is designed to address concerns of the local drinking water purveyor.

2. Whether adequate measures have been proposed by the ESD to protect against contamination of the drinking water source of supply now and in the future.

   The natural, built, and operational features provide a high level of confidence that groundwater will be protected by this system; however, they do not guarantee it. Project features are presented in Section 2.1

3. Whether the Project is in compliance with federal, state and local laws, Clean Water Act law and guidelines including, but not limited to Water Quality and Groundwater Standards, and Best Management Practices ("BMP's"), and Underground Injection Control Program Best Management Practices "BMP's".

   The Project is consistent with regulations and guidance reviewed. Regulatory compliance is covered in Section 2.2

4. Whether the monitoring plan, as presented, is of sufficient scope and duration to monitor potential impacts of the Project to the water quality of the affected surface and ground water supply?

The five-year monitoring period should be sufficient to identify effects of routine operations given the estimated 600-day travel time between the downgradient monitoring well and the closest infiltration well. See Section 2.3.3 for further discussion of travel time and monitoring duration.

5. Whether the monitoring plan is adequate in providing data that can be used to determine the Project's contribution to future possible contamination at Deer Creek supply source or the District's well field.

   The analytes selected for monitoring are appropriate and sufficient to detect potential contamination from the Project. Analytes are further discussed in Section 2.3.4.

6. How and for what period of time and at what locations should the groundwater discharge by the ESD be monitored?

   The five-year monitoring period should be sufficient to identify effects of routine operations given the estimated 600-day travel time between the downgradient monitoring well and the closest infiltration well. See Section 2.3.3 for further discussion of travel time and monitoring duration.

   The monitoring locations are appropriate as long as the groundwater flow direction does not change over the project duration. See Section 2.3.2 for further discussion on monitoring locations.

1.0 PROJECT DESCRIPTION

The Project is located on a 40-acre parcel owned by the District in Edmonds, WA. The school is in the process of being replaced but the number of students will stay the same – 650. The site is located within the 10-year capture zone of the Deer Creek Group A municipal water supply source, operated by Olympic View Water and Sewer District (OVWSD).

The Project site includes a bluff which drops 80 feet from east to west. The two hydrogeologic units present at land surface near the site are the Vashon Till and the Vashon Advance Outwash (Qva). The Qva is the primary drinking water aquifer in the area and is overlain east of the bluff by the Vashon Till. The Qva reportedly outcrops (is at or near land surface) at the base of the bluff west of the school. Groundwater beneath the site flows generally from East to West towards Puget Sound.

Before remodeling, the site was drained by sheet flow to the west down the bluff (M. Wills, Personal Communication). The new design includes four clusters of four injection wells each, for a total of 16 wells. They penetrate the till and terminate 40 to 50 feet above the water table in the Qva. Wells are completed such that water flows into the top of the sand pack at lower flows. Once flow reaches a threshold, flow is also directed into well casing which is connected to a well screen at the bottom of the sand pack. Gate valves have been added for shutoff of individual wells.

The parking lot is considered a pollution generating surface. Thus, water from the parking lot is treated with an oil/water separator and bioretention pond with underdrain which leads to UIC wells. Wells "that only receive runoff from a roof coated with an inert, non-leachable material and a roof that is not subject to venting of manufacturing, commercial, or other indoor pollutants" are considered to automatically meet the non-endangerment standard" (WAC 173-218-100). The Madrona roofs are coated with such a material (Mahlum 2018) and thus roof runoff is piped straight to the UIC well system.

The wells require registration as Class V (stormwater) Underground Injection Control (UIC) wells (WAC 173-218) with the Department of Ecology. Application for registration may only be submitted once the project is under construction. Ecology has not issued a UIC registration letter for this project yet.

1.1 GROUNDWATER MONITORING SYSTEM

The effects of the injection system on the underlying aquifer will be monitored at one upgradient (OW-4) and one downgradient monitoring well (OW-3) for five years after injection begins (Shannon & Wilson, 2018).

Groundwater elevations will be monitored using data logging transducers to confirm separation is maintained between the water table and the bottom of the UIC wells.

Groundwater quality samples will be collected both before injection (to establish background) and after injection (to evaluate effects of the project). Background samples include 8 events approximately 8 weeks apart from both monitoring wells, before injection begins. Once the system is in operation, samples will be collected quarterly for 2 years, followed by 3 years of annual sampling.

Analytes to be evaluated as part of the monitoring plan include:

- Field parameters (pH, temperature, specific conductance, dissolved oxygen, and turbidity)
- Primary and secondary drinking water inorganic chemical characteristics and physical characteristics listed in Tables 5 and 6 of Washington Administrative Code 246-290-310
- Selected petroleum hydrocarbon-related constituents (diesel-, oil-, and gasoline range organics and benzene, toluene, ethylbenzene, and xylenes)
- Polycyclic aromatic hydrocarbons
- Pesticides and herbicides
- Other analytes required by Ecology include bis(2-ethylhexyl) phthalate and PCBs

2.0 PROJECT EVALUATION

PGG reviewed general designs for pretreatment, the UIC wells, and the proposed monitoring plan to understand the intention of the stormwater disposal system. The work did not include detailed review or confirmation of as-built conditions, and PGG did not provide opinions reserved for engineering (as opposed to hydrogeologic) or legal professions.

2.1 PROJECT DESIGN

Design standards, including pretreatment, are established in Chapter 173-218 WAC, Underground Injection Control Program, Guidance for UIC Wells that Manage Stormwater (05-10-067) (Ecology, 2006), and the applicable stormwater design manual which in this case is the 2005 Stormwater Management Manual for Western Washington according to City of Edmonds.

The project intends to use Underground Injection Control (UIC) wells to infiltrate treated stormwater. UIC wells are a common way to infiltrate stormwater throughout Washington State. Ecology's UIC database lists 1245 municipalities in Washington with stormwater UIC wells, and each has from one to thousands of individual wells (https://fortress.wa.gov/ecy/uicsearch/). UIC stormwater wells are allowed in urban settings that are more vulnerable than the Madrona School setting. Examples include the City of Redmond Washington where very shallow groundwater is used for drinking water.

The Madrona School UIC wells are relatively deep UIC stormwater wells and are designed to infiltrate below the shallowest soil layer that restricts natural downward flow of groundwater recharge. That soil layer also has the potential to remove pollutants from the recharge. Although the shallowest restrictive layer has been excluded by design, the built portions of the system, and the vadose zone between the bottom of the wells and the water table, appear to meet requirements for rule authorization of the UIC wells. Rule authorization means that design standards have been met and Ecology will thus presume groundwater will not be contaminated (ie: it meets the non-endangerment standard[1]).

For this project, natural characteristics and designs serving to protect groundwater from contamination include:

- Oil/water separation (Mahlum 2018)
- Pretreatment by biofiltration with a raised underdrain (Mahlum 2018)
- Shut-off valves for each well (Mahlum 2018)
- Vadose zone soils which appear to meet requirements for "medium" and "low" treatment capacity (Ecology 2006)

[1] The non-endangerment standard protects all groundwater and is thus a higher standard than a design basis focused on protecting only groundwater at water supply sources (springs and wells).

With the exception of the shut-off valves, the measures above are identified in Ecology's design guidance document (Ecology 2006). The shut-off valves appear to be an additional measure added by designers in this case. Note that the vadose zone between the bottom of the wells and the water table is part of the water quality treatment system. Thus, complete performance monitoring can only occur within the aquifer.

In addition to natural conditions and engineering measures, the following operational and monitoring measures were offered by ESD in an addendum to the project SEPA environmental checklist (March 2017):

- Coordinate stormwater infiltration efforts in the project area with OVWSD to facilitate OVWSD's compliance with Washington State Department of Health source water protection requirements established under the Watershed Control Program (see protective measures stated in Section 3.1, Deer Creek Water Supply Protection Plan).
- Monitor the performance of the UIC clusters so that appropriate maintenance or UIC well rehabilitation can be scheduled.
- Install and monitor data logging transducers in some of the wells and conduct periodic manual water level measurements.
- Implement a landscape management plan designed to eliminate the use of pesticides, minimize the use of fertilizers, and reduce pollutants throughout all areas of the site that drain into the UIC wells, in accordance with the local stormwater code requirements.
- Implement an operations and maintenance manual for maintenance of the bioretention facilities, and UIC's including soil cleanup and replacement from spill contamination.
- Perform a regular and perpetual maintenance program for all of the site infiltration facilities to reduce siltation and bio-fouling, in accordance with the local stormwater code requirements.
- Perform bioretention facility soil cleanup and replacement if spills occur, in accordance with the local stormwater code requirements.
- Protect groundwater observation wells through the facility construction process and use them to facilitate measurement of facility performance.
- Repair or properly abandon wells damaged during construction in accordance with WAC 173-160

The natural, built, and operational features provide a high level of confidence that groundwater will be protected by this system; however, they do not guarantee it.

2.2 REGULATORY COMPLIANCE

Summary description of the project's compliance with UIC stormwater well design is presented below (UIC Program), followed by review of two land use regulations that pertain to siting of such facilities (Water Supply Protection Plan, and CARA regulations).

2.2.1 Underground Injection Control Program

ESD has applied to Ecology for registration of its UIC wells via submittal of an Underground Injection Control Program Registration Form. Design data have been submitted and Ecology has requested additional information on source control, landscape plan, and operation and maintenance (pers. Comm. Mary Sheleen-Hansen, May 2018). A registration letter has not been issued yet. PGG understands that Ecology's opinion based on submittals so far is that the system will likely be rule-authorized. To the extent of our review of hydrogeologic aspects, PGG concurs that the proposed use and design appear to meet criteria for rule authorization.

2.2.2 DOH Guidance

A DOH Discussion Paper (2015) identifies three criteria that define a "desired state" where the interests of utility managers and stormwater managers can be met. The Project appears to meet all three criteria. The three criteria are discussed below:

1. Vulnerable sources have adequate and appropriate Best Management Practices (BMPs).

   The requirement for BMPs has been met by pretreatment including the bioswale and oil/water separator, the individual shut off valves, and the monitoring plan.

2. Utilities with vulnerable supplies are informed and consulted when stormwater projects using UIC wells are developed in critical wellhead areas.

   OVWSD has been informed and is in discussions with ESD.

3. No UIC wells are sited in SCAs without water utility approval

   The size of an SCA is not explicitly defined in the context of the Discussion Paper; however, it mentions sanitary setbacks of 100 feet for wells and 200 feet for springs. It also mentions BMPs may be necessary for 3-6-month WHPA zones. Since the Project is within the OVWSD 10-year WHPA, it appears to be outside the intended scope of the DOH Discussion Paper.

2.2.3 The Deer Creek Water Supply Protection Plan

The OVWSD plan (Penhallagon Associates and Robinson and Noble 2001) was developed to protect and enhance water supply from the Deer Creek water supply facility. It outlines well head protection areas and the one-, five-, and 10-year time of (groundwater) travel zones. Water supply protection plans can only be enforced through coordination with municipalities with land use authority (eg: cities).

The plan identifies stormwater flows from the north (not Madrona School) that should be prevented from flowing into the protection area; however, it does not recommend a general prohibition of stormwater infiltration. It recommends "adequate storm drainage

facilities" within the one-year time-of-travel zone and does not address stormwater management in the five- and 10-year time of travel zones (the Madrona school is between the five- and 10-year time-of-travel isochrons). The proposed Madrona school UIC wells appear to be consistent with measures in the OVWSD plan pertaining to siting of stormwater features.

The Protection Plan also recommends several risk reduction measures including involvement of Olympic View Water and Sewer District in land use permitting (which would include stormwater management plans). It requested that the City of Edmonds, Town of Woodway, and Snohomish County maintain a wellhead protection map overlay that would presumably be used in land use planning. PGG did not investigate whether this recommendation was implemented by municipalities with land use authority (City of Edmonds in this case) – we understand that OVWSD was not notified by City of Edmonds regarding proposed use of UICs, but that ESD contacted OVWSD as soon as ESD learned of OVWSD's concern.

2.2.4 Critical Aquifer Recharge Areas (CARAs)

The City of Edmonds Code states "no areas meeting criteria for CARAs exist in the vicinity of the city of Edmonds. Thus, additional specific provisions for protection of this critical area type are not provided within this title" (Edmonds City Code Ch. 23.60). The proposed Madrona school UIC wells therefore do not violate the applicable CARA regulation.

Additional discussion on the CARA topic is provided below for context and consideration during future revision of the regulation:

The City code does not cite a technical basis for their opinion that no areas meeting criteria for CARA exist in the vicinity; however, maps published in a 1997 USGS report are the likely basis.

PGG's opinion is that the City code errs in indicating that no areas meeting criteria for CARA exist in the vicinity. The method used by the USGS to assess sensitivity assigns most of the Qva outcrop area in Edmonds as "low sensitivity", which is not true for the Qva outcrop area near the Deer Creek water source. PGG recommends that the City's CARA regulation be reviewed, and possibly amended, to consider the OVWSD water source protection plan.

2.3 ADEQUACY OF GROUNDWATER MONITORING PLAN

The Department of Ecology Guidance for UIC Wells that Manage Stormwater (Ecology 2006) does not require monitoring of groundwater for UIC stormwater wells. However, Shannon and Wilson (2018) identified three Site Suitability Criteria from the Stormwater Management manual for Western Washington that refer to the need to evaluate whether the Project has caused a violation of Ecology's Groundwater Quality Standards. The DOH Discussion Paper (DOH, 2015) also mentions requiring site specific monitoring of

UICs near vulnerable water supply wells. Shannon and Wilson prepared a monitoring plan (Shannon and Wilson 2018) which has subsequently been reviewed by Ecology and amended. Individual aspects of the plan are reviewed below.

2.3.1 Groundwater Level Monitoring

Two locations are proposed for groundwater elevation monitoring: OW-3 and OW-4. The purpose of the proposed groundwater monitoring is to confirm separation between the UICs and water table. The proposed monitoring is sufficient for this purpose.

The location of the down gradient monitoring well is based on the current water table configuration. However, it is not known whether groundwater flow directions change seasonally. A minimum of three monitoring points is required to evaluate groundwater flow directions. Therefore, PGG recommends monitoring groundwater elevations in a third well for one year after groundwater injection begins to evaluate Project and seasonal groundwater flow directions.

2.3.2 Water Quality Locations

The groundwater monitoring system includes two monitoring wells: OW-3 and OW-4. Monitoring well OW-3 is downgradient of the site; OW-4 is the upgradient monitoring well. Given the measured groundwater flow direction in Mahlum 2018, OW-3 is directly downgradient of infiltration wells SW#200 – SW#204, which infiltrate treated water from the parking lot. Water from the parking lot is more likely to contain contaminants than water from other basins and therefore monitoring downgradient from where it is injected is logical. As long as OW-3 is down gradient of infiltration wells SW#200 – SW#204 consistently during operation of the UICs (see Groundwater Level Monitoring section above), the location proposed is appropriate. If there is significant change in the ground-water flow direction, the downgradient monitoring location should be re-evaluated.

2.3.3 Duration of Monitoring

Ecology (Ecology 2017) initially requested the Project collect samples for four quarters and then annually once the drywells are online. This was later expanded to the current monitoring system which includes two years of quarterly sampling followed by three years of annual sampling, for a total of five years (Shannon & Wilson. Feb 20, 2018).

The distance from the downgradient observation well (OW-3) to the nearest upgradient injection points (SW #200 – SW #204) is approximately 500 feet. Shannon and Wilson (2016) report an aquifer gradient of 0.008 and a hydraulic conductivity of 55 feet/day (S&W, 2016). Assuming a porosity of 0.2, the groundwater travel time from the closest infiltration to the observation well is estimated at 600 days, or almost two years. That is likely a sufficient length of time to capture effects of routine operations. The system de-sign and monitoring plan are also likely sufficient to detect effects from parking lot spills that occur during that period. If a spill occurs after the monitoring period expires, PGG recommends reinitiating the monitoring program. The design includes flow through an oil/water separator and filtration by soil media that will retain and retard most pollutants.

The retardation and retainage should reduce or eliminate pollutants from entering the UIC wells and will spread-out water quality effects in the aquifer over time.

2.3.4 Analytes Selected

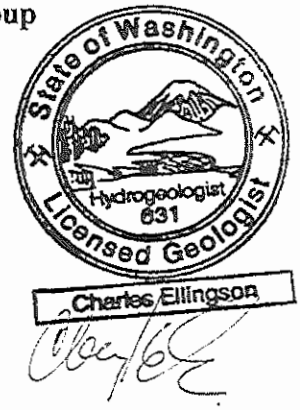
The analyte set was first proposed by Shannon and Wilson in the Draft Groundwater Monitoring Plan dated April 19, 2017. The plan was developed to fulfil requirements of the Stormwater Management Manual for Western Washington (Ecology, 2005). OVWSD reportedly expressed concerns regarding inconsistencies between analytes required for Ecology and DOH regulations. ESD responded by proposing a hybrid analyte list. Further analytes were added after review by the Department of Ecology.

Potential contaminants from the site include oil and gasoline components from the parking lot and fertilizers and herbicides from landscaping activities. The proposed analyte list includes constituents appropriate for monitoring these uses including nitrate, herbicides, and hydrocarbon components, among other constituents. Therefore, the analyte list proposed adequately addresses potential contamination.

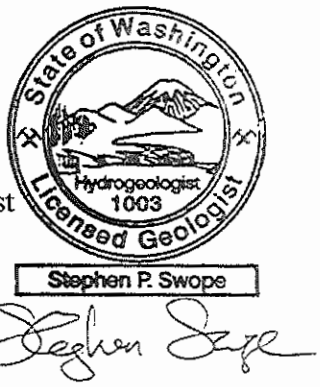
Sincerely,

Pacific Groundwater Group

Charles "Pony" Ellingson
Principal Hydrogeologist



Stephen Swope
Principal Hydrogeologist



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