2008 Annual Water Quality Monitoring Report

Spokane Valley-Rathdrum Prairie Aquifer Long Term Monitoring Program

Prepared by:

Spokane County Water Resources

Division of Utilities

1026 West Broadway Avenue

Spokane, Washington 99260

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Introduction

The following report presents the field work, analytical results and findings from the 2008 Spokane Valley Rathdrum Prairie (SVRP) Aquifer Long Term Water Quality Monitoring Program. Spokane County Water Resources staff collected field data and groundwater samples on a quarterly and monthly basis during 2008 from 29 dedicated monitoring wells, 17 public supply wells, and 4 springs.

1.1 Background

In 1978 the Environmental Protection Agency (EPA) designated the SVRP Aquifer as a "Sole Source Aquifer" under Section 1424(e) of the Safe Drinking Water Act. From May 1977 to June 1978 the Spokane County Water Quality Management Program conducted a one year study of the aquifer to determine if surface "recharge" is occurring to carry ground surface pollutants to the aquifer, and if so, the effect of such activities. The study concluded that domestic, municipal, commercial, agricultural, and industrial activities do impact aquifer water quality.

The 1978 Spokane Aquifer Cause and Effect Report determined that on-site sewage systems contribute to water quality degradation in the SVRP aquifer. As a result the 1979 Spokane Aquifer Water Quality Management Plan included the following:

> *The recommendations for handling sanitary wastewater and mitigation of its pollution to the groundwater include the collection of all sewage from urbanized areas and treatment for discharge in such manner that the pollutants cannot enter the aquifer. Central sewer planning within the aquifer sensitive area should result in sewering of areas that have been urbanized or are to be urbanized.*

The 1983 update to the Spokane Aquifer Cause and Effect Report found that there was an increasing trend in nitrate concentrations in the aquifer confirming the need to address on-site sewage disposal.

Spokane County Utilities began implementation of the Septic Tank Elimination Program (STEP) to address concerns that onsite sewage systems contribute to water quality degradation in the aquifer. To date, a significant portion of existing septic systems have been converted to sewer and it is anticipated that STEP will be completed by 2012.

As a result of the study findings the *Spokane Aquifer Water Quality Management Plan* was developed. One recommendation of the plan was to develop and implement a long term ground water quality monitoring program to assess the effectiveness of STEP. From 1980 to 2000 the Spokane Regional Health District (SRHD) conducted the aquifer monitoring program and in 2000 the Spokane County Water Resources section of the Division of Utilities (formerly the Spokane Water Quality Management Program) undertook the aquifer monitoring program.

The original study included 80 sample locations. Sixty locations were existing water supply wells, both water purveyor and private wells, and 20 locations were dedicated monitoring wells. From 1980 to 1996 all sampling locations were water supply wells. In 1996 dedicated monitoring wells were added to the monitoring network. In 2007 4 spring/seep sampling locations were added. Currently the monitoring network is comprised of 29 dedicated monitoring wells, 17 public supply wells and 4 spring locations. Figure 1 shows the current sampling locations.

1.2 Program Objectives

The SVRP long term monitoring program has three objectives: 1) Asses the current aquifer water quality; 2) Identify spatial and temporal water quality trends; and 3) Evaluate water quality trends that are related to the Spokane County Septic Tank Elimination Program.

2 Study Area Description and Hydrogeological Setting

2.1 Aquifer Hydrogeology

The SVRP aquifer underlies about 370 square miles of relatively flat, alluvial valley surrounded by bedrock highlands (Kahle and others, 2005). The aquifer consists primarily of coarse-grained sediments including sand, gravels, cobbles, and boulders. There is generally a greater percentage of finer material near the margins of the valley and becomes more coarse near the center throughout the Rathdrum Prairie and Spokane Valley. In the northwest portion of the aquifer, often referred to as the Hillyard Trough, the deposits are finer grained and the aquifer consists of sand with some gravel, silt, and boulders. The aquifer is highly productive. Aquifer wells yield as much as several thousand gallons per minute with relatively little drawdown. The hydraulic conductivity of the aquifer sediments is at the upper end of values measured in the natural environment (Kahle and others, 2005)

2.2 Spokane River/SVRP Aquifer Interaction

The Spokane River is the largest source of recharge to the aquifer and receives the largest amount of discharge from the aquifer. A groundwater budget for the SVRP Aquifer developed by the USGS in 2007 estimates the Spokane River discharges 718 ft^3/s to the aquifer, representing 49 percent of the total mean annual aquifer inflow of 1,417ft^3/s. The Spokane River receives an estimated 861 ft^3/s from the aquifer representing 59 percent of the total mean annual outflow of 1,468 ft^3/s. There are two distinct river reaches where the Spokane River receives water from the aquifer: 1) Flora Road to Upriver Dam; and 2) The Spokane Gage to Nine Mile Dam. These reaches are considered gaining reaches. There are also two distinct river reaches were the Spokane River discharges to the aquifer: 1) Coeur d'Alene Lake to Flora Road; and 2) Green Street to Monroe Street. These reaches are considered losing reaches. Aquifer water quality in the immediate vicinity of the river in the losing reaches is influenced by river water quality.

2.3 Monitoring Network

The current monitoring network is spatially distributed to provide information on water quality throughout the aquifer. In addition to assessing general water quality, the monitoring network provides data for specific objectives. Four monitoring locations are at the Washington/Idaho border and provide a baseline to which water quality data from down gradient wells can be compared. At Barker Road there are four monitoring locations that provide data to evaluate the water quality in the vicinity of a losing reach of the Spokane River. At Sullivan Road there are three monitoring locations that provide data to evaluate water quality in the vicinity of a gaining reach of the Spokane River.

Samples from the dedicated monitoring wells are taken from 1 to 1.5 feet below the static water level, or water table, and therefore provide data on water quality at the surface of the aquifer. The rational for this approach is that impacts to the aquifer will occur first at the surface. There are two locations that have "nested wells" that provide data at the same location but different depths. Many of the water supply wells also withdraw water from greater depth than the dedicated monitoring wells.

In 2007 four spring locations were added to the monitoring network. Three locations are sampled quarterly, and one location (Sullivan Springs) is sampled when the river elevation allows sample collection, usually during the summer. These locations provide additional water quality information on aquifer water that enters surface water bodies, both the Spokane and Little Spokane Rivers.

3 Summary of Field Activities

3.1 Monitoring Events

Two separate monitoring programs were implemented in 2008, a quarterly program and a monthly program. The quarterly program included all wells and all analytes included in the SVRP Long Term Monitoring Program, while the monthly program focused on select wells and two analytes, total phosphorus, and orthophosphate.

The quarterly program included groundwater elevation measurement, field parameter measurement and sample collection at all monitoring locations identified in Appendix A and laboratory analysis of analytes included in Appendix B. Quarterly monitoring events in 2008 occurred during the last two weeks of January, the second week of May, the second week of August, and the First week of November.

The monthly sampling program began in April 2008 and included collection of samples at the following locations:

1. 6631M07 Idaho Road - East Farms monitoring well at CID11
2. 5411R03 Sullivan Park South, monitoring well
3. 5311J05 Hale's Ale Nested Site, east
4. 5310Q01 monitoring well at SCC
5. 5212F01S Three Springs
6. 6211J01S Spokane Fish Hatchery, Griffith Spring
7. 6306P01S Waikiki Springs

Monthly sampling events were scheduled to occur on the second Tuesday of each month to coincide with Department of Ecology sample collection from the Spokane River.

3.2 Field Methods

Dedicated monitoring wells were sampled in the following manner. The depth to groundwater in the well was measured and recorded on field sheets. The pump intake was positioned at the top of the screened interval. If the water level was below the top of the screened interval the pump was set 1 to 1.5 feet below the water table surface. Appendix A shows the monitoring well construction details used to set the pump depth. The monitoring wells were purged utilizing low flow sampling techniques according to EPA guidelines. Those techniques are described in the *Spokane County Water Resources Long Term Monitoring Program Quality Assurance Project Plan* (QAPP), August 2007. Water supply wells used for groundwater monitoring are run a minimum of five minutes before the sample is collected to obtain a representative sample. Groundwater samples are collected from spigots on the purveyor well discharge lines as close to the pump as possible. The field parameters depth-to-water, temperature, pH, and specific conductance are recorded on field sheets. Groundwater samples are delivered to the laboratory under Chain-of-Custody procedures. Copies of the Chain-of-Custody forms are available on request.

4 Program Results

Quarterly analytical and field results are presented in Appendix B. Monthly total phosphorus and orthophosphate results are presented in Appendix C

4.1 Data Quality

Analytical services were provided by SVL Analytical in Kellog, ID and Aquatic Research in Seattle, WA. Analytical results were validated to ensure data quality objectives - including precision, accuracy, representativeness, and completeness - outlined in the QAPP were met. Data anomalies that have a small impact on data quality and usability are documented in Appendix D.

One major data anomaly occurred in 2008. Total phosphorus and orthophosphate results provided by SVL Analytical for the first quarter were all rejected. Significant issues with the results were identified including:

- Two separate sample delivery groups had several results (3 of 8 and 7 of 8) of orthophosphate greater than total phosphorus.
- Two samples that were analyzed twice yielded relative percent difference in excess of 100 percent.
- It was determined that the calibration curve utilized for the spectrophotometer was 2-200 ug/L instead of the appropriate curve for low level phosphorus, 2-50 ug/L.

Following the first quarter Spokane County staff worked with SVL Analytical staff to resolve these issues. Data provided during the remainder of 2008 met data quality requirements. In addition to working with SVL Analytical to resolve the identified issues, beginning in April 2008 duplicate samples were sent to Aquatic Research for total phosphorus and orthophosphate analysis.

Total phosphorus and orthophosphate results reported in Appendix B are the results provided by Aquatic Research. Aquatic Research achieves lower detection limits for both total phosphorus and orthophosphate than SVL Analytical. Since the total phosphorus and orthophosphate results typically found in the samples collected for this monitoring program are near detection limits the Aquatic Research data provides more results that are above the detection limit and therefore provide more value in data analysis.

4.2 Aquifer Water Levels

Table 4-1 presents a comparison of static water levels measured in dedicated monitoring wells with historical averages. The majority of wells have a period of record extending back to 1999. The difference between the historical average and the value measured in 2008 was compared on an annual and quarterly basis. Historical data for the quarterly comparison was computed for the respective quarter, i.e. 1^{st} quarter 2008 was compared to historical 1^{st}

quarter data. Negative values indicate static water levels below the average level. On an annual basis the static water levels in a majority of the wells was above average. Quarterly results indicate that during the first quarter the average static water level was below average but above average the rest of the year. This correlates to the Spokane River flows during 2008.

Table 4-1: Static Water Level Comparison - 2007 vs. Historical Average

	annual	1st qtr	2nd qtr	3rd qtr	4th qtr
Average difference (ft)	0.35	-1.51	0.88	1.19	0.91
Standard Deviation (ft)	1.39	0.94	0.82	0.84	0.84
Maximum above average (ft)	3.1	0.38	3.07	2.81	3.1
Maximum below average (ft)	-3.5	-3.5	-0.74	-1.06	-0.21
Number of wells below average	35	28	3	2	2
Number of wells above average	78	1	26	26	25

4.3 Water Quality Standards

The following section identifies analytical results that exceed either the Primary Maximum Contaminant Levels (MCL) or Secondary drinking water standards as defined by the EPA (40 CFR Chapter 1 Part 141) and State of Washington (WAC 246-290-310). In regulation these standards apply to source sampling performed by public water purveyors as prescribed in State of Washington Drinking Water regulations. These standards provide a basis for comparison for the Long Term Monitoring Program results, but exceedance of the standards is not a basis for regulatory action.

Primary MCLs are standards set for the protection of human health. During 2008 there were no exceedances of the Primary MCLs. Secondary Drinking Water Regulations (secondary standards) are non-enforceable guidelines regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. EPA recommends secondary standards to water systems but does not require systems to comply. The State of Washington has also identified “trigger levels” for some contaminants. Trigger levels are analyte concentrations that trigger additional sampling requirements for public water purveyors. Four analytes were found in excess of the trigger level or secondary standard during 2007: 1) Iron; 2) Arsenic; 3) Manganese; and 4) Nitrate/Nitrite.

4.3.1 Iron

Iron is not a health hazard in drinking water and therefore no iron primary MCL is established. Iron is an aesthetic contaminant and has a secondary water quality standard. Dissolved iron gives water a disagreeable taste. When the iron combines with tea, coffee and other beverages, it produces an inky, black appearance and a harsh, unacceptable taste. Vegetables cooked in water containing excessive iron turn dark and look unappealing. Concentrations of iron as low as 0.3 mg/l will leave reddish brown stains on fixtures, tableware and laundry that are very hard to remove. When these deposits break loose from water piping, rusty water will flow through the faucet.

The secondary standard (0.3 mg/l) was exceeded at 3 wells at least one time during 2008, and the trigger level (0.1 mg/l) was exceeded at 2 additional wells at least one time during 2008. Detailed information for each of the 5 wells, including a chart of historic data, summary statistics, and trend analysis, are provided in Appendix F. Well locations and 2007 results are presented in Figure 3.

4.3.2 Arsenic

Arsenic in drinking water is a health hazard. It has a primary MCL of 0.010 mg/l and a trigger level of 0.005 mg/l. It enters drinking water supplies from natural deposits in the earth or from agricultural and industrial practices.

The arsenic primary MCL was not exceeded at any well during 2008. The trigger level was exceeded at 10 wells at least once during 2008. Five of the wells have an overall average concentration that exceeds the trigger level and five have an overall average concentration that is below the trigger level. No wells have a statistically significant increasing trend and three have a statistically significant downward trend. Detailed information for each of the ten wells, including a chart of historic data, summary statistics, and trend analysis, are provided in Appendix E. Well locations and 2008 results are presented in Figure 2.

4.3.3 Manganese

Manganese is not a health hazard in drinking water and therefore no manganese primary MCL is established. The secondary drinking water standard for manganese is 0.05 mg/l. At this level and above, water may be cloudy, form black precipitates, contribute to mineral depositing in pipes or cause difficulty in sudsing and darkening of clothing during washing.

Manganese concentrations exceeded the secondary standard in one well, (5404A01 – Plantes Ferry Park monitoring well) during 2008. This well was recently installed and has been monitored only ten times since 2006. Iron concentrations in this well were an order of magnitude greater than all other wells sampled in 2008. This well is located on the margin of the aquifer and the well log indicates that the geology in the vicinity is quite different than all other wells in the monitoring network.

4.3.4 Nitrate

Nitrate is a health hazard in drinking water. It has a primary MCL of 10 mg/l and a trigger level of 5 mg/l. Nitrate is especially harmful to infants, who consume a large quantity of water relative to their body weight. Nitrate concentrations above the MCL can lead to methemoglobinemia, a condition that reduces the oxygen carrying capacity of blood.

Nitrate concentrations exceeded the trigger level in one well (6436N01 – East Valley High School monitoring well) during 2008. The mean nitrate concentration at this well is 6.33 mg/L, with no apparent trend, though the well has only been sampled ten times since its installation in 2006. Detailed information for the well, including a chart of historic data, summary statistics, and trend analysis, are provided in Appendix G.

4.4 Nitrate Trend Analysis

The largest anthropogenic sources of nitrate in groundwater are septic tanks, application of nitrogen-rich fertilizers to turfgrass, and agricultural processes. To assess the effectiveness of STEP, introduced in section 1.1, a trend analysis was conducted on wells currently in the Long Term Monitoring Program. Some wells have a longer period of record than others, but taken as a whole, the analysis provides indication of overall nitrate trends.

The Mann-Kendall trend test was utilized to determine if a statistically significant trend was present at each well. The Mann-Kendall test was chosen because it does not assume a data distribution (non parametric), allows for missing data, allows for non-detect data, and is not affected by gross data errors and outliers. If a trend was detected the Sen's slope estimation method was utilized to determine the magnitude of the trend. The Table 4-2 and Figure 5 presents the results of the trend analysis. A detailed summary of the trend test results is provided in Appendix H.

Table 4-2: Nitrate Trend Analysis Results

Station ID	Sen's Test			Mann-Kendall Test		
	increasing	decreasing	no trend	increasing	decreasing	no trend
5213B01		-0.0021			x	
5304G01			x			x
5307M01		-0.0078			x	
5308A02		-0.0052			x	
5308H01		-0.0056			x	
5310Q01			x			x
5311J05		-0.0028			x	
5311J07		-0.0025			x	
5312C01			x			x
5312H01	0.0071			x		
5315L01		-0.0156			x	
5322A01		-0.0175			x	
5322A03		-0.0194			x	
5322F01		-0.0081			x	
5323E01		-0.04			x	
5324G01		-0.005			x	
5404A01			x			x
5405K01			x			x
5407C01	0.0296			x		
5408N01		-0.0069			x	
5409C02			x			x
5411R02		-0.0055			x	
5411R03		-0.0051			x	
5411R04			x			x
5415E03			x			x
5426L01			x			x
5427L01		-0.0135			x	
5505D01	0.0073		x	x		
5507A04		-0.0027			x	
5507H01			x			x
5508M01			x			x
5508M02			x			x
5515C01		-0.0092			x	
5517D05		-0.0052			x	
5518R01		-0.0115			x	
6211K01		-0.0059			x	
6320D01			x			x
6327N04		-0.0178			x	
6328H01			x			x
6330J01		-0.0083			x	
6331J01		-0.0069			x	
6436N01			x			x
6524R01			x			x
6525R01		-0.0054			x	
6631M04			x			x
6631M07			x			x

Trend analysis was conducted on 46 wells. Twenty five wells show a decreasing trend in nitrate concentrations, 3 wells show an increasing trend in nitrate concentrations, and 18 show no significant trend. In general, nitrate concentrations in the aquifer show a decreasing trend. With some exceptions, the decreasing trend is more pronounced in the central portion of the aquifer. Wells showing no significant trend are generally located on the aquifer margins with the following notable exceptions.

- Wells 5508M01, 5508M02, and 5507H01, which are in close proximity to a losing reach of the Spokane River near Barker Road, do not show a trend. Nitrate concentrations at these wells demonstrate a stronger correlation with river nitrate concentrations than nitrate concentrations throughout the aquifer.
- Well 5411R04 does not show a trend. Like the wells discussed above it is also in close proximity to the river near the south side of the Sullivan Road bridge. This reach, though, is considered a gaining reach and wells on the north side of the river (5411R02 and 5411R03) do show a decreasing trend. While it is generally considered a gaining reach, river and groundwater elevation data indicate that during spring high flows the reach gains from the north side and loses from the south side. This periodic river influence makes trend determination difficult
- Well 5415E03 is centrally located in the aquifer, though it does not show a trend. This is most likely the result of the short period of record for this well. Data for this well only exists for 2006, 2007 and 2008.
- Wells 6328H01 and 6327N04 are located near each other, though one shows a decreasing trend and one does not show a trend. This is most likely the result of the differing sampling depth. Well 6327N04 is a dedicated monitoring well and sampling occurs at the surface of the aquifer water table while well 6328H01 is a water supply well and samples are taken at greater depth. Since anthropogenic water quality impacts usually occur at the top of the water table decreasing trends are more apparent in dedicated monitoring wells.