2022
Water Quality Analysis

prepared for the

Scott Lake Maintenance Company

Water Committee

by

Northwest Water Systems, Inc.

Planning • Management • Engineering

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1.0 System Description
This report has been prepared by Northwest Water Systems for the purpose of providing analysis and recommendations for water quality improvement for the Scott Lake Water System (WSID 767876).

The Scott Lake Water System is a Group A public water system in Thurston County serving the Scott Lake Community. The system currently has 600 total service connections and is approved for 663 connections. There are 6 non-residential connections and 594 residential connections. Water is supplied from a groundwater well (S02) and a wellfield (S06) comprised of three wells (S03, S04, S05). Raw water from well S02 is chlorinated due to hydraulic connectivity with the lake. All wells are pumped in parallel to send water through a corrosion control treatment facility then uphill to an 80,000-gallon concrete storage reservoir. The concrete reservoir provides gravity fed distribution to lower elevation connections known as Zone 1. A lift station at the concrete reservoir sends water further uphill to a 60,000-gallon steel reservoir. The steel reservoir provides gravity pressure for middle elevation connections in Zone 2 and a booster station at the steel reservoir provides pressure to higher elevation connections in Zone 3.

2.0 Background and Description of Problem
Customer complaints of dirty water have been received, most often originating in Zone 1 residences connected to older distribution mains at lower elevation. Dark sediment has been observed in the bottom of toilet tanks. Another primary description of poor water quality includes an orange or gray tint when collected in a clear bottle.

3.0 Water Quality Analysis
The source water from well S02 and the wellfield (S06) was analyzed for a range of parameters.

Table 1: Water Sample Results

Source	Well 2	Well 4	Well 6	Wellfield[1]	Pre-Calcite Tanks	Post Calcite Tanks	Distribution (fire house)	Distribution (11547 Entrée View)
Date	5/24/22	7/12/22	7/12/22	5/24/22	7/12/22	5/24/22	5/24/22	7/12/22
pH	7.1		7.2			7.3	7.0	
HPC (cfu/100mL)	0			1400			0	
Alkalinity (mg/L)	44.3	25.9	34.8	35	35.8	70		
Calcium (mg/L)	34	26	31	32	28	70		
Conductivity (umhos/cm)	127.1			121.1		182		
Hardness (mg/L)	52	38	46	54	45	82		
Manganese (mg/L)	ND	ND	ND	0.073	0.022	0.125	0.037	0.317
Iron (mg/L)	ND	0.17	ND	21.3	0.13	0.64	0.29	1.76

Source	Well 2	Well 4	Well 6	Wellfield[1]	Pre-Calcite Tanks	Post Calcite Tanks	Distribution (fire house)	Distribution (11547 Entrée View)
TDS (mg/L)	51.3	100	107	78	104	129		
TOC (mg/L)	0.46			0.44				
Ortho PO4 (mg/L)	0.04	0.034	0.034	0.148	0.036		0.05	
Ammonia (mg/L)	ND	ND	ND	ND	ND			
Silica (mg/L)	29	27	30.1	33	29		28.2	
Tannin (mg/L)				ND			ND	

[1]The wellfield sample on 5/24/22 was taken downstream of wellhead 6 check valve with well pumps off. Water was discolored even after flushing several minutes prior to collection. Since well pumps were off, this was a backflow condition which was flushing accumulated/concentrated iron sediment in the wellfield pipe out through the hose bib, which is the reason for the excessively high iron result of 21.3 mg/L.

Fortunately, the majority of parameters investigated, which commonly cause water quality problems do not appear to pose significant challenges.

Scott Lake's primary water quality challenge appears to be naturally occurring iron and manganese, which are present in the source water in a dissolved state, which become oxidized and form a precipitate (sediment) in the reservoir and pipes. This sediment makes its way into individual homes where it can cause staining, plug screens, and overall cause a nuisance. Sediment buildup in the bottom of the pipes and reservoir can also cause an anaerobic zone, which is associated with a degradation in the taste and odor of the water.

The orange, brown, and gray sediment and staining are associated with iron and manganese. The more orangey (even red), the more iron is associated with the problem. The more grey (or even black), the more manganese. Iron and manganese will oxidize and precipitate out of solution at different rates, which is why there are some areas where iron appears to be worse, and other areas where manganese appears to be worse.

Occasional additional complaints associated with brighter red/pink stains are likely associated with microbial grow (most likely pseudomonas sp). These most often occur in showers, the backs of toilets, and other areas that are regularly damp or wet for long periods of time. This water quality parameter does not appear to be endemic throughout the water system and is likely associated with the "natural" bacterial populations that exist in each household.

Another complaint or concern was associated with white staining. White staining is usually a mineral deposit. If it can be removed by scrubbing it with vinegar, it is a water hardness deposit. If not, it is likely a silica deposit. Silica deposits can be removed with a product called A-MAZ. If the spots are not removed by vinegar, and are removed with A-MAZ, then the deposits are almost certainly silica. As with the red/pink stains, this problem does not appear to be throughout the water system. The water system does have moderate levels of silica. One would not expect silica spots to occur, but they could be problematic in areas where water regularly accumulates and then evaporates. Once deposits are removed, drying, or squeegeeing surfaces will help prevent mineral build-up.

4.0 Analysis of Alternatives

Three general alternatives exist for improving water quality:

1. Find a new water source
2. Treatment
3. Flushing

4.1 Find a new source of water

Finding a new source of water is not a viable alternative. The primary different source of water would be to drill a deeper well. On average, deeper wells tend to have more dissolved minerals. Therefore, one would expect that a deep well could yield worse water quality than the current wells exhibit.

4.2 Treatment for Removal of Iron and Manganese

There are three primary treatment strategies for the removal of iron and manganese:

1. Sequestration
2. Ion Exchange
3. Oxidation FIltration

4.2.1 Sequestration

The first method, sequestration, does not actually remove iron and manganese, but rather mitigates the effects of those metals. Sequestration uses a polyphosphate molecule to sequester, or "hug" the iron and manganese. This keeps the iron and manganese in suspension and keeps them stable in solution rather than allowing them to oxidize and form sediment or stains. While sequestration is the least expensive treatment alternative ($5,000 engineering, $8,000 installation), it is also the least reliable. As the water works its way through the system and gets "older", the polyphosphate molecules can start to break down, resulting in less effective treatment. Homeowners who go on vacation, or do not use a guest bathroom down the hall, often find brown water as it sits in the pipes and the polyphosphates break down and are no longer able to sequester the iron and manganese. The use of sequestration would certainly make the water quality significantly better, as well as reduce the frequency of flushing needed; however, it would not result in "perfect" water.

4.2.2 Ion Exchange

Ion exchange works by running water through a specialized media where iron, manganese, and other cations are "exchanged" for sodium ions. This technology is commonly referred to as a water softener. This approach is very effective in the removal of small amounts of iron and manganese; however, it also requires the consumption of significant amounts of salt to provide the sodium ions to exchange with the iron, manganese, and other cations. Scott Lake also provides corrosion control mitigation where water is run through a calcite filter to increase the amount of calcium in the water to reduce the corrosivity of the source water. Ion exchange treatment would remove natural calcium from the water along with removing iron and manganese, counteracting the beneficial features of the calcite filters. Therefore, Ion Exchange is not considered a viable alternative for the Scott Lake Water System.

4.2.3 Oxidation Filtration

Oxidation-Filtration is a treatment technology whereby the dissolved iron and manganese in the source water are first oxidized with air, chlorine, or another oxidant. This turns the dissolved iron and manganese into solid particles that can be filtered out of the water. While this is the most expensive of the viable treatment options, it is also the most flexible option. The water has low pH, low phosphates, and just moderate silica. These are all parameters that, if elevated, can inhibit oxidation-filtration treatment. Therefore, it is anticipated that oxidation-filtration should work very well, and that high flow rates should be able to be achieved through the filters. We would anticipate that engineering for an oxidation-filtration plant would cost approximately $30,000. Installation would cost approximately $1,500 per gpm of treatment capacity.

We would recommend not treating at your full source capacity since you have redundant capacity and never need the full flow. In addition, typically, water systems only need a peak flow a couple days a year, and most of the year could operate at 75% or less of their peak need. Therefore, a treatment plant could be sized to handle the need 90% of the time, and allow a little untreated water to bypass the treatment plant the other 10% of the time. More capacity could always be added in the future, if desired. This could cut the cost of your treatment plant by as much as half. A capacity analysis would be required to provide these options, treatment plant sizes, and cost estimates. Nevertheless, we can reasonably assume that a treatment plant able to meet the needs of the Scott Lake water system would cost in the neighborhood of $250,000.

4.2.4 Treatment Recommendations

If the community wants the highest quality water, oxidation-filtration is the only reasonable option. Northwest Water Systems recommends; however, that the community start with an aggressive flushing program. Regularly and thoroughly flushing the distribution system will significantly improve water quality. From there, the community will have a more accurate water quality baseline. Once this baseline water quality is experienced by the community, the cost of iron and manganese treatment can be balanced with the cost associated with that treatment, minus the cost savings associated with reduced flushing and reduced reservoir cleaning once treatment is installed.

4.3 Flushing

Regular distribution main flushing for removal of settled iron and manganese can be implemented immediately and have significant positive results. It does not require regulatory agency approval, major capital expenses, or significant changes to the water system. However, effective flushing of the Scott Lake system has significant challenges due to complex system layout. Flushing requires high flow velocities for a duration sufficient to remove sediment. Unidirectional flushing, where water is flowing only one direction, is preferred. Unidirectional flushing is achieved by isolating a specific pipe section by opening or closing valves and water is directed through to the end of that section by opening a blowoff. This approach minimizes migration of sediment to other portions of the system and maximizes flow velocity in the section targeted for flushing.

Communication with residents prior to flushing is extremely important. Residents should be notified to expect temporary periods of reduced water pressure and possibly find sediment in water. The initial flushing events will likely generate a increased customer complaints as the procedure is worked out and years of accumulated sediment is disturbed.

A written flushing plan should be used as guidance, and that plan should be actively managed and revised based on what is found to most effectively generate high velocity unidirectional flow in the field. Flushing should be performed by very methodical personnel who are thoroughly trained, able to troubleshoot, and will keep good records. A “simple” flushing philosophy approach, manipulating valves without critically thinking how to achieve the maximum flushing velocity through individual sections, will result in wasted funds and no improvements. Hiring a water system professional with understanding of the overall purpose for flushing who is motivated to improve water quality in the community is highly recommended.

There are 30 existing blowoffs and 4 meter stops which could be used for flushing which are listed in Table 2. Replacement of the meter stops with 2” blowoffs is recommended, as noted in Table 2. Based on input from repair contractor, KCL Excavating, Inc., only six blowoffs are known to be in good working condition. Remaining blowoffs are in unknown condition should be evaluated and repaired as necessary to restore flushing capability. A typical repair is valve replacement at the blowoff. Additionally, as the system begins to replace sections of distribution main, new flushing stations should be added to the terminus of all dead-end lines which do not have blowoffs.

Table 2: Existing Blowoffs

Blowoff Location	Size	Working Condition
Rough Ct	1-1/2”	Unknown
Iron Ct	1-1/2”	Unknown
Lakeview Ct	1-1/2”	Unknown
Handicap Ct	1-1/2”	Unknown
Fairway Dr SW & 123rd Ave SW	2”	Good
Champion Dr & Green Ct	1-1/2”	Unknown
Green Ct Lot 54	2”	Good
Link Ct	2”	Unknown
Wood Dr (in meter box)	2”	Unknown
Vantage Ave SW & Shoreview Dr SW	2”	Unknown
Vantage Ct	2”	Unknown
Vantage Ave SW and Driver St SW[1]	3/4”	Unknown
Wellfield Scott Creek Dr SW	2”	Good
118th Ct[1]	3/4”	Unknown
119th Ct[1]	3/4”	Unknown
Blooms Ct[1]	3/4”	Unknown
Scott Creek Dr Lot 17	1-1/2”	Unknown
Scott Creek Dr & 118th Ct SW	2”	Unknown
Scott Creek Loop Golf Course Maint. Shop (in traffic box)	2”	Unknown
Scott Creek Loop Lot 16	2”	Unknown
Scott Creek Loop Lot 1	2”	Unknown
Scotlac Ct	2”	Unknown
Scotlac Dr SW Lot 58 (footbridge)	2”	Unknown
Scotlac Dr SW Lot 28	2”	Unknown
Scotlac Dr SW & Driver St	2”	Unknown
Scotlac Dr SW Lot 37	2”	Unknown
Trevue Ave SW & Entrée View Dr SW	2”	Unknown
Case Ext SW Lot 1 (in traffic box)	2”	Unknown
Bonavista Dr SW Lot 24	1-1/2”	Unknown
Bonavista Ct Lot 9 (in meter box)	1”	Unknown
Trevue Ave SW & Scott Creek Dr SW (by irrigation well in traffic box)	2”	Good
Trevue Ave SW & 114th Way SW	2”	Good
114th Ave SW Lot 21 (in traffic box)	2”	Good
Scott Creek Dr & 113th Way SW Lot 45	1-1/2”	Unknown
[1]Replacing 3/4" meter stops with 2” blowoffs is recommended at these four locations: Driver St., 118th Ct., 119th Ct., Blooms Ct.,		

Effective flushing requires a methodical procedure to maximize contaminant removal and prevent contaminants from migrating to other system locations. A flushing procedure is enclosed. We recommend this procedure be implemented immediately as it will provide a good starting point for improving water quality and evaluating blowoff conditions. Flushing is recommended to be accomplished 4-6 times per year, at least. Initially, flushing will likely need to be more frequent since it is unlikely that all the sediment accumulated over several years will be removed in the first attempt. Careful notes should be taken during flushing. A flushing log form is enclosed and should be used during each flushing evolution to formally capture information which can be used to improve the procedure, report deficiencies, and estimate volume of flushing water consumed.

5.0 Summary

The primary factor causing poor water quality in the Scott Lake community appears to be iron and manganese sediment accumulating in pipes and migrating into homes. The recommended course of action for improvement is to implement regular system flushing. After regular flushing establishes a water quality baseline, complaints should be documented and investigated to ensure flushing is achieving the intended effect. As necessary, the flushing procedure should be updated to target specific distribution areas for improvement. As reserve funds allow, the board may wish to consider installation of an oxidation filtration treatment plant for removal of iron and manganese as a long-term solution.

6.0 Report Preparation

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