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Report of the Arsenic Pilot Study Conducted at SCWA's Madison Hill, Montauk, NY Plant.

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Study conducted by Hungerford & Terry, Inc. for Suffolk County Water Authority.
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Summary

Hungerford & Terry, Inc. conducted a pilot study at SCWA's Madison Hill plant, located on Madison Hill Road, Montauk, New York. The purpose of the study was to determine if the arsenic present in Wells 1, 2 and 3A could be reduced to non-detectable concentrations using the naturally occurring iron and a dual media, Greensand Plus and anthracite bed. It was desirable to reduce the arsenic to non-detectable concentrations without the use of ferric chloride, or other chemical(s) in addition to that already applied at the plant. SCWA provided laboratory analysis for iron, manganese, and arsenic with a 24-hour turn-around. The results indicate that the iron, manganese and arsenic in Wells 1 and 3A can be readily reduced to non-detectable concentrations without the need for additional chemical treatment. The results further indicate that the iron and manganese in Well 2 can be readily reduced to non-detectable concentrations. The arsenic in Well 2 was readily reduced to 1 – 1.3 µg/L, which is just above the detection limit. The addition of no more than 2 mg Fe/L further reduced the arsenic, in Well 2 to non-detectable concentrations.

Equipment Detail

The pilot unit was a 9.5" diameter fiberglass filter unit operated at a 2 gpm, or 4 gpm/ft^2 filtration rate. SCWA supplied chlorinated well water to the pilot unit using a ½" PVC pipeline equipped with a normally-closed-energized-to-open solenoid valve. The valve was energized when a well pump operated. The pilot unit operated only when the plant operated. The discharge hose of the pilot unit was routed above existing piping to prevent the pilot unit from draining when the well pump stopped. The existing piping had an elevation higher than the top of the pilot unit.

The plant operated intermittently as a function of the local demand. Several taps located within the plant were opened in an effort to maximize the well run time and to facilitate the study. The blowoff using interior taps was sent to a controlled drain. Using a local hydrant, or other means of blowoff would have taxed the plant too much and might have caused problems associated with freezing. Typically, the well would operate for approximately one (1) hour before shutting off for approximately 15 minutes. The blowoff's were closed during overnight hours at the request of SCWA, but the pilot unit was equipped to operate overnight, albeit for significantly less hours.

SCWA provided laboratory support with 24 hour turn-around on the iron, manganese and arsenic results. The results would dictate the course of the study. There were three (3) wells to study and the results would determine if additional study of any one well was required, and if so, under what conditions.

The soda ash feed at the Madison Hill plant was shut off for the duration of the study. The naturally occurring pH of all well sources was above 7.0 and, therefore, did not mandate pH adjustment. It was desired to eliminate the soda ash feed during this study so that the natural conditions could be studied and, because higher pH's can adversely effect arsenic treatment. However, the impact of pH adjustment was not studied during this period. It will not be known if the addition of soda ash upstream of the filter system will have an adverse effect on the treatment process. It might be necessary to adjust the pH after the filters if SCWA desires to continue applying soda ash.

Report

Treatment of Wells 1 and 3A

Wells 1 and 3A performed similarly in that the iron, manganese and arsenic were readily reduced to non-detectable concentrations using chlorine only. The treatment of these wells did not require the addition of any chemicals beyond that which was already being applied. The absence of soda ash did not hinder the process and because the natural pH was above 7, the full-scale system was not adversely impacted.

Treatment of Well 2

The treatment of Well 2 performed similarly to the treatment of Wells 1 and 3A in that the iron and manganese were readily reduced to non-detectable concentrations using chlorine as the only oxidant. The arsenic, however, was reduced to 1.1 - 1.3 µg/L. This is well within the regulatory limits for arsenic, but does not meet SCWA's objective of achieving non-detectable arsenic concentrations.

Iron was added to the process in an attempt to further reduce the arsenic concentration to below the 1.0 µg/L detection limit. Ferric chloride was used to provide the iron desired. The intent was to add 0.5 mg Fe/L and based upon those results, determine the appropriate course of action. The ferric chloride solution was incorrectly made-up for 0.5 mg Fe/L, and was actually made-up to deliver 1.0 mg Fe/L. Results with the 1 mg Fe/L iron addition indicate that there was no improvement in the arsenic reduction.

The iron dosage was effectively doubled to approximately 2 mg Fe/L on the last day of the study. The lab results indicate that the arsenic was effectively reduced to concentrations less than the detection limit with the application of 2 mg Fe/L. It can be readily concluded that non-detectable arsenic concentrations can be achieved when treating Well 2 using an iron dosage of no more than 2 mg Fe/L. The addition of iron will shorten the runlength accordingly, when treating this well compared to the absence of iron addition.

Filter Runlength

The runlength for Well 3A was determined to be approximately 8 hours operating at a filtration rate of 4 gpm/ft^2. The runlength for the other wells was not determined during this study, because Wells 1 and 2 were not studied long enough to incur an iron breakthrough, or significant headloss. The runlength for Well 3A was based on iron breakthrough. Well 3A having the highest iron concentration, had the shortest runlength. The runlength was impacted by the intermittent service of the wells. The intermittent service of the wells imposed a water hammer on the filter effectively pushing the iron through the filter with every start of the well. Wells 1 and 2, having lesser concentrations of iron than Well 3A, did not reach breakthrough before the end of their respective study periods.

The selection of a media bed without anthracite is recommended given that the headloss at the time of iron breakthrough was not significant. The media bed for this study consisted of 18 inches of Greensand Plus and 12 inches of anthracite. The elimination of the anthracite would counter the apparent in-depth filtration that is taking place, thereby, possibly resulting in a longer runlength.

The water hammer on the pilot unit helped push iron through, but this is expected to be less severe on the full-scale plant. The pilot unit, unlike the full-scale plant, was not equipped to retain pressure when a well shut down. The hammer from the start of a well is significantly less severe on the full-scale plant, than on the pilot unit resulting in a shorter runlength on the pilot unit for the same filter load.

Chlorine Application

Chlorine was applied at the pilot unit to ensure that the process stream was chlorinated throughout the study. The supply to the pilot unit was to be chlorinated, but the full-scale plant chlorine feed often failed due to a loss of prime of the chlorine pump(s). The chlorine feed at the pilot unit was not intended to increase the total chlorine dosage, but to ensure that chlorine was being applied whenever the pilot was in service. The chlorine dosage applied at the pilot unit was approximately 1 mg/L.

The Manganese Greensand and Greensand Plus processes can continue to effectively remove the iron and manganese in the well supply during temporary losses in the chlorine feed. However, arsenic reduction might be reduced, or eliminated. The removal of arsenic is highly dependent on the oxidation state, or species, of the arsenic and on contact between the iron and arsenate. Arsenate (As(V)) is the oxidized species of arsenic, and is removed more effectively than is Arsenite (As(III)), the reduced species of arsenic. Arsenite is readily oxidized to arsenate by chlorine, but the speciation of the arsenic at Madison Hill is not known. The loss of the chlorine feed could eliminate the formation of arsenate, or the contact between the arsenate and iron, the result of which would be reduced arsenic treatment.

The total throughput during this study was over 4731 gallons. The actual throughput is not known due to the fact that the totalizing meter jammed. The meter could not be cleaned before the end of the study. The hours of service for each well were periodically recorded during the study period. The operating hours for Wells 1, 2 and 3A are estimated at 13.9, 12.7 and 14.2, respectively. For the bulk of this study, each well was operated independently of the others. The rare instance that multiple wells were in service occurred only when a filter was in the process of being backwashed.

Conclusion

It is concluded that the arsenic in all the wells can be reduced to concentrations less than the detection limit of 1 μg/L, at a filtration rate of 4 gpm/ft^2 with the maintenance of a free chlorine residual and good iron removal. Well 2 requires the application of an iron feed, at a dosage of no more than 2 mg Fe/L, to supplement the naturally occurring iron for the arsenic to be reduced to non-detectable concentrations. Furthermore, the iron and manganese were readily reduced to non-detectable concentrations using chlorine as the only oxidant.

Lastly, it is recommended to consider eliminating the anthracite and utilizing a deeper, single media filter bed to achieve a longer filtration runlength.