June 4, 2014

Adrienne L. Widmer, P.E.
Acting Administrator
Las Cruces Utilities
Water Resources
P.O. Box 20000
Las Cruces, NM 88004

Re: Fluoride in CLC drinking water

Dear Ms. Widmer:

Introduction

As requested, Daniel B. Stephens & Associates, Inc. (DBS&A) has prepared this letter to summarize some of the main issues pertaining to fluoride in drinking water. This has been done in response to questions raised by a Las Cruces resident's questions regarding the potential health effects of fluoride in drinking water in Las Cruces. In preparing this letter, we have looked at the regulatory status of fluoride in drinking water, reviewed water quality data for the City of Las Cruces drinking water wells, summarized treatment technologies, and performed a feasibility level of evaluation of costs to remove fluoride from drinking water.

Regulations

Fluoride concentrations in drinking water are regulated by the U.S. Environmental Protection Agency (EPA), with the Maximum Contaminant Level (MCL), set at 4.0 milligrams per liter (mg/L) or 4 parts per million. The MCL has been set as close to the public health goal as EPA believes may be achieved with the use of the best available technology, taking cost into consideration. This standard is set to protect against risks from excessive exposure to fluoride over the span of a lifetime. There is a secondary (non-enforceable) MCL, known as SMCL, of 2.0 mg/L also set by the EPA to prevent against adverse cosmetic and aesthetic effects of fluoride.

Current Conditions within the City of Las Cruces

First and foremost, it is important to note that the City does not add fluoride to its drinking water supply and all fluoride detected is naturally-occurring. Detected fluoride concentrations in City supply wells range between 0.26 and 0.8 mg/L. These concentrations are all well below standards for fluoride in drinking water.

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Removal Methods

The removal of fluoride from drinking water is complicated because its chemistry is closely related to chloride, which is regularly added for water treatment (disinfection) purposes. Common methods for fluoride removal are 1) coagulation, 2) adsorption/ion exchange, and 3) membrane processes.

Coagulation

The coagulation method involves the introduction of an agent, such as lime, which when mixed with water forms an amorphous hydroxide precipitate that sweeps through the solution providing a source for the deposition of charged particles like fluoride. This precipitate and the deposited particles can then be removed through sedimentation (Ayoob et a., 2008). This method is of limited value in large-scale systems for reasons including long settling times of the precipitates and large amounts of sludge that are often generated.

Adsorption or Ion Exchange

Adsorption occurs when one species adheres to the surface of another. The most common treatment applications include clays and activated alumina. Clay is packed into columns where the water is forced through. The uniform quality of the clay is critical to providing a media for adsorption. This process of ion exchange with the clays is inherently slow and is further exacerbated as the ion exchange can cause plugging of the pore spaces of the clay. Activated alumina (AA) has been recognized as one of the best available technologies for the removal of fluoride (Chauhan et al., 2006). However, success is dependent upon pH, surface loading, and the presence of other interfering ions (Ayoob et al., 2008), and is thus complicated and dependent on source water quality, management of pH, and the maintenance of the alumina material.

Membrane Filtration

The most widely used membrane filtration processes is reverse osmosis (RO). RO is a pressure driven membrane filtration process that removes up to 99% of salts. The main disadvantages of RO are related to the high energy costs of maintaining the pressure differential, high rates of membrane fouling, and the loss of a percentage of water as high salinity concentrate. (Ayoob et al., 2008).

Feasibility Level Cost Estimate

The primary factors that were considered in developing this estimate were: 1) initial fluoride concentrations; 2) the number of treatment locations; and 3) required continual operation and maintenance (O&M) costs. As the City's wells are a distributed system it is likely that treatment would be required at individual wellheads; therefore, RO was deemed to be the most likely option for treatment. The costs associated with an RO system are primarily related to the location of treatment, the volume of water being treated, disposal of brine, and overall water quality.

Based upon communications with a vendor that provides wellhead treatment systems, treatment costs range between approximately $300,000 at 200 gpm and $1,200,000 when treating 700 gpm. RO treatment is accomplished using modular skids, with larger wells requiring multiple units. For instance, to treat a 2,800 GPM well, four of the 700 GPM units would run in parallel, which results in a cost of between $3,200,000 and $6,000,000. Given that the fluoride concentrations in all wells already meet all standards, it is assumed only a portion of the water from each well would be treated. The treated water would then be blended with the untreated water to provide reduced levels of fluoride while maintaining some balance of minerals.

An additional cost that requires consideration is related to the concentrated brine water that is produced during RO treatment. Initial calculations indicated that on the order of 215,000 gallons of concentrate water would need to be managed daily. Because of this, large evaporation ponds or deep injection wells would be required at each well. This is water that is currently used as drinking water that would no longer be available for beneficial use.

If individual home owners wanted to remove fluoride at their homes, a variety of under-sink treatment systems, including RO, are commonly available. These systems cost from $250 to $1,000+ excluding installation. These systems treat on the order of 50 gallons per day. RO systems operate by pulling a highly-purified stream of water from the input stream, leaving a concentrated waste stream to be disposed of. Installation of an RO system will increase household water use as measured at the water meter because 50 percent or more of the water run through unit will be sent to the sewer as waste. For example, to get 100 gallons of treated water the system will pull 200 gallons of water from the City's distribution system. Also, a de-chlorination unit is usually included with RO system as chlorine can cause damage to the membranes. Therefore, an additional disinfection unit may be needed to re-chlorinate the water after treatment, depending on use. These systems will require maintenance, including cleaning and membrane replacement. These systems are readily available for purchase and can be installed by a licensed contractor.

Conclusions

Per a CLC Utilities request, DBS&A has reviewed water quality data for the Las Cruces drinking water. First and foremost, it should be noted that fluoride is not being added to the drinking water and all fluoride is naturally occurring. Additionally, fluoride levels in CLC water are below EPA health-based standards. Although fluoride levels are below standards, we reviewed the most common technologies for fluoride removal and determined that RO is the most practicable technology if fluoride removal were to be implemented. Implementation of fluoride treatment would be tens of millions of dollars in capital costs alone, and would substantially increase CLC Utilities's operation and maintenance costs due to increased labor, chemical, electrical, replacement, and concentrate disposal costs.

However, as discussed above, if individual home owners wanted to remove fluoride at their homes, a variety of under-sink and whole house treatment systems, including RO, are commonly available and cost anywhere from $250 to $1,000 or more. Maintenance costs vary depending on water use, with the typical maintenance involving periodic changing out of filters.

References

Ayoob, S., A.K. Gupta, and Venugopal T. Bhat. A Conceptual Overview on Sustainable Technologies for the Defluoridation of Drinking Water. Critical Reviews in Environmental Science and Technology. 38.6 (2008): 401-70.

Sincerely,

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KI/js