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I have completed the review of the CH2M report on the Nitrate Management Plan dated March, 2016. The report contains four basic sections: 1) Des Moines Water Works system demand for water, 2) Nitrate concentration trends and projections for the future, 3) Treatment processes for meeting the USEPA drinking water standard for nitrate and 4) Nitrate management compliance and implementation plan. I will group my comments by the same sections.

Des Moines Water System Demand for Water

Table 2-6 in the CH2M report presents the Historical Water Use and Future Demand Projections. The table presents an average population growth of 3,000 people/year for the period 1920-2000. From 2000 to 2010 there was a significant growth at 8,400/ year. This was a time when Des Moines Water Works connected additional wholesale customers to its system. The projections for 2020 and beyond seem high. The projection for 2030 is 649,091, while the Des Moines Area Metropolitan Planning Organization projects the 2030 population to be 614,000 which includes areas not served by Des Moines Water Works. If the growth rate was 5,000 per year, the average day water demand for 2035 would be 55 million gallons per day (mgd) and the peak demand 109 mgd, as compared to 69 mgd and 150 mgd as contained in the report.

Total water consumption for 2004-2013 decade has been relatively constant except for 2012 which was a dry year. During this same time period, water consumption inside the City of Des Moines has decreased while water consumption outside of the city has increased. In 1996 the split was approximately 63% inside and 37% outside the city. In 2013 the split was 42% inside and 58% outside the city. While the breakdown of water use by customer type is not contained in the report, an estimate can be made from the cost of service. That breakdown for 2014 would be:

Customer Class	2014 Estimated % of Total Consumption
City of Des Moines Residential	32%
City of Des Moines Commercial	3.4%
City of Des Moines Industrial	6.6%
Wholesale outside the city	49%
Other outside city	9%

Nitrate Concentration Trends and Projection

Nitrate concentrations in the Raccoon and Des Moines Rivers are affected by a number of factors. Some of those but not limited to are:

1. The amount of fertilizer applied to the land in the watersheds
2. The amount and timing of rainfall in the watershed
3. The crop type and acreage planted in the watershed
4. Municipal and industrial discharges
5. Mineralization of organic soil matter

Due to the high variability of factors, it is difficult to determine a trend when the available data is over a short timeline. The report used the data from 1970 to 2015 on the Raccoon River and 1980 to 2015 on the Des Moines River. Using a linear regression and projecting to the year 2020, the report recommended a value of 30 mg/L for peak nitrates in the Raccoon River and 25 mg/L in the Des Moines River. The peak measured value in the Raccoon River was 24.4 mg/L in 2013 and 18.6 mg/L in the Des Moines River in 2013. Various researchers have been studying the trends of nitrates in Iowa Rivers. Some have concluded that the concentration will continue to increase since the amount of nitrogen fertilizer applied to the land has increased, since it may take years for the nitrogen to pass through the soil profile. Other researchers have concluded that peak concentration may not rise much in the future since the application rate for nitrogen per acre has been steady or decreasing over the last 30 years. Finally, in a recent article by the Iowa Institute of Hydraulic Research indicated that the peak trend may be decreasing due to a reduction in the number of acres of soybeans. In conclusion, it would seem that a projection of 30 mg/L on the Raccoon River and 25 mg/L on the Des Moines River may be high and that a lower number would be more appropriate for planning purposes.

Treatment Processes

The report was comprehensive in exploring both physical/chemical and biological systems for nitrate treatment. The one system which was not explored was the use of dilution with water from Storage and Recovery (ASR) wells. This is a treatment that can be used at the McMullen Treatment Plant and might be of value at the Fluer Drive Treatment Plant. If the water stored in the ASR well is managed, it could have a lower value of nitrates.

Nitrate Management Compliance and Implementation

I feel the selection of wetlands and ion exchange treatment is a viable solution. The wetlands are going to be difficult to operate and I feel the maintenance of the system will be more costly than estimated due to the issues of periodic flooding of the wetlands. The biggest issue not talked about is the sand that will collect in the wetlands after a flood. Using a series of ponds similar to the chain of lakes at the McMullen Treatment Plant would be an easier biological system to operate. The ion exchange process operating in the bicarbonate mode would need to pay careful attention to the recarbonation process after lime softening in order to not have a depositing chemistry in the ion exchange tanks.

The approach could be modular, which allows treatment units to be added as demand and nitrate concentrations develop over time. I feel the pilot for the wetland is needed and I would also suggest a pilot for the bicarbonate ion exchange be conducted. Historically, a pilot study was completed before the original ion exchange system was built, a review of the study may be useful for the new system. I would also suggest a study to recondition the existing ion exchange tanks rather than replacing them with new tanks. Special care needs to be observed to not overload the concrete columns in the clearwell.

A 1990 Comparison to Projected 2035

Water demand has change significantly since 1990 and is forecasted to change as is presented below:

Year	CH2M Average Day (mgd)	CH2M Peak Day (mgd)	Alternate Average Day (mgd)	Alternate Peak Day (mgd)
1990	34.8	50.7	34.8	50.7
2035	69.3	150.8	55	109
% Increase	99%	197%	58%	114%

Regardless of which projection is selected, there may be a significant increase in demand for water.

If the existing three treatment plant were available and the water demand was as it was in 1990, there would be no need for additional nitrate treatment. If only the Fleur Drive Treatment Plant was the only plant, as in 1990, the ion exchange system would have to be doubled or a wetland around 40 acres would need to be developed.

When evaluating the factors affecting the need for the expansion of the nitrate removal treatment at Des Moines Water Works, the primary factor is increased demand for water in the metropolitan area. The data presented in the CH2M report shows high levels of nitrates in the late 1970s similar to the 2010s, however, for a shorter time. The treatment needs are dependent on the nitrate concentration. In summary, the capital cost for the needed improvements are being driven by the growth in demand for water and the operating costs are being driven by both growth and river water quality.

If you have any questions, feel free to contact me.

Sincerely,

L.D. McMullen

L.D. McMullen, Ph.D., P.E.
Senior Engineer