Internal Monitoring Report

Policy #: O-2B Water Quality **Date**: July 22, 2014

I certify that the following information is true.

Signed ______________________________, General Manager

Policy Language:

Madison Water Utility consumers will receive high quality water that meets or is better than all primary and secondary drinking water standards, including their public notification requirements, and complies with board-adopted water quality goals, incorporated by attachment.

The Madison Water Utility recognizes that drinking water standards are subject to revision and that new compounds of concern will be determined. This dynamic is a result of health studies being conducted by health organizations and government agencies on the state, national and international level. The technology to quantify compounds at increasingly minute levels is constantly improving.

The Madison Water Utility shall maintain and promulgate a Watch List of compounds of concern by unit well of compounds that are increasing and may approach the primary and secondary drinking water standards. The Watch List shall identify which wells require action.

General Manager's interpretation and its justification:

Few things are more vital to a community than the availability of high quality drinking water. It promotes public health, public safety, and the economic interests of our community. To that end, the water utility will consistently deliver water that meets the primary, health-based drinking water standards, the secondary (aesthetic) standards, and the additional policy goals established by the Board. The Water Utility Procedural Guideline GUIDE 3, which establishes policies regarding iron and manganese, contains the following:

> The Madison Water Utility, under normal operating conditions, shall provide water that contains less than the National Secondary Drinking Water Standard for Fe (currently 0.3 mg/L) and Mn (currently 0.05 mg/L) at the customer's tap.

I interpret this to mean that 95th percentile results from our routine distribution water quality monitoring program shall be less than these values for iron and manganese.

Utility staff will remain vigilant in following developments related to currently unregulated and emerging contaminants like pharmaceuticals, endocrine disruptors, and chromium-6 that may pose problems in the future. Furthermore, the utility will employ multiple methods to adequately inform its consumers of the safety and quality of their drinking water including the federally-required Consumer Confidence Report (CCR), the water utility website, e-mail distribution lists, neighborhood listservs, citizen meetings, and through staff contact in the field and office.

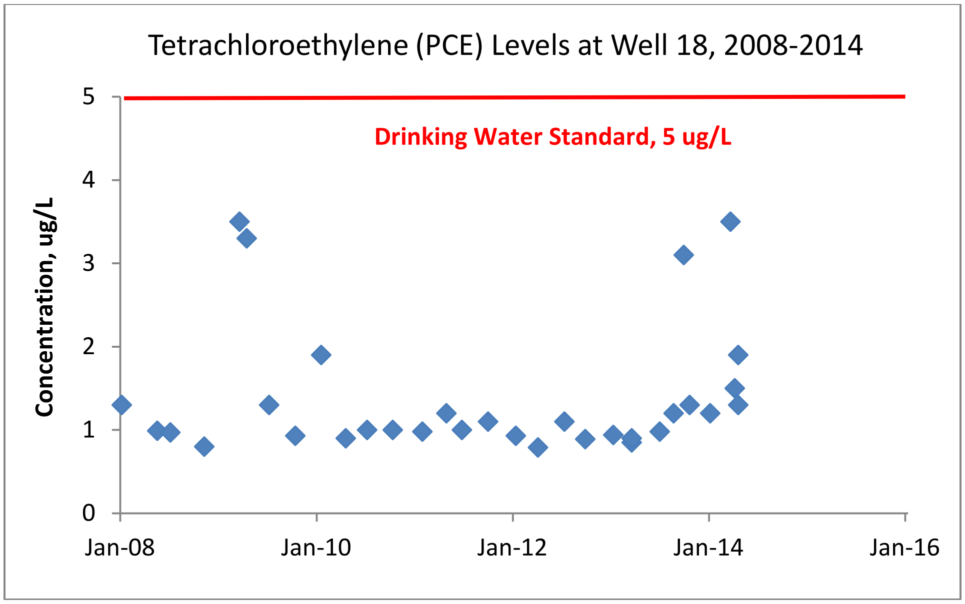
Data directly addressing the General Manager's interpretation:

Primary Drinking Water Contaminants:
Between April and June, 914 water samples were collected from routine monitoring points in the distribution system including the entry points at the wells (203 samples). None of these samples showed the presence of coliform bacteria.

Also during the April to June monitoring period, six wells showed the presence of at least one volatile organic compound (VOC), with PCE being the most common. Quarterly monitoring is conducted at four wells (6, 9, 15, and 18). Detections are summarized in the table below.

Volatile Organic Compound	MCL, ppb	Well 6	Well 9	Well 15	Well 17	Well 18	Well 18	Well 18	Well 18	Well 27
	Sample Date	4/7	4/3	4/3	5/5	4/7	4/23	5/6	5/6	4/23
1,2-Dichloroethane	5	<0.16	<0.16	<0.16	**0.20**	<0.16	<0.16	<0.16	<0.16	<0.16
Tetrachloroethylene [PCE]	5	**0.74**	**1.7**	<0.18	<0.18	**3.5**	**1.5**	**1.9**	**1.3**	**0.26**
1,1,1-Trichloroethane	200	<0.15	<0.15	<0.15	<0.15	**0.26**	<0.15	**0.18**	<0.15	<0.15
Trichloroethylene [TCE]	5	<0.11	<0.11	<0.11	<0.11	**0.40**	**0.23**	**0.24**	**0.15**	**0.19**
Disinfection By-Product										
Bromodichloromethane	80	<0.15	**0.66**	<0.15	**1.6**	**0.22**	**0.37**	**0.24**	<0.15	**0.30**
Bromoform	80	<0.16	**0.49**	**0.43**	**0.45**	**0.24**	**0.24**	**0.21**	<0.16	<0.16
Chloroform	80	<0.19	**0.28**	<0.19	**1.0**	<0.19	<0.19	<0.19	<0.19	<0.19
Dibromochloromethane	80	**0.22**	**1.1**	**0.38**	**1.4**	**0.39**	**0.54**	**0.43**	<0.15	**0.45**

The PCE level at Well 18 has been inconsistent in recent quarters. The level has historically hovered around 1 μg/L with a 3.5 μg/L peak in early 2009. That spike was observed following maintenance work at the well when pumping ceased for five months. In the last eight months, 3.5 and 3.1 μg/L peaks have been observed without maintenance activity at the well. Recent test results are illustrated in the figure below.



The Technical Advisory Committee recommends that the utility not proceed with a groundwater investigation at this site since the source (landfill) is well known and remediation efforts are not likely to reduce source contributions. Instead, the committee felt money could be better spent providing wellhead treatment or other improvements at the well.

Between April and June, radionuclide (gross alpha and radium) samples were collected at twenty wells. The results are summarized below. The highest levels were observed in confined aquifer wells (#7, #19, and #27) which draw water exclusively from the Mt. Simon aquifer.

	Gross Alpha pCi/L	Gross Beta pCi/L	Radium-226 pCi/L	Radium-228 pCi/L	Combined Radium
Minimum	0.5	0.8	0.26	0.23	0.52
Median	3.2	3.1	0.99	0.72	1.70
Maximum	9.6	8.8	2.7	1.8	4.5
MCL	**15**	**50**	**5***	**5***	**5**

The annual inorganic samples were collected from each well in early July. Samples are tested for a range of contaminants including nitrate, arsenic, chloride, and manganese. Results are not yet available.

Policy Goals for Iron and Manganese:

Routine distribution testing from April through June showed that all 86 samples met the manganese policy goal and all but four samples met the iron goal. Three of the samples exceeding the iron standard were receiving water from Well 7 which is now out of service for construction of an iron and manganese filter. The table below shows summary statistics for the second quarter and year to date.

Manganese, µg/L

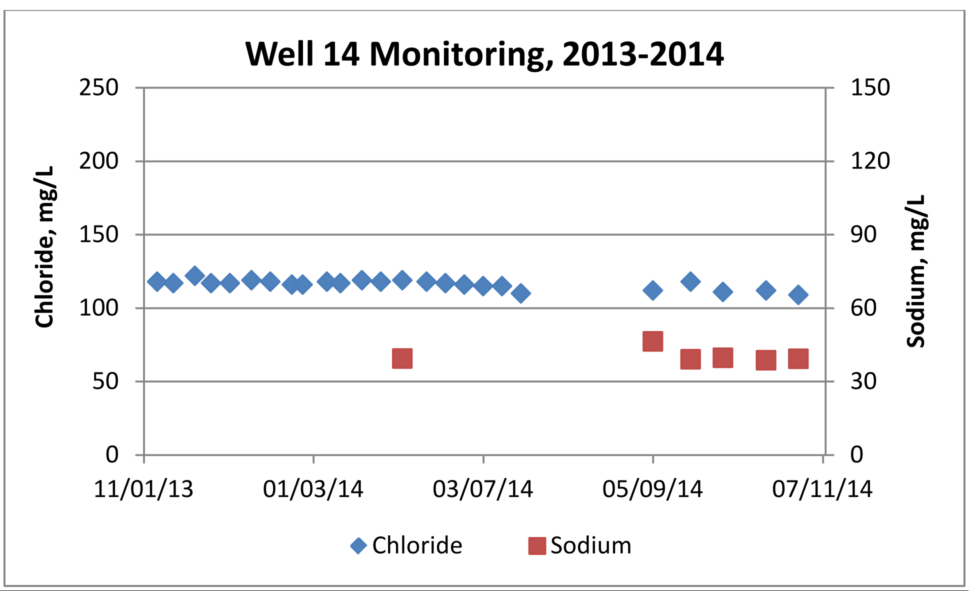
	Apr - Jun	2014
Policy Goal	50	50
Median	2.4	2.3
Average	4.7	4.2
95th	***24***	***17***
Maximum	32	46
Count	86	169
>50	0	0

Iron, mg/L

	Apr - Jun	2014
Policy Goal	0.3	0.3
Median	0.01	0.01
Average	0.05	0.03
95th	***0.16***	***0.11***
Maximum	0.94	0.94
Count	86	169
>0.3	4	4

Other Secondary Drinking Water Contaminants

Biweekly chloride and sodium monitoring continues at Well 14. Results are illustrated in the figure below. Recent chloride results range from 109 to 112 mg/L compared to 115 to 122 mg/L during winter months. With one exception, the sodium level is stable around 40 mg/L. A white paper on road salt reduction initiatives for the University Avenue corridor was finalized and provided to Dane County staff. The City has asked that the County consider reducing road salt application rates on the stretch of road located within the Well 14 Wellhead Protection Area. Any deviation from current practices will require approval from the State Department of Transportation. A copy of the white paper is included in this report.



Unregulated and Emerging Contaminants:

Chromium monitoring was conducted in April and May at eighteen wells. Results for total and hexavalent chromium were similar to previous tests. The highest levels were observed at Wells

6, 12, 14, 16, and 23 where the hexavalent chromium ranged from 1-2 µg/L. The remaining four wells were sampled in June; results are not yet available.

Investigative samples were collected at Well 9 and Well 11 for low level VOC and 1,4-dioxane, respectively, due to previous detections of these currently unregulated contaminants. Results are not yet available.

Public Outreach on Water Quality:
The Annual Drinking Water Quality Report, commonly known as the Consumer Confidence Report (CCR), was released in early May. The report was posted to the utility website and 133,000 postcards mailed notifying customers of the report's availability. Paper copies were also distributed to the Madison public libraries and are available by request.

Water utility staff (Quality & Supply) attended a SASY Neighborhood Association meeting in early June to discuss both short and long-term plans for Well 8. The utility also solicited volunteers to participate in the public participation process for the well improvements planned at Well 8 beginning in 2015. Seven citizens expressed an interest in participating.

I report compliance.

Attachments:
Road Salt Reduction in Well 14 Wellhead Protection Area
Water Quality Technical Advisory Committee Meeting Notes April 15 2014

Making the Case for a Reduced Salt Zone on University Avenue

Objective: Slow the increases in chloride and sodium levels at municipal Well #14 by lowering road salt applications on the county-maintained portion of University Avenue and the adjacent city-maintained roads located within the capture zone for Well #14.

City of Madison Unit Well #14 is located at 5130 University Avenue. It is the primary supply point for the western portion of the main pressure zone (Zone #6) in the City of Madison providing water to the University Avenue corridor between Allen Boulevard (City of Middleton) and N. Randall Street. It also supplies water to neighborhoods between University Avenue and Lake Wingra east of Glenway Street. Over the last decade, the well supplied 2.3 million gallons per day or 819 million gallons annually. The well consistently rates among the top three most productive wells in the City.

While many City of Madison wells show signs of water quality impacts from application of road salt, Well #14 is by far the most dramatic. The average chloride concentration at the well in January 2014 was 118 mg/L. With one exception, the remaining twenty-one wells are all below 55 mg/L chloride. Furthermore, chloride at Well #14 has more than doubled since 2000 and will likely exceed the Preventive Action Limit of 125 mg/L (WI Admin Code, Chapter NR 140) – the Public Welfare Groundwater Quality Standard – by 2016. At the current rate, chloride at Well #14 could surpass the Secondary Drinking Water Standard of 250 mg/L within two decades and would be above the reported taste threshold when associated with sodium – the other typical component of road salt. If this level were reached, water drawn from Well #14 would be sufficiently degraded that many customers might find the taste objectionable.

Like chloride, there is no federal or state primary (health-based) drinking water standard for sodium. Rather, the US EPA established a drinking water advisory level of 20 mg/L sodium for individuals on sodium restricted diets. Water with sodium above this level is not a risk to the general population; however, individuals with severe sodium restrictions (recommended sodium intake below 500 mg/day) should include sodium consumed in drinking water in their calculations of sodium intake. The trend at Well #14 mirrors that of chloride with sodium nearly doubling since 2000; the latest sample measured 39 mg/L sodium. The EPA reports a taste threshold of 30-60 mg/L for sodium.

Further evidence that groundwater around Well #14 is impacted by road salt is data collected over the past two years from monitoring wells located 200 feet south and 900 feet southeast of the municipal well. Chloride in these water table wells has averaged 501 and 396 mg/L and has tested as high as 705 and 556 mg/L, respectively. The wells are located in the right-of-way of University Avenue and S. Whitney Way. Infrastructure improvements, including curb and gutter and new storm water and sanitary sewer pipes, were completed along this stretch of University Avenue in 2012. They are expected to provide some benefit to groundwater quality by helping to convey chloride-laden melt water to the lake rather than allowing it to infiltrate to shallow groundwater.

Chloride is a conservative ion; once applied in the environment it does not break down, transfer to the gaseous phase, or bind to soil particles. Road salt applied to University Avenue (or other roadways, sidewalks, and parking lots) will dissolve in melt water and infiltrate the soil – later adding chloride to groundwater – or travel by the storm water system to surface water. Salt remaining on the land surface follows similar pathways during later precipitation events. Chloride is rapidly conveyed with ground and surface water to the water table or to nearby lakes and streams. Therefore, the ultimate fate of the tons of road salt annually applied to University Avenue is the local groundwater and Lake Mendota.

Several de-icing alternatives to sodium chloride are available including potassium and calcium chloride. Unfortunately, they are generally more costly than sodium chloride and they still contain the chloride ion. The City of Madison evaluated the potential for using beet juice as a de-icing agent; however, this alternative carries two significant drawbacks – high heavy metals load (particularly zinc and copper) as well as biological oxygen demand (BOD). The latter is problematic for aquatic species in receiving bodies as anoxic conditions (absence of oxygen) can develop when the beet juice components are decomposed by bacteria. Calcium magnesium acetate (CMA) is another organic-based option. It is chloride-free but shares the BOD problems of beet juice and other organic alternatives.

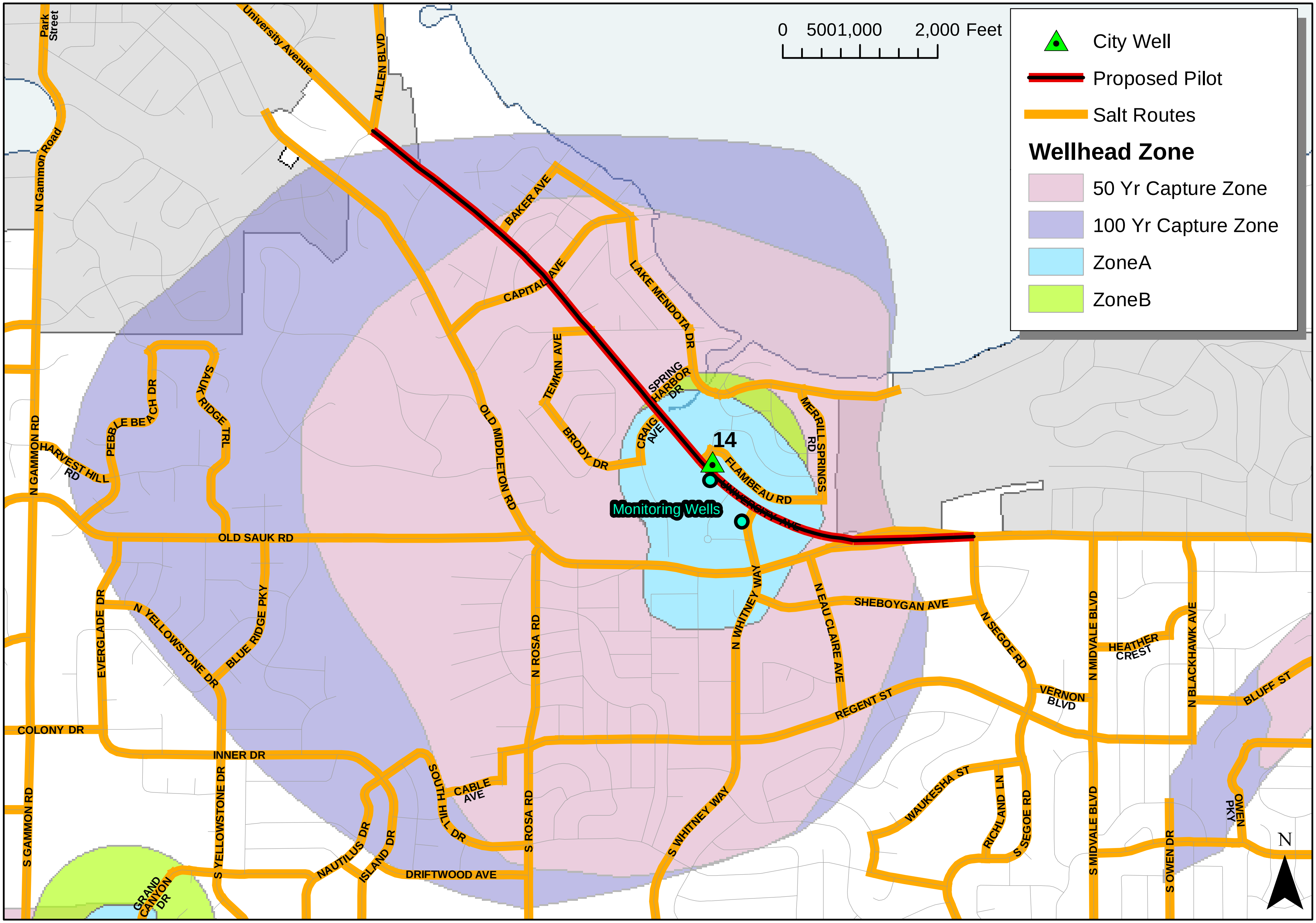
The goal of this initiative is to stabilize chloride and sodium concentrations in water drawn from Well #14 by reducing the amount and frequency of road salt application on University Avenue between Allen Boulevard and N. Segoe Road. This road is currently maintained by Dane County under a state contract with the Department of Transportation. Although the City of Madison Streets Division has implemented a number of initiatives aimed at reducing the amount of road salt applied to city streets, these efforts have not led to a measurable effect at Well #14 since the City does not maintain University Avenue. This initiative seeks to target the portion of University Avenue located in the Wellhead Protection District of Well #14 for reduced salt application.

Two alternate approaches to a proposed reduced salt zone would be wellhead treatment or changes to the well itself. Because Well #14 has a relatively short casing, water drawn from the well is largely from the upper aquifer – the aquifer most susceptible to human-induced contamination including road salt. Extending the well casing to below the shale aquitard offers the potential for lower chloride and sodium; however, this change might affect the productivity (specific capacity) of the well or its water quality. Chloride and sodium levels below the shale layer are not known and sealing off the upper aquifer could lead to elevated levels of iron, manganese, or radium – naturally occurring contaminants that could require wellhead treatment. This change would incur initial capital costs and annual operating expenses related to pumping from a greater depth or the wellhead treatment for contaminant removal. Reverse osmosis treatment of all or a portion of the water pumped from Well #14 also could lower chloride and sodium to acceptable levels but it would come with a large price tag – significantly higher energy costs, reject water waste stream, and pre-treatment to prevent fouling of the membranes. High operating costs ($500,000 annually) challenge the feasibility of this alternative.

Implementation of a reduced salt zone on University Avenue could be accomplished in one of two ways – either Dane County is permitted by the State to deviate from contract agreements regarding road salt application or the City of Madison Streets Division would be granted permission to oversee winter maintenance of this portion of the state highway. During this trial period, chloride and sodium levels would be monitored at the municipal and monitoring wells in addition to the storm water outflow into Lake Mendota at Spring Harbor. The goal is to reduce, or slow the increase, in chloride and sodium levels seen at the municipal well.

Reducing road salt applications in the vicinity of municipal Well #14 should result in maintaining or improving water quality and extend the expected service life of the City's highly valued asset. While alternative de-icing agents are available, they tend to be costlier and impose unacceptable risks to public safety and/or the quality of Madison's cherished lakes. Well modifications or wellhead treatment address the symptoms not the cause of this emerging problem at Well #14; they are also expensive alternatives. To maintain public safety and sustain groundwater quality, we believe that the most prudent approach is to target road salt application rates in the vicinity of the municipal well.

Well 14 Pilot Salt Reduction Area



Water Quality Technical Advisory Committee – Notes for the WUB Report

Meeting Date – April 15, 2014

A. Wellhead 31 Water Quality Data Review

Well 31 (Tradewinds Parkway), Madison's new production well, has been drilled and is currently capped awaiting construction of the well house in May/June of 2015. Water quality data were distributed. Volatile organic analysis showed the presence of chloromethane at the detection limit; however, it was also detected in the trip blank.

Well 31 is cased to the lower aquifer and contains iron that is in excess of the WUB treatment policy but similar to other confined aquifer wells. Other inorganic parameters were at low levels. Radionuclides, consistent with other wells cased to the lower aquifer, were low in both the test and production wells. Uranium analysis, although not required, was included in order to gain baseline information.

There is a possibility Well 31 may become a 2 borehole production well. If this is pursued and approved by the DNR, water from both the upper and lower aquifers would be blended on site, prior to entry into the distribution system. Several benefits of this approach include a reduced level of iron and greater production capabilities. Ken offered to help determine the potential production capacity based on previous test data.

B. Well 15 Pilot Study Update

Six trials of different air flow rates were evaluated while keeping constant the water flow (750 gpm). The airflows tested were 4500, 3750, 3000, 2250, 1500 and 0 cubic feet per minute (cfm). Complete PCE removal (to below the detection limit) was observed at 3750 and 4500 cfm. PCE and TCE removal was directly correlated with a reduction of airflow through the stripper. With the blowers off, the pH was 7.2; with the blowers on (even at a low air flow) the pH increased to 8. A handout illustrated the PCE and TCE removal rates under each scenario.

During the pilot study, the PCE and TCE concentration of the raw water varied somewhat. Regardless of the level of VOCs in the raw water, the same percentage of VOC removal was realized.

Additional scenarios to be investigated may include changing the water flow and removing one of the trays in each air stripper chamber. Removal of the tray would reduce the residence time of water in the stripper and potentially strip less carbon dioxide. The deep well pump at Well 15 has a VFD drive; water flow during the summer months tends to be 1500 gpm to support customer demand.

C. Road Salt Reduction Initiative – WHPA 14

The work group met to discuss alternatives to the de-icing agent currently used by the State DOT on University Avenue. It is unlikely the de-icing product will change, even if maintenance of this stretch of road is transferred to City Streets. Alternative products are unlikely to be used due to undesirable side effects and lower effectiveness; beet juice contains heavy metals and CMA has a high biological oxygen demand (BOD).

The group is continuing to work towards transferring winter maintenance from the County to the City. Historical data suggest that the City applies less de-icing product to the roads than the County. Additionally, the salt routes within the WHPA are also being targeted for reduction in the amount of product applied.

A question was raised if changing the winter treatment pattern at West Towne Mall along with determining the volume of salt in the runoff from this area would be helpful. It is possible the historical volume of storm water may be available but unknown if the level of sodium in the storm water has been measured.

Adrianna will be meeting with DHS in a few weeks and will mention the road salt reduction initiative in hopes of involving a larger network (State) of interested parties. Reducing the amount of salt used at Water Utility facilities was suggested. This would reduce the amount of salt in close proximity to the wellhead along with helping the utility better understand and communicate the amount of salt needed and potential impacts on water quality. A suggestion was made for the management team to work with the Common Council to broaden this issue to a broader scope beyond Well 14.

D. Water Quality Monitoring

The utility established a *Water Quality Watch List* several years ago to monitor regulated and unregulated organic and inorganic contaminants. Organic compounds included on the watch list have been detected at least once in the previous five years. Classification is based on the NR 140 Preventative Action Level (PAL), which is generally 10% to 20% of the MCL.

Watch List contaminants include

- PCE (regulated organic) at four wells. The air stripper has resolved the PCE at Well 15.
- TCE (regulated organic) detected below the PAL at five wells; appears to be stable.
- 1,4-Dioxane (unregulated organic) at two wells.
- Nitrate (regulated inorganic) detected above 2 mg/L (MCL = 10 mg/L) at eight wells.
- Iron & Manganese (unregulated inorganics) detected at numerous wells. The filter addition has resolved this issue at Well 29; additional filtration is planned at four additional wells over the next several years.
- Sodium (unregulated inorganic) at three wells. Road Salt Reduction Initiative at Well 14 is continuing.

On-going monitoring continues at all wells. Inorganics are tested annually although, except for nitrate, testing is only required once every three years; volatile organic compounds are tested quarterly at four wells (Well 6, 9, 15 and 18) and annually at all other wells. A quarterly update of the Watch List is submitted to the Water Board; the biggest changes usually occur in the third quarter following receipt of the annual inorganic testing results.

Disinfection-by-products (DBP) have been tested annually at seven designated distribution sites with the potential for high water age. DBPs include Total Trihalomethanes (TTHM) and Haloacetic Acids (HAA5). The sum total of TTHMs must be below 80 µg/L and the sum total of HAA5s must be below 60 µg/L. For reference, the highest TTHM measurement was 10.5 µg/L and the highest HAA5 measurement was 7.2 µg/L.

DBP monitoring includes sampling larger storage tanks two times per year (summer and winter), within each pressure zone, and at extremes of the distribution system. In 2012, the federal regulation changed (Stage 2) to require monitoring two locations on a quarterly basis; the two locations are Towers 225 and 229. Given the low levels of DBPs, the utility is on reduced monitoring. This committee supports reduced monitoring unless there is a sudden increase in chlorine demand or a significant increase in natural organic matter.