Internal Monitoring Report

Policy #: O-2B Water Quality **Date**: April 26, 2016

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.

Water Utility Board Procedural Guideline GUIDE 8 – Executive Summary of Water Quality Treatment Policies – establishes monitoring requirements and the utility's approach for responding to increasing contaminant levels. Generally, the policy establishes two thresholds – one when a contaminant exceeds 50% of a maximum contaminant level (MCL), secondary MCL, or other numerical guideline, and two when it surpasses 80% of this mark.

The first triggers increased monitoring and an investigation into treatment alternatives, operational changes, or other actions to reduce contaminant levels while the second leads to implementation of a mitigation strategy.

The policy applies to any contaminant, regulated or not, that is capable of impairing the health, safety, or aesthetic quality of drinking water. 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.

The utility will use multiple communication methods to adequately inform 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:

Contaminants with a primary MCL or Enforcement Standard

Coliform Bacteria - Between October and March, 1760 water samples were collected from routine monitoring points in the system including the entry point at the well houses (380 samples). None tested positive for coliform bacteria. Thirty-seven raw water samples were also collected during this reporting period. All were free of coliform bacteria.

Volatile Organic Compounds - Eighteen wells were monitored for volatile organic compounds (VOC) during the period from October to March. PCE is the most commonly detected VOC. Maximum detections are shown in the table below. None of over forty VOCs were detected at thirteen wells, including treated water at Well 15.

Maximum detection (in µg/L) for each well and VOC.

	Samples	DCE, cis	TCE	PCE	TCA	TCFM
Well 6	2	<0.30	<0.30	**1.1**	<0.32	<0.30
Well 9	2	<0.30	<0.30	**1.5**	<0.32	<0.30
Well 11	2	**0.35**	**0.26**	**0.63**	<0.32	**1.0**
Well 14	2	<0.30	<0.30	**0.58**	<0.32	<0.30
Well 18	2	<0.30	**0.34**	**3.5**	**0.28**	<0.30
	TCFM = Trichlorofluoromethane			TCA = 1,1,1 Trichloroethane		

Quarterly monitoring occurs at any well in which PCE exceeds 0.5 µg/L; otherwise, annual samples are collected at each well. The above table does not include results for disinfection by-products such as trihalomethanes. Ten-year trends for VOC occurrence at seven Madison wells can be found as attachments to the WQ Technical Advisory Committee meeting notes.

Radium - In accordance with GUIDE 8, six wells were tested quarterly for radium between October and March because combined radium (radium 226 + 228) exceeded 2.5 pCi/L, or one half the MCL, in previous testing. Well 27 was tested monthly in 2015 due to elevated radium results.

Combined Radium (226+228), pCi/L

	October	November	December	February
Well 7	No sample	**1.4**	No sample	**1.11**
Well 8	Inactive	Inactive	Inactive	Inactive
Well 19	**3.6**	Inactive	Inactive	Inactive
Well 24	No sample	**2.5**	No sample	**3.1**
Well 27	**5.6**	**4.3**	**3.6***	**4.7**[#]
Well 28	No sample	**3.5**	No sample	**2.22**
Well 30	No sample	**2.2**	No sample	**3.6**

*Average of twelve samples collected during Well 27 investigation
#Average of two samples collected 4 hours apart

Twelve entry point samples were collected from Well 27 and tested for radium during an investigation at the well. Combined radium results ranged from 1.46 to 5.6 pCi/L. A similar range of results was observed among twenty-two deep well samples. Limitations in the analytical method led to inconclusive results when comparing two pumping scenarios and their effect on radium levels at the well.

Contaminants with a secondary MCL

Iron and Manganese

Iron and Manganese - Monthly well samples are collected when iron and manganese are elevated. During the period from October to March, none of the samples exceeded the secondary MCL for either iron or manganese – 0.3 mg/L and 50 µg/L, respectively. Test results are shown below.

Iron, mg/L	Oct	Nov	Dec	Jan	Feb	Mar
Well 7	<0.01	<0.01	0.03	<0.01	<0.01	<0.01
Well 24	0.21	0.21	0.20	0.23	0.21	0.20
Well 26	0.03	<0.01	0.02	<0.01	0.02	<0.01
Well 27	0.12	n/s	0.12	0.14	n/s	0.15
Well 28	0.18	0.19	0.21	0.14	n/s	0.17
Well 29	0.01	<0.01	<0.01	<0.01	<0.01	0.01
Well 30	0.23	0.19	0.24	n/s	0.21	0.20

Manganese, µg/L	Oct	Nov	Dec	Jan	Feb	Mar
Well 7	0.4	0.3	1.7	<0.2	<0.2	<0.2
Well 24	26	25	23	25	30	22
Well 26	17	11	16	13	2.5	16
Well 27	26	n/s	27	28	n/s	26
Well 28	21	24	25	21	n/s	20
Well 29	4.6	0.7	0.6	0.2	0.4	2.5
Well 30	16	14	17	n/s	14	14

Iron and manganese monitoring also occurs in the distribution system at all coliform sample locations. Test results, summarized in the table below, show iron and manganese infrequently exceed the established benchmarks and over 95% of the samples are below one half the policy goals.

Manganese, µg/L

	Oct - Mar	**2015**
Policy Goal	**50**	**50**
Median	1.7	1.9
Average	3.5	4.5
95th Percentile	***13***	***17***
Maximum	54	106
Count	169	329
>50	1	4

Iron, mg/L

	Oct - Mar	**2015**
Policy Goal	**0.3**	**0.3**
Median	<0.02	<0.01
Average	0.04	0.03
95th Percentile	***0.14***	***0.14***
Maximum	1.8	1.08
Count	169	329
>0.3	2	4

Chloride - Regular chloride monitoring continues at Well 14. Twelve samples were collected between October and March. In that time, the average chloride level was 128 mg/L with a maximum of 138 mg/L.

Unregulated and Emerging Contaminants

Sodium - In accordance with GUIDE 8, monthly chloride testing at Well 14 continues. Eight samples were collected between October and March with most samples measuring between 41 and 44 mg/L sodium. The US EPA recommends that drinking water not exceed 20 mg/L. These guidelines are intended for high risk populations including individuals with high blood pressure or those on severe sodium restricted diets.

Water Quality Watch List

The Water Quality Watch List has been updated to include the early 2016 test results for organic and radiological contaminants.

Water Quality Technical Advisory Committee

The committee has spent the last two meetings (January 12 and April 12) discussing test results from the radium investigation at Well 27 and VOC occurrence at Madison wells. The radium study was inconclusive due to the highly variable radium-228 results. Gary Krinke (Wisconsin State Lab of Hygiene) described the complexities of the radium analytical methods at the April meeting. The committee raised some concerns about the VOC results at Wells 6, 11, and 18; however, they noted that current levels are below the thresholds that would trigger additional action by the utility. The committee also reviewed lead results from the three most recent lead monitoring periods with an emphasis on locations with results greater than 3 μg/L lead. Continued collaboration with Public Health for risk communication related to lead in water was suggested. No lead testing was recommended for 2016.

Wellhead Protection Activities

The Water Quality Technical Advisory Committee previously reviewed a technical memo prepared by an environmental consultant describing likely sources of PCE contamination at Well 6 and Well 9. Former and/or active dry cleaning facilities were identified as probable sources. At the urging of the committee, a request was sent to WDNR to "expedite, without delay, the process of remediating these [dry cleaning] sites with the immediate goal of eliminating the impact of PCE contamination from these sources on Madison's municipal wells." The letter and complete technical memo are attached. A written response to this letter has not yet been received by the water utility.

Annual Consumer Confidence Report (CCR)

The annual Consumer Confidence Report (CCR) is in the final stages of production. Both English and Spanish versions will be produced again this year. Postcard notification and electronic delivery are planned for early May. The water quality reports, including inorganic and volatile organic tables, for each individual well are being updated and expected to be available on our website in time for the CCR release.

Attachments:

Water Quality Watch List
Water Quality Technical Advisory Committee Meeting Notes
    10-year Trends for VOC Occurrence
    Well 27 Investigation – Radium
    Lead Review - 2016
    Letter to DNR with attached Technical Memo

MADISON WATER UTILITY
WATER QUALITY WATCH LIST

Organics - Regulated

Contaminant	Maximum*	Units	MCLG	PAL	MCL	Detects Below PAL%	Watch List	Action Plan	Reference
1,2-Dichloroethane	0.20	µg/L	zero	0.5	5	#17	none		NR 809.24
1,2-Dichloroethylene (cis)	0.54	µg/L	70	7	70	#8, #11	none		NR 809.24
Tetrachloroethylene [PCE]	3.9	µg/L	zero	0.5	5	#27	#6, #9, #11, #14, #18	Quarterly Monitoring	NR 809.24
1,1,1-Trichloroethane	0.28	µg/L	200	40	200	#18	none		NR 809.24
Trichloroethylene [TCE]	0.43	µg/L	zero	0.5	5	#11, #14, #18, #27	none		NR 809.24
Xylene, Total	1.5	µg/L	10000	400	10000	#225	none		NR 809.24

* Maximum detection observed at any Madison well from 2012 through 2016

% Detected in at least one sample collected from 2012 through 2016

Organics - Unregulated

Contaminant	Maximum*	Units	MCLG	PAL	ES	Detects Below PAL%	Watch List	Action Plan	Reference
Dichlorodifluoromethane	0.20	µg/L	n/a	200	1000	#14	none		NR 140.10
1,1-Dichloroethane	0.08	µg/L	n/a	85	850	#9	none		NR 140.10
1,4-Dioxane	0.63	µg/L	n/a	0.3	3	#9, #14, #15, #17, #18	#11	Monitor	NR 140.10
Trichlorofluoromethane	1.0	µg/L	n/a	698	3490	#11	none		NR 140.10

* Maximum detection observed at any Madison well from 2012 through 2016

% Detected in at least one sample collected from 2012 through 2016

Radionuclides

Contaminant	Maximum	Units	MCLG	Watch	MCL	Wells with Detects	Watch List	Action Plan	Reference
Gross alpha	11.2	pCi/L	zero	5	15	All Except Well#14	#19, #24, #27, #28, #30	Monitor	NR 809.50
Gross beta	8.8	pCi/L	zero	10	50	All Except Well#14	none		NR 809.50
Combined Radium	6.2	pCi/L	zero	2.5	5	All Wells	#7, #8, #19, #24 #27, #28, #30	Quarterly Monitoring	NR 809.50
Uranium	2.0	µg/L	zero	3	30	All Wells	none		NR 809.50

ES - Enforcement Standard (NR 140 - Groundwater Quality)

MCL - Maximum Contaminant Level Legal Limit

MCLG - MCL Goal (Public Health Goal)

PAL - Preventive Action Limit (NR 140 - Groundwater Quality)

MADISON WATER UTILITY
WATER QUALITY WATCH LIST

Inorganics - Regulated

Substance	Maximum*	Units	MCLG	PAL	MCL	Detects Below PAL	Watch List	Action Plan	Reference
Arsenic	0.9	µg/l	zero	1	10	#6, #8, #9, #14, #17, #19 #23, #24, #25, #27, #28, #30	none		NR 809.11
Barium	57	µg/l	2000	400	2000	All Wells	none		NR 809.11
Chromium, Total	2.8	µg/l	100	10	100	All Except #7, #17, #19 #24, #27, #28, #30	none		NR 809.11
Mercury	0.02	µg/l	2	0.2	2	#9	none		NR 809.11
Nickel	3.1	µg/l	100	20	100	All Wells	none		NR 809.11
Nitrogen-Nitrate	4.2	mg/l	10	2	10	#9, #12, #18, #20, #25, #26, #27, #29	#6, #11, #13, #14, #15, #16, #23	Monitor	NR 809.11
Nitrogen-Nitrite	0.09	mg/l	1	0.2	1	#12, #20, #28	none		NR 809.11
Selenium	1.3	µg/l	50	10	50	#6, #9, #11, #13, #14, #15,#16, #23, #25, #29	none		NR 809.11
Thallium	0.2	µg/l	0.5	0.4	2	#6, #9, #11, #12, #15, #17, #19, #23, #27	none		NR 809.11

* Based on 2015 annual test data

Inorganics - Unregulated

Substance	Maximum*	Units	MCLG	Watch	SMCL	Wells with Detects	Watch List	Action Plan	Reference
Aluminum	7.8	µg/l	n/a	50	200	All Wells	none		NR 809.70
Chloride	118	mg/l	n/a	125	250	All Wells	none		NR 809.70
Iron	0.62	mg/l	n/a	0.15	0.3	All Except #7, #12, #14, #15, #16, #18, #20, #26	#8, #19, #24, #30	#8 - Install Filtration (2017) #19 - Install Filtration (2016) #30 - Install Filtration (2020)	NR 809.70
Manganese	53	µg/l	n/a	25	50	All Except Well#16	#8, #17, #19, #23, #24, #27	#8 - Install Filtration (2017) #19 - Install Filtration (2016)	NR 809.70
Sodium	42	mg/l	n/a	20	n/a	All Wells	#11, #14, #15, #16, #23	Monitor	EPA DWEL
Sulfate	89	mg/l	n/a	125	250	All Wells	none		NR 809.70
Zinc	31	µg/l	n/a	2500	5000	All Wells	none		NR 809.70

* Based on 2015 annual test data

MCL - Maximum Contaminant Level (Legal Limit) MCLG - MCL Goal Public Health Goal PAL - Preventive Action Limit (NR 140 - Groundwater Quality) SMCL - Secondary MCL (Aesthetic Guideline)

DWEL - Drinking Water Equivalency Level

Water Quality Technical Advisory Committee

Meeting Notes
Olin Avenue Conference Room
January 12, 2016 – 1:00 p.m.

Attending: Janet Battista, Greg Harrington, Jocelyn Hemming, Amy Barrilleaux, Joseph Grande, Joe DeMorett, Al Larson

Absent: Sharon Long, Tom Heikkinen

Agenda:

1. **Agenda Repair/Announcements -** No changes to the agenda were proposed. The utility has had positive coverage on several media outlets (Facebook, City website and Channels 3 & 27) regarding the lowest water use in the City since 1969.

2. **Review of Meeting Notes -** No changes to the October 13, 2015 notes were proposed.

3. **Well 27 Radium Investigation & Discussion (Handout)**

   a. **Well Operation Study**

      Provided update on radium investigation. Two pumping scenarios were examined to see if any relationship to radium. Potential sources of radium include Eau Claire shale, base of Mt. Simon, or “red beds” – glaucanite beds 60’ from base of Mt. Simon, also layers in the Tunnel City. Time before equilibrium achieved – 24 hours, 72 hours, 7 days, etc. – is unknown. Tim Grundel from UW Milwaukee might have insights into zones that have highest radium or if there are any trends geologically? Greg previously worked with Tim when exploring aquifer storage and recovery.

   b. **Borehole Investigation**

      Radium is believed to originate at base of Mt. Simon, or in shaley layers of the Tunnel City or Eau Claire formations. WGS staff has applied for a grant to analyze core samples for possible radium occurrence (not specifically related to Well 27). Utility planning a borehole study for spring 2016.

4. **Wellhead Protection – Well 6 & Well 9 Study**

   Using the updated Dane County Groundwater Flow Model, potential sources of PCE contamination to Wells 6 & 9 were identified. Probable sources are former and active dry cleaners. At Well 6 (University Avenue), a former dry cleaner was located about 300’ west of the well, within the 5-year capture zone. An active dry cleaner is currently located at a closed remediation site further west. At Well 9 (Spaanem Avenue) an active dry cleaner and potential source is located approximately 2000’ west of the well. This facility has been operating at this location for at least 60 years.

   When Well 6 operates year-round, rather than seasonally, the increased pumpage has led to increased PCE levels. However, based on historical data, the highest levels of PCE were seen in the mid 1980’s prompting the change to seasonal pumping.

   The committee recommended notifying DNR staff in the Public Water Supply Program and the R&R Program. Janet offered to contact both with the results, if needed. The committee felt the study was a good start and that now the authority and responsibility rests with the DNR to bring about enforcement – to further study and require clean-up. DNR is to determine location of intermediate wells and the pace and thoroughness of any clean-up. Some committee members expressed concern about potential for a good media story.

5. Water Quality Monitoring Results & Discussion

2015 VOC data:

Well 6: PCE between 0.74 – 0.96 μg/L; gradually increasing with increased pumping

Well 9: PCE between 1.4 and 1.8 μg/L

Well 11: Mix of contaminants that are consistently present including cis-1,2-Dichloroethene; TCE; PCE; and Trichlorofluoromethane; combined concentration – 1.8 to 2.4 μg/L.

Well 14: PCE at 0.6 μg/L; TCE occasionally above the detection limit

Well 15: PCE up to 4.2 μg/L in untreated water; below detection in treated water (air stripper)

Well 18: PCE between 1.4 and 3.5 μg/L, four measurements below 2 μg/L; level seems to be higher in the fall. Additional testing of the deep well similar to sampling at Well 27, is tentatively planned for February 2016. Committee discussed the previous pump test, possible impact of the Olin landfill and the larger area of PCE contamination unearthed during Fish Hatchery Road & Emil Street road construction project. An air stripper for Well 18 is included in the Capital Improvement Plan.

Well 27: PCE at 0.25 μg/L

6. Future Agenda Items

- **MWU Master Plan & Capital Improvement Plan**
- **Program Update – Private Well Surveys in Wellhead Protection Areas**
- **Feasibility Study – Conversion to Surface Water Source**

7. Adjournment

Next meeting: Tuesday, April 12, 2016 at 1 p.m. in the Olin Avenue Conference Room.

Water Quality Technical Advisory Committee - DRAFT

Meeting Notes
Olin Avenue Conference Room
April 12, 2016 – 1:00 p.m.

Attending: Janet Battista, Greg Harrington, Jocelyn Hemming, Sharon Long, Amy Barrilleaux, Joe Grande, Al Larson

Absent: Tom Heikkinen, Joe DeMorett

Guests: Gary Krinke (WSLH Chemist); Water Utility staff

Agenda:

1. Agenda Repair/Announcements

Sentinel well test results are not available; agenda item deferred to later meeting. A suggestion was made to invite Brynn Bemis, City Engineering, to a future meeting since she oversees the landfill monitoring program for the City.

The next meeting will be Tuesday, July 12th at 1 p.m.

2. Review of Meeting Notes - No changes to the January 12, 2016 notes were proposed.

3. Well 27 Radium Investigation & Discussion (Handout)

Gary Krinke, WSLH chemist, reviewed the radium results and discussed factors that could impact results. The method of radium-226 analysis is more robust and has fewer and less complicated precipitation steps. The data show widely varying activities (Ra-228) particularly for samples DW-10 through DW-14 which were all collected from the same source within a 12-hour span. Variability more likely related to laboratory factors than underlying geology or well operations. Radium-228 results below 1 pCi/L are suspect given other results for the well. The inconsistent results make drawing definitive conclusions very difficult. As a result, the impact of different well operation schemes on radium levels in pumped water was inconclusive.

Committee recommendations:

- Use 10-liter carboy to obtain true split samples rather than collecting consecutive samples
- Consider duplicate or triplicate samples and using multiple labs when completing borehole investigation
- When discussing radium results, avoid language that implies a single sample exceeds the MCL since compliance with the MCL is determined by the running annual average of quarterly samples. Instead, state the actual test result if above 5 pCi/L.
- Conduct borehole investigation; also consider analysis of borehole core samples (WGS)

4. Water Quality Monitoring Results & Discussion

a. Volatile Organic Compounds (Handout)

Trends for VOC occurrence at Wells 6, 9, 11, 14, 15, 18 and 27 from 2006 to present were reviewed. Discussion focused on (1) intermittent PCE spikes at Well 18, (2) recent upward PCE trend at Well 6, and (3) mix of several VOC contaminants at Well 11. The chart for Well 15 affirmed the wise investment in an air stripper. Committee would like to review any new toxicological data that might impact the MCL or groundwater standards (NR 140) before revising the current water quality treatment policies. Based on current information, believe policies are protective of public health. Stated radium at Well 27 was more problematic than any of these VOC issues. Bill Phelps at the DNR is a point of contact for NR 140 standards development.

b. Sentinel Well Test Results - Deferred to a future meeting.

5. Lead Monitoring Review (Handout)

Reviewed a subset of 2011 and 2014 Lead and Copper Monitoring results highlighting sample locations that had an elevated lead level in at least one previous sampling event. Discussion focused on communication and follow-up of sample results with the property owner. Committee encouraged collaboration with Public Health in the development of risk communication related to lead in water. Supported lead testing recommendation for concerned customers.

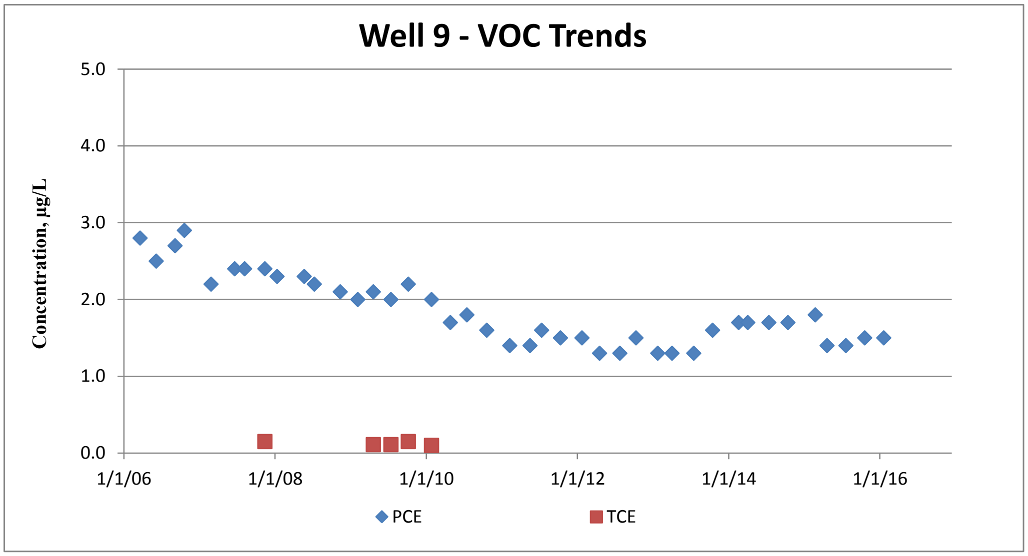
Compliance monitoring for lead and copper to occur in 2017; required sample size will be 50 homes. Recognizing the value of historic records and long-term trends, committee members recommended splitting the homes between repeats and randomly-selected locations. Selection will be limited to 100 homes previously surveyed not the larger sample pool of nearly 600 homes. No lead testing is currently planned for 2016.

6. Future Agenda Items

- **MWU Master Plan & Capital Improvement Plan**
- **Program Update – Private Well Surveys in Wellhead Protection Areas**

7. Adjournment

Next meeting: Tuesday, July 12, 2016 at 1 p.m. in the Olin Avenue Conference Room.


Well 9 - VOC Trends
Concentration, µg/L
5.0
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3.0
2.0
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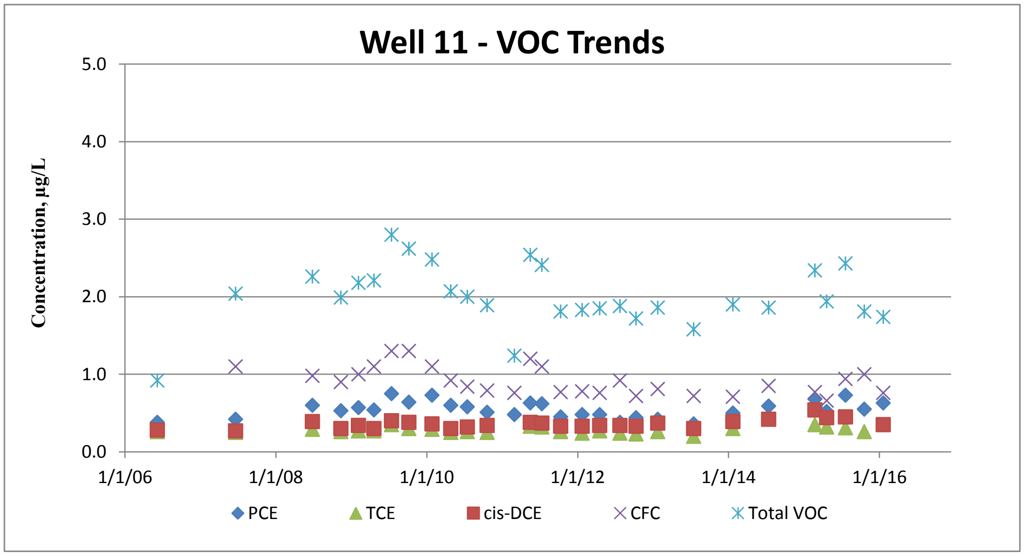
1/1/14
1/1/16
◆ PCE
■ TCE


Well 11 - VOC Trends
Concentration, µg/L
5.0
4.0
3.0
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◆ PCE
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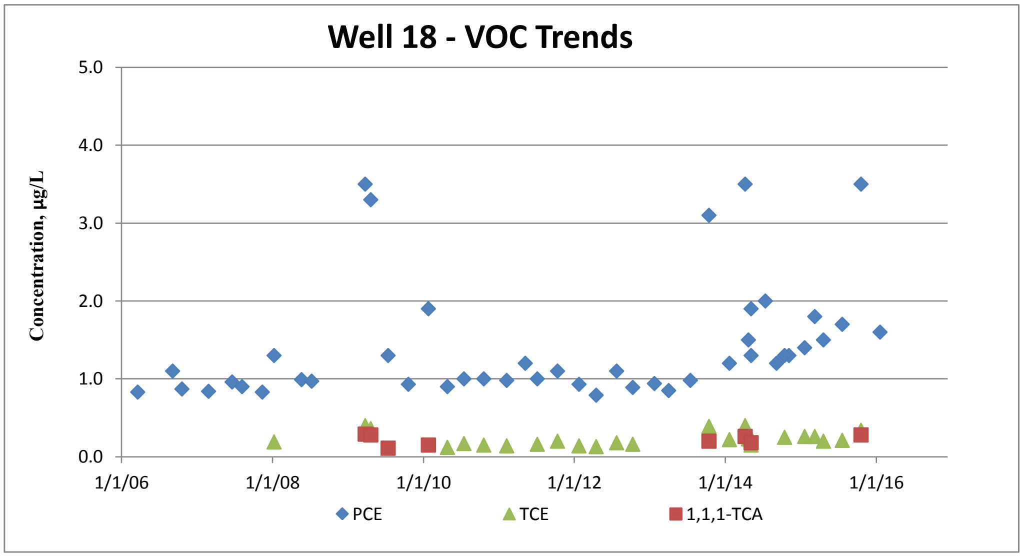
■ cis-DCE
× CFC
✳ Total VOC


Well 18 - VOC Trends
Concentration, µg/L
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◆ PCE
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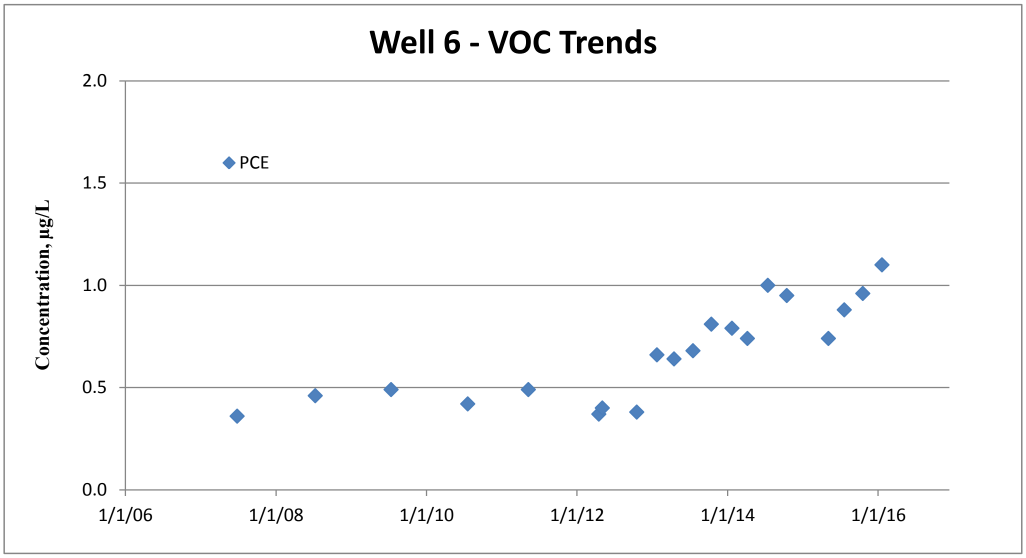
■ 1,1,1-TCA


Well 6 - VOC Trends
Concentration, µg/L
2.0
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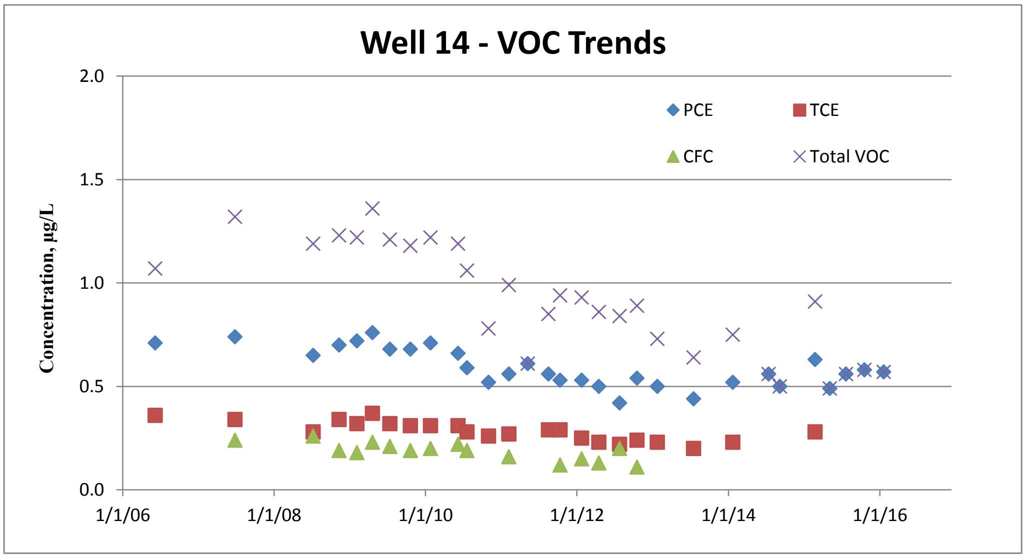
1/1/16
PCE


Well 14 - VOC Trends
Concentration, µg/L
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0.0
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1/1/12
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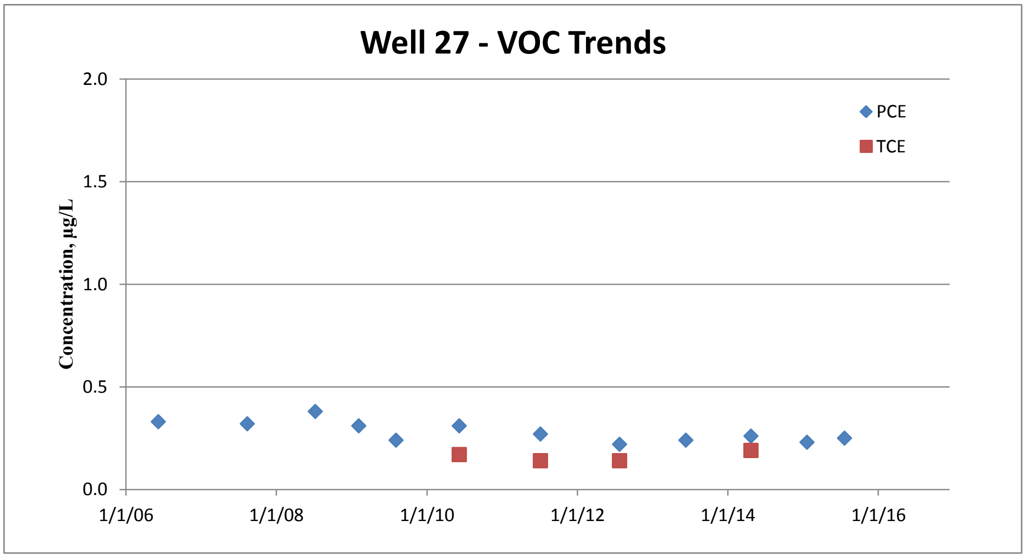
1/1/16
PCE
TCE
CFC
Total VOC


Well 27 - VOC Trends
Concentration, µg/L
2.0
1.5
1.0
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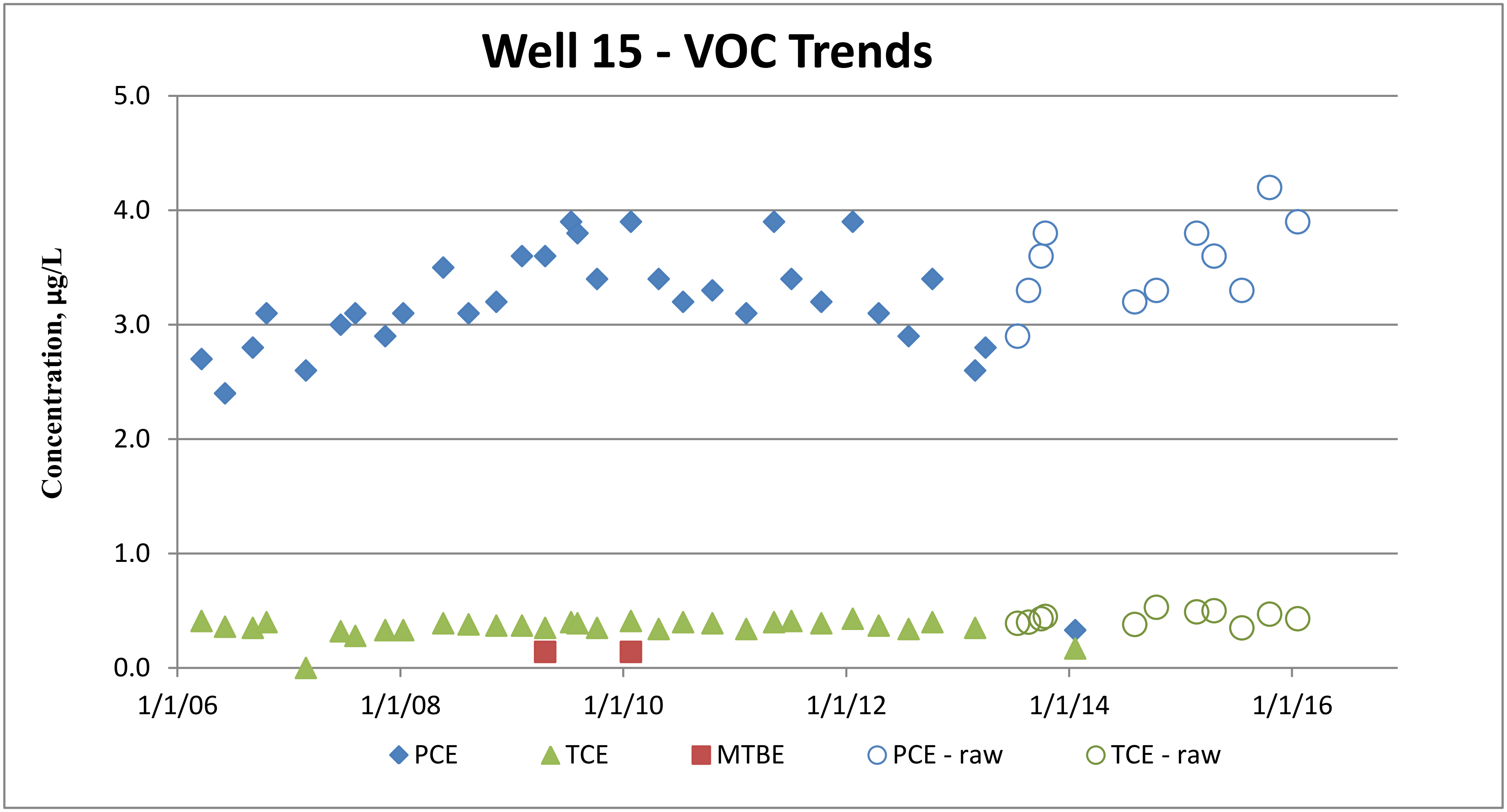
1/1/16
PCE
TCE

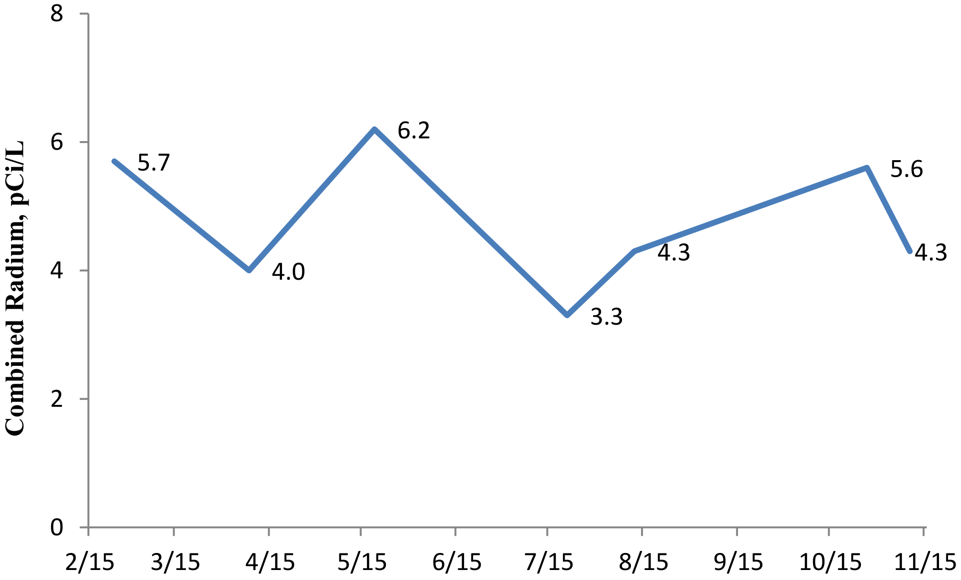


Well 15 - VOC Trends
Concentration, µg/L
5.0
4.0
3.0
2.0
1.0
0.0
1/1/06
1/1/08
1/1/10
1/1/12
1/1/14
1/1/16
PCE
TCE
MTBE
PCE - raw
TCE - raw

Radium Investigation – Well 27

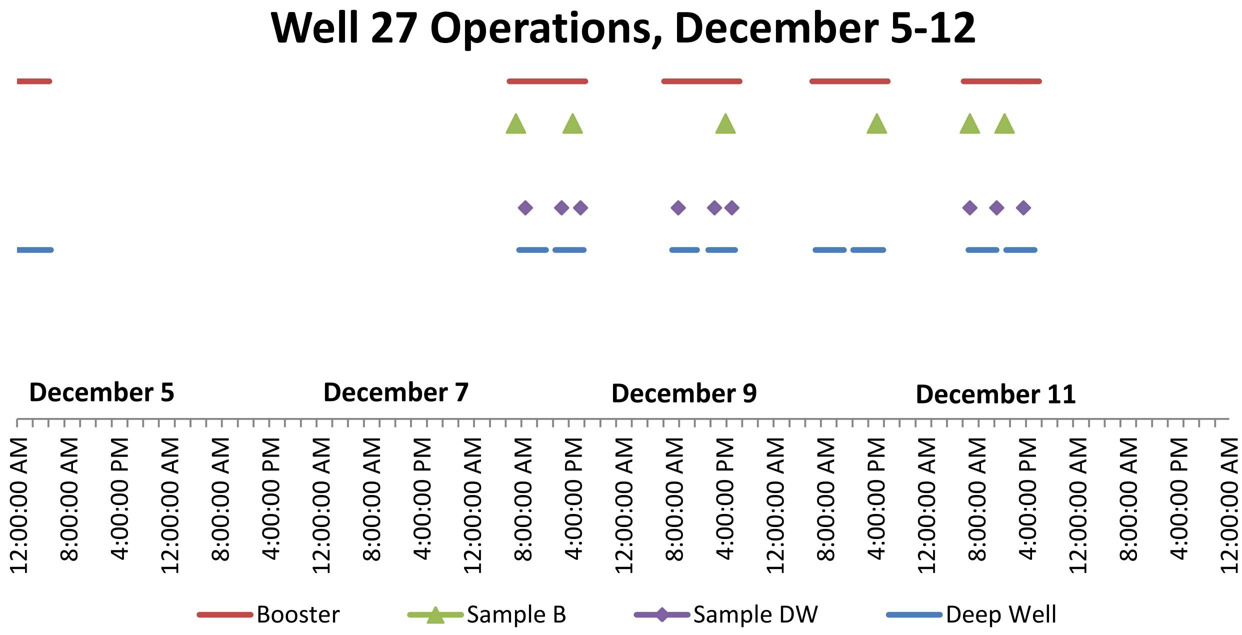
Adoption of water quality treatment policies for radium and other water quality constituents has resulted in the collection and testing of water samples above and beyond those required by the Wisconsin DNR. The new policy increased frequency of radium testing at Well 27 from once every three years to once every quarter, or four times a year. Samples are analyzed for the two isotopes – radium 226 [an alpha particle emitter] and radium 228 [a beta particle emitter] – with regulatory compliance determined by the sum of these two isotopes. The maximum contaminant level [MCL] for combined radium is 5 picocuries per liter, pCi/L.

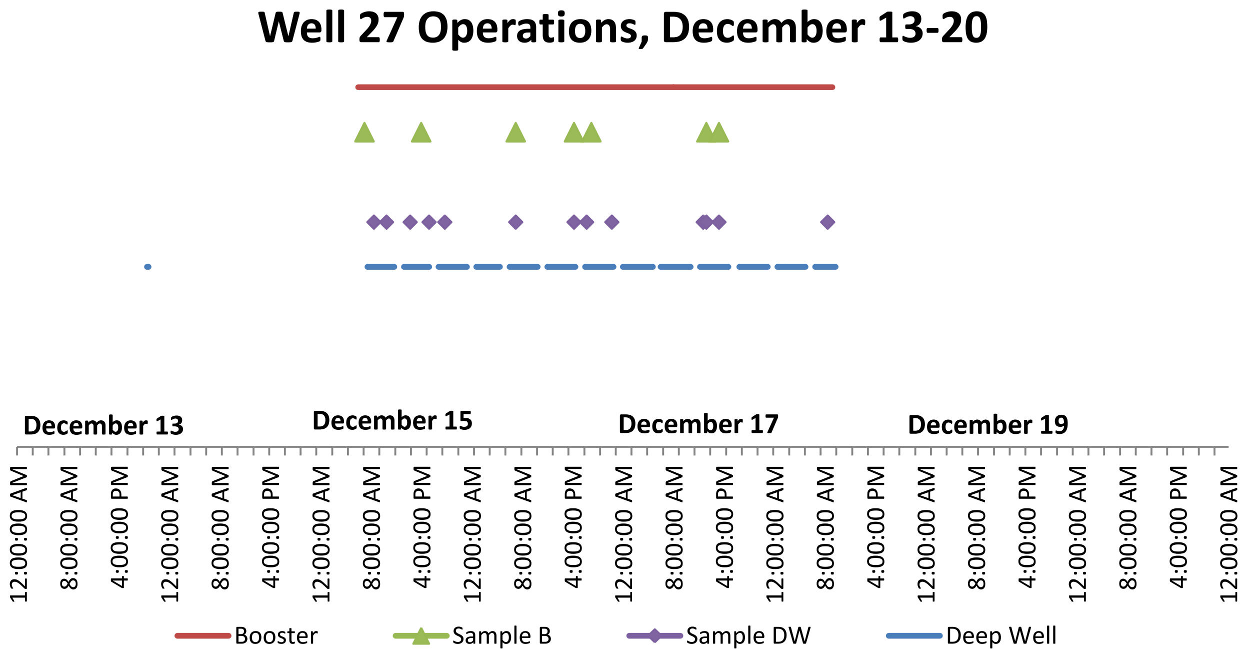
Testing between 2002 and 2014 demonstrated that water from Well 27 had a radium level close to but below the MCL, measuring 3.0 pCi/L in 2002 and 4.9 pCi/L in 2008. Samples collected in 2011 and 2014 fell within that range; however, a sample collected in February 2015 tested above the MCL. A confirmation sample tested below the federal standard but the next quarterly sample again tested above it. After this second high test result, the utility increased monitoring to once a month. In 2015, combined radium at Well 27 has fluctuated between 3.3 and 6.2 pCi/L (see the figure below). Results for September are not included because the laboratory had a problem with that sample.



Radium is a natural constituent of the rock that makes up Madison's underground aquifer. The exact source of elevated radium is currently unknown; however, researchers speculate that it may be associated with shale layers within the Eau Claire formation or brine rich waters at the base of the Mt. Simon aquifer. A possible borehole investigation planned for spring 2016 may reveal the origins of elevated radium at Well 27.

A review of well operations and radium levels at Well 27 showed a potential relationship. For example, three of the MCL exceedances followed periods when the well was run intermittently for 12 to 16 hour with longer periods of not running in between. In mid-December, the utility investigated two scenarios to evaluate the potential impact of operations on radium levels. The first involved alternating between 12 hours of pumping the booster pump followed by 12 hours of rest. This on/off cycle was repeated for four days. During each 12-hour pumping cycle, the deep well cycled on twice and pumped for two, 4-hour periods. For the second scenario, the booster pump was operated continuously for 75 hours with the deep well pump cycling on/off thirteen times – each time operating for about four hours with approximately one hour of rest in between pumping cycles. Both pumping scenarios followed 72 hours of no pumping at the well. Periodic samples were collected from the deep well and booster pumps. Attempts were made to match sampling times between the two scenarios (see figures below).





Sample ID	Cumulative DW Run Time (hr)	Deep Well Cycle #	Time Since DW Start	Sample Match	Combined Radium
Scenario 1 - 12 hours on / 12 hours off (booster); repeated 4 days					
DW-1	1:00	1	1:00	DW-10	4.7 pCi/L
DW-2	5:20	2	1:02	DW-12	4.4
DW-3	8:19	2	4:01	DW-13	3.5
DW-4	9:43	3	1:00	DW-14	3.6
DW-5	13:55	4	1:03	--	3.8/4.5
DW-6	16:35	4	3:43	--	4.0
DW-7	26:31	7	0:10	DW-17	1.75
DW-8	30:41	7	4:20	DW-18	3.2
DW-9	33:37	8	2:54	--	2.9
Scenario 2 - 75 hours of continuous operation (booster)					
DW-10	1:02	1	1:02	DW-1	4.2
DW-11	3:02	1	3:02	--	1.39
DW-12	5:18	2	1:02	DW-2	7.1
DW-13	8:16	2	4:00	DW-3	3.7
DW-14	9:22	3	1:00	DW-4	2.27
DW-15	17:22	5	0:57	--	3.9
DW-16	24:53	6	4:00	--	4.1
DW-17	25:22	7	0:10	DW-7	4.9
DW-18	29:32	7	4:20	DW-8	4.3/3.3
DW-19	39:19	10	0:30	--	--
DW-20	39:49	10	1:00	--	1.71/4.7
DW-21	41:49	10	3:00	--	3.3
DW-22	54:34	13	2:01	--	3.1
Restart normal operations; 72-hour rest					
DW-23	0:30	1	0:30	--	4.2

Sample ID	Cumulative Booster Run Time (hr)	Combined Radium	Sample ID	Cumulative Booster Run Time (hr)	Combined Radium
Scenario 1 - 12 hrs on / 12 hrs off			**Scenario 2 - 75 hrs continuous operation**		
B-1	1:00	4.6	B-7	1:00	2.7 pCi/L
B-2	10:00	4.4	B-8	10:02	2.27
B-3	21:40	3.6	B-9	25:08	4.3
B-4	34:19	5.6	B-10	34:17	3.8
B-5	36:59	3.0	B-11	37:02	1.46
B-6	42:29	3.4/3.4	B-12	55:22	3.8
			B-13	57:22	4.4

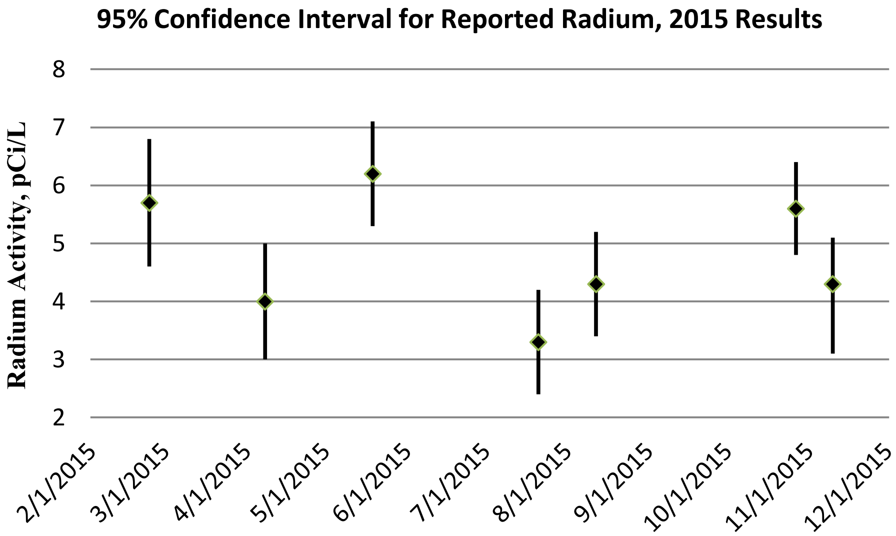
Objectives

The objective of this investigation was to investigate whether well operations plays a role in the radium level observed in water pumped from either the deep well or booster, or both. Given the current understanding of potential sources of elevated radium, there were two plausible outcomes when examining radium levels in water pumped from the deep well:

- If the radium source was primarily the Eau Claire formation, one would expect the radium level to be higher at the beginning of pumping and gradually diminish over time, and the response would be muted in Scenario 1, as compared to Scenario 2, where the aquifer was allowed to recover for 12 hours between pumping cycles.

- Alternatively, if elevated radium was associated with groundwater at the base of the Mt. Simon aquifer, one would expect relatively lower radium concentrations near the onset of pumping with the radium level expected to rise as the duration of pumping increased. The radium response would be greater in Scenario 2 where the deep well pumping was higher (nearly double) and there was less time for aquifer recovery.

One potential limitation of this study relates to the uncertainty or counting error associated with radium measurements especially when radium activity is low and/or close to the detection limit. For example, previous results for radium at Well 27 ranged from 3.3 to 6.2 pCi/L; however, the reported 95% confidence interval was 1 pCi/L, or 14-27% of the magnitude of the radium result. The analytical method itself may be too coarse for one to compare, with statistical significance, results between two pumping scenarios or two periods within the same scenario. Nevertheless, the high number of samples collected in this investigation can provide insights into the expected range and variability of radium results under a given pumping scenario.



Results and Discussion

Overall, radium 226 was less variable than radium 228. In particular, radium 226 results for the deep well samples ranged from 1.4 to 2.0 pCi/L. The average and standard deviation were 1.6 and 0.16 pCi/L, respectively. Radium 228 varied from 0.0 to 5.6 pCi/L with an average and standard deviation of 2.1 and 1.20 pCi/L. Similar summary statistics held for booster samples. Complete test results can be found in Tables A-1 and A-2.

During the two week test period, combined radium for 25 deep well samples averaged 3.7 pCi/L while combined radium for 14 booster samples averaged 3.6 pCi/L. The range of results for the booster samples (1.5 – 5.6 pCi/L) in this investigation was similar to the range observed during the remainder of the year (3.3 – 6.2 pCi/L).

There were no significant differences in radium 226 when comparing results between the two pumping scenarios. The average radium 228 result was not significantly different in Scenario 2 when compared to Scenario 1but the results were more highly variable. The standard deviation of radium 228 under Scenario 2 was nearly double that of Scenario 1 (1.50 vs. 0.87 pCi/L).

	Scenario 1		**Scenario 2**	
	Ra 226	Ra 228	Ra 226	Ra 228
Minimum	1.4	0.1	1.4	0.0
Average	1.6	2.0	1.6	2.1
Maximum	1.8	3.0	1.9	5.6
St deviation	0.14	0.87	0.15	1.50

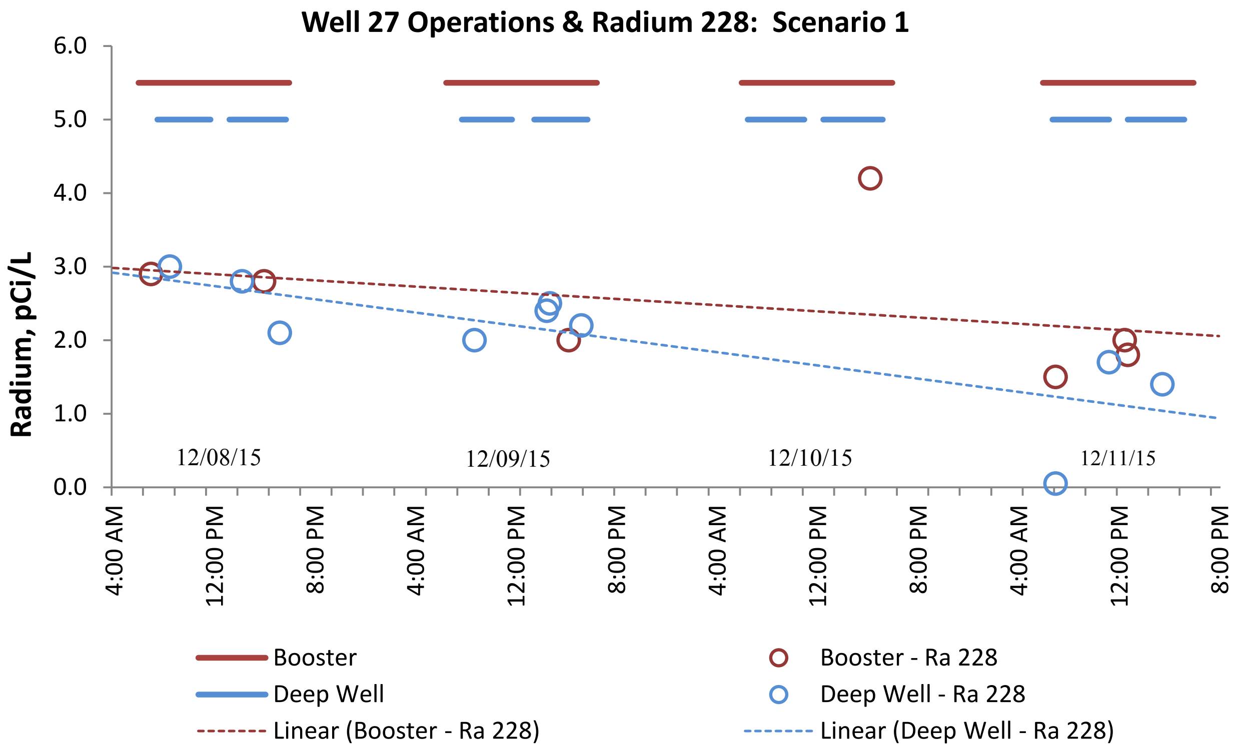
Radium 226 levels did not appear to be influenced by either pumping scenario. During the four-day test periods, radium 226 stayed within a narrow range.

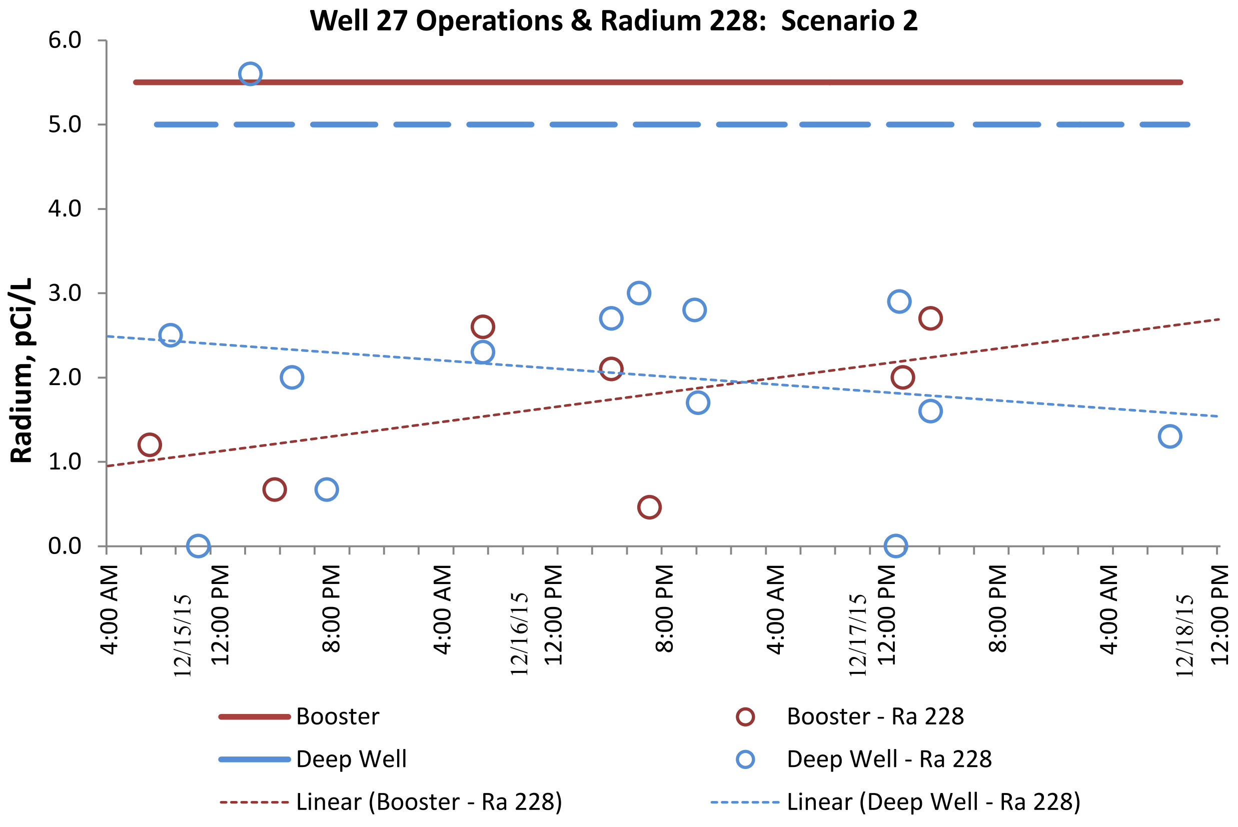
Radium 228: Comparison of Pumping Scenarios

Pumping Scenario 1 appeared to influence the radium 228 level in water pumped from the deep well. In particular, radium 228 exhibited a downward trend over the four days of pumping. This trend was more evident in well samples compared to booster samples. In Pumping Scenario 2, divergent trends were observed for radium 228. Deep well samples trended downward while the booster samples increased as the test progressed. The deep well trend was strongly influenced by a single sample [DW-12] which had the highest radium 228 result – 5.6 pCi/L. Without this data point, the slope would be flat or slightly positive.

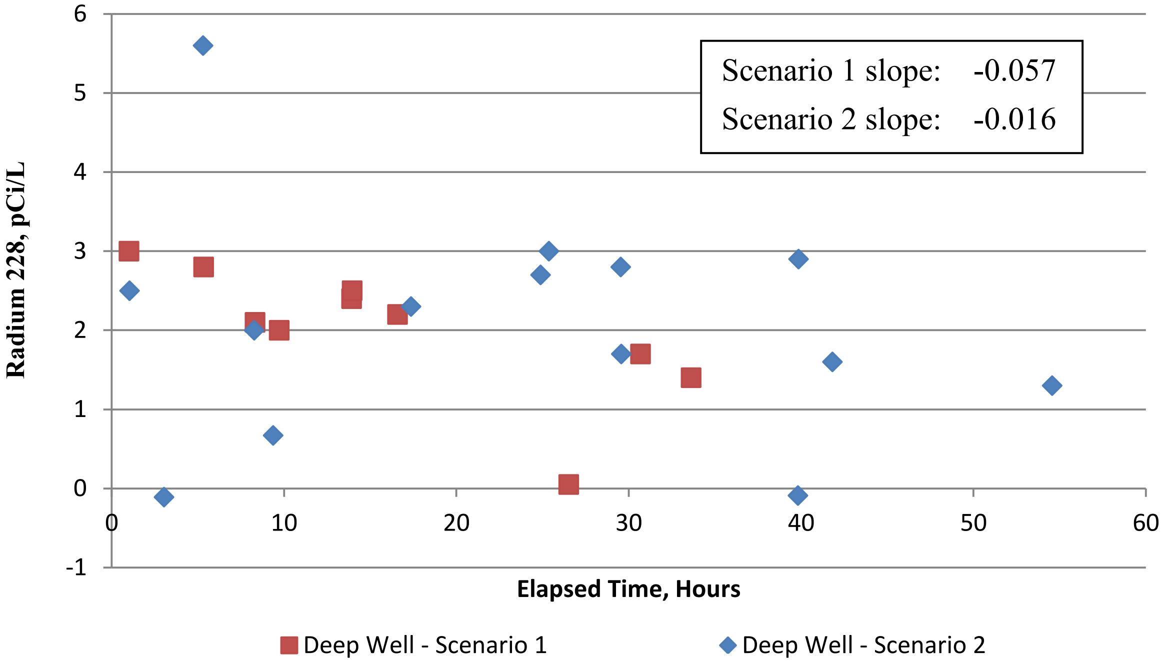
Radium 228: Cumulative Pumping Effects

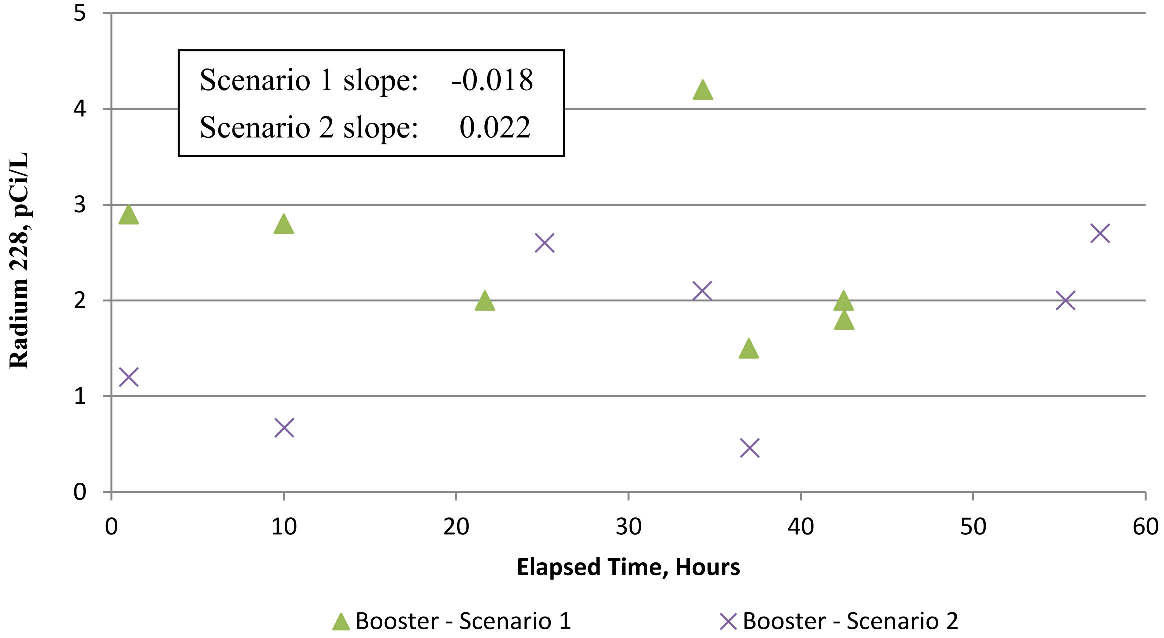
Cumulative deep well pumping time also appeared to influence radium 228 levels. Scenario 1 initially resulted in radium 228 between 2.5 and 3.0 pCi/L; however after 16 hours of pumping, radium 228 was below 2.0 pCi/L. Except for an extreme outlier, radium 228 was initially lower


Well 27 Operations & Radium 228: Scenario 1
Radium, pCi/L
6.0
5.0
4.0
3.0
2.0
1.0
0.0
12/08/15
12/09/15
12/10/15
12/11/15
4:00 AM
12:00 PM
8:00 PM
4:00 AM
12:00 PM
8:00 PM
4:00 AM
12:00 PM
8:00 PM
4:00 AM
12:00 PM
8:00 PM
Booster
Deep Well
Linear (Booster - Ra 228)
Booster - Ra 228
Deep Well - Ra 228
Linear (Deep Well - Ra 228)


Well 27 Operations & Radium 228: Scenario 2
Radium, pCi/L
6.0
5.0
4.0
3.0
2.0
1.0
0.0
4:00 AM
12/15/15
12:00 PM
8:00 PM
4:00 AM
12/16/15
12:00 PM
8:00 PM
4:00 AM
12/17/15
12:00 PM
8:00 PM
4:00 AM
12/18/15
12:00 PM
Booster
Deep Well
Linear (Booster - Ra 228)
Booster - Ra 228
Deep Well - Ra 228
Linear (Deep Well - Ra 228)

during Scenario 2 compared to Scenario 1. After 20 hours of deep well pumping, radium 228 was lower under Scenario 1 pumping conditions. Similarly, radium 228 was generally lower for samples taken after 20 hours of booster pump run time under Scenario 1 compared to Scenario 2.





Conclusions

Well operations do not appear to impact radium 226 levels. Radium 226 was consistently present within a narrow, predicable range regardless of well pumping. On the other hand, well operations did appear to influence radium 228 levels although results were highly variable for this isotope. Continuous booster pump operation, in which the deep well alternately cycles on and off [Scenario 2], resulted in initially lower radium 228 levels that increased slightly as the test progressed. After about 20 hours of deep well run time under Scenario 1, radium 228 was consistently below 2.0 pCi/L and lower than radium 228 levels observed under Scenario 2.

The results of this study may be used to ensure that water delivered from Well 27 is capable of consistently meeting the federal standard for radium. Radium 226 routinely tested below 2 pCi/L regardless of well operations. To meet the regulatory limit, radium 228 must be maintained below 3 pCi/L. Operating the booster pump for 12 hours daily for four consecutive days was shown to result in radium 228 below this level. Furthermore, operating under these conditions, radium 228 tested below 2 pCi/L after about 16 hours of cumulative deep well run time. More testing would be needed to confirm that radium 228 remains low after sustained pumping and throughout the year as seasonal demand ebbs and flows.

Table A-1. Radium results, in pCi/L, for deep well samples from Well 27

Sample	Date	Ra 226	Ra 228	Combined	+/-
DW-1	12/8/2015	1.7	3.0	4.7	0.6
DW-2	12/8/2015	1.6	2.8	4.4	0.7
DW-3	12/8/2015	1.4	2.1	3.5	0.6
DW-4	12/9/2015	1.6	2.0	3.6	0.6
DW-5	12/9/2015	1.4	2.4	3.8	0.6
DW-5d	12/9/2015	2.0	2.5	4.5	0.6
DW-6	12/9/2015	1.8	2.2	4.0	0.7
DW-7	12/11/2015	1.7	0.05	1.75	0.61
DW-8	12/11/2015	1.5	1.7	3.2	0.7
DW-9	12/11/2015	1.5	1.4	2.9	0.6
DW-10	12/15/2015	1.7	2.5	4.2	0.5
DW-11	12/15/2015	1.5	-0.11	1.39	0.5
DW-12	12/15/2015	1.5	5.6	7.1	0.8
DW-13	12/15/2015	1.7	2.0	3.7	0.6
DW-14	12/15/2015	1.6	0.67	2.27	0.62
DW-15	12/16/2015	1.6	2.3	3.9	0.6
DW-16	12/16/2015	1.4	2.7	4.1	0.6
DW-17	12/16/2015	1.9	3.0	4.9	0.7
DW-18	12/16/2015	1.5	2.8	4.3	0.6
DW-18d	12/16/2015	1.6	1.7	3.3	0.6
DW-20	12/17/2015	1.8	-0.09	1.71	0.65
DW-20d	12/17/2015	1.8	2.9	4.7	0.7
DW-21	12/17/2015	1.7	1.6	3.3	0.5
DW-22	12/18/2015	1.8	1.3	3.1	0.7
DW-23	12/21/2015	1.5	2.7	4.2	0.7

Average	1.63	2.07	3.70
Standard Dev.	0.16	1.20	1.19
	10%	58%	32%

Table A-2. Radium results, in pCi/L, for entry point samples from Well 27

Sample	Date	Ra 226	Ra 228	Combined	+/-
B-1	12/8/2015	1.7	2.9	4.6	0.7
B-2	12/8/2015	1.6	2.8	4.4	0.7
B-3	12/9/2015	1.6	2.0	3.6	0.6
B-4	12/10/2015	1.4	4.2	5.6	0.7
B-5	12/11/2015	1.5	1.5	3.0	0.7
B-6	12/11/2015	1.4	2.0	3.4	0.7
B-6d	12/11/2015	1.6	1.8	3.4	0.5
B-7	12/15/2015	1.5	1.2	2.7	0.6
B-8	12/15/2015	1.6	0.67	2.27	0.64
B-9	12/16/2015	1.7	2.6	4.3	0.7
B-10	12/16/2015	1.7	2.1	3.8	0.5
B-11	12/16/2015	1.0	0.46	1.46	0.69
B-12	12/17/2015	1.8	2.0	3.8	0.5
B-13	12/17/2015	1.7	2.7	4.4	0.6

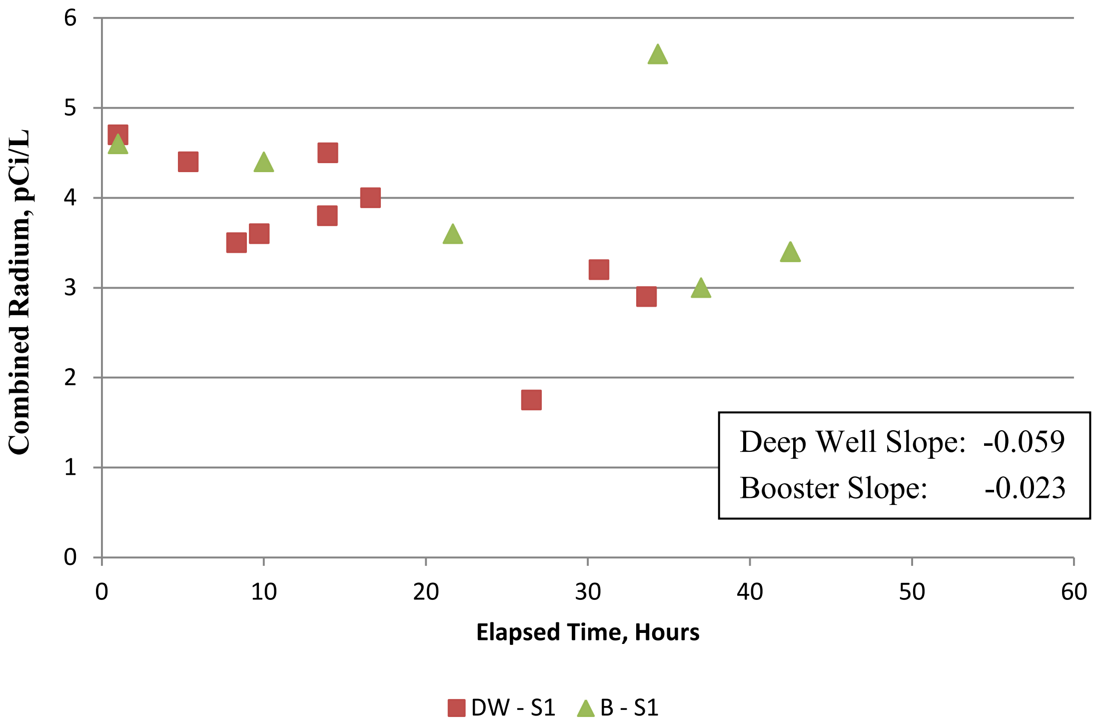


Figure A-1. Combined radium results for Pumping Scenario 1.

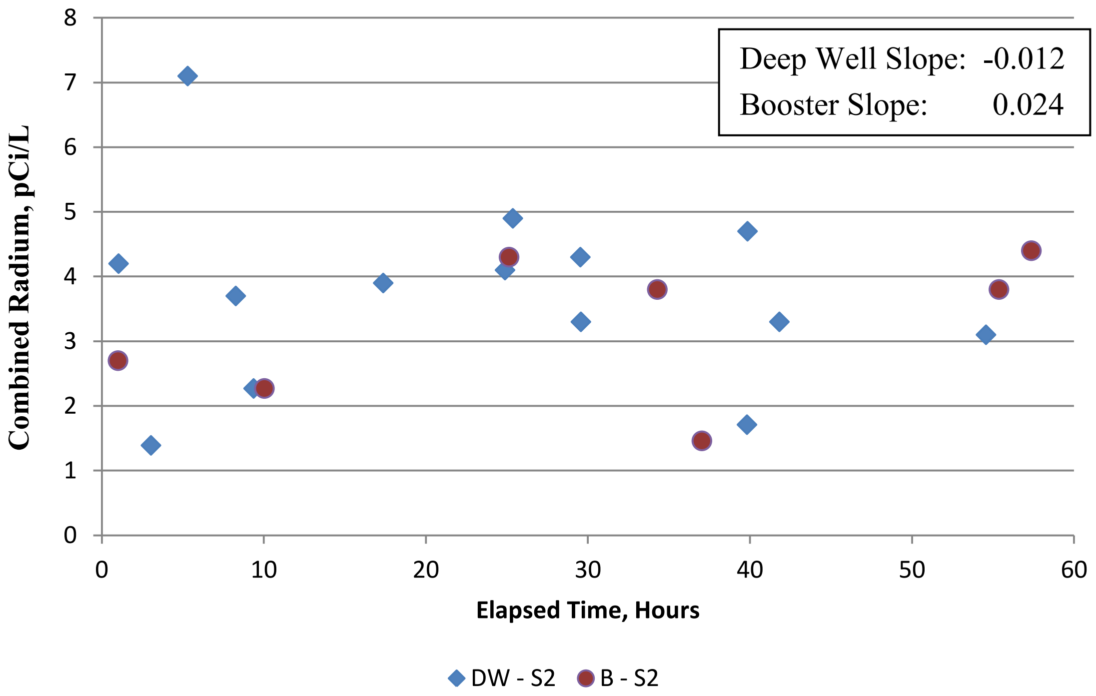


Figure A-2. Combined radium results for Pumping Scenario 2.

Lead Review - 2016

Site ID	Area	Location	Sample Date	Pb Total ug/L	Pb Diss ug/L	Mn ug/L	Fe mg/L	Sample Date	Pb Total ug/L	Pb Diss ug/L	Mn ug/L	Fe mg/L	Sample Date	Pb Total ug/L
11-45	NW	Bath	4/21/2011	3.1	3.0	0.7	**0.001**	9/29/2011	3.9	3.7	2.0	**0.001**	7/16/2014	5.6
92-39	NE	Kitchen	4/18/2011	3.3	1.9	2.6	0.012	9/28/2011	4.3	3.4	1.4	0.006	7/16/2014	3.6
11-44	NW	Kitchen	4/19/2011	2.8	2.6	0.2	0.003	9/29/2011	3.4	2.7	0.2	0.013	7/17/2014	3.5
11-21	EB	Kitchen	5/1/2011	1.4	0.6	2.4	0.024	9/28/2011	0.5	**0.5**	**13**	0.040	7/17/2014	10.4
11-100	W	Kitchen	4/20/2011	1.6	**0.5**	7.4	0.078	9/28/2011	8.6	3.9	1.7	0.002	8/27/2014	1.8
11-27	S	Kitchen	4/17/2011	1.7	1.5	0.6	0.009	9/28/2011	2.6	2.1	0.3	0.008	7/25/2014	5.7
92-59	SW	Kitchen	4/20/2011	0.8	0.7	0.4	**0.001**	9/28/2011	0.9	0.8	**0.2**	**0.001**	7/16/2014	5.5
11-37	NE	Kitchen	4/17/2011	4.2	2.6	2.9	0.011	9/28/2011	3.6	2.5	2.9	0.006	7/16/2014	1.8
11-58	SW	Kitchen	5/20/2011	1.1	1.0	**0.2**	**0.001**	9/27/2011	1.8	1.0	**0.2**	**0.001**	7/16/2014	3.4
11-101	E	Kitchen	--	--	--	--	--	12/9/2011	2.4	1.3	2.7	0.034	7/18/2014	3.1
11-42	C	Kitchen	4/17/2011	9.0	**0.5**	**34**	**0.217**	9/29/2011	4.3	**0.5**	**21**	0.099		n/s
11-4	E	Kitchen	4/17/2011	8.9	**0.5**	7.9	0.075	9/28/2011	11.5	**0.5**	5.8	0.084		n/s
11-82	W	Kitchen	5/10/2011	5.6	5.6	**0.2**	**0.001**	11/3/2011	3.9	3.2	0.8	0.007		n/s
11-19	EB	Kitchen	4/19/2011	20.6	**0.5**	**44**	**0.390**	9/30/2011	1.3	**0.5**	7.2	0.028		n/s
11-87	W	Kitchen	4/21/2011	1.8	**0.5**	5.8	0.055	9/30/2011	17.5	3.8	3.3	0.063		n/s
11-51	SW	Kitchen	5/11/2011	2.6	2.2	0.5	**0.001**	10/5/2011	5.5	5.5	**0.2**	**0.001**		n/s
92-26	EB	Kitchen	4/18/2011	2.1	1.1	1.5	0.020	9/30/2011	4.2	0.5	**14**	0.048		n/s
11-24	EB	Kitchen	4/16/2011	3.0	2.0	2.7	0.014	9/28/2011	3.2	0.7	**12**	0.035		n/s

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January 22, 2016

Linda Hanefeld
Remediation & Redevelopment (RR) Program
Wisconsin Department of Natural Resources
3911 Fish Hatchery Road
Fitchburg, WI 53711

Dear Ms. Hanefeld,

The City of Madison Water Utility strives to deliver the highest quality drinking water possible and has demonstrated a commitment to continual improvement of our finished water. As evidence of this objective, the utility installed filtration for iron and manganese removal, low-profile tray aeration for VOC removal, and reconstructed a well to mitigate radium in recent years. Two wells have also been abandoned as a result of water quality problems – carbon tetrachloride pollution and manganese occurrence. As part of wellhead protection activities, the utility recently contracted with an environmental consultant to investigate sources of VOC contamination, namely tetrachloroethene (PCE), at two of our existing wells – one on University Avenue (Well No. 6) and the other on Spaanem Avenue (Well No. 9).

The consultant utilized the updated Dane County Groundwater Flow Model to simulate capture zones for each well and then obtained a Radius Map Report from Environmental Database Resources, Inc. (EDR) to identify potential contamination sources within these capture zones. Once identified, case files for potential sources were further investigated at the Department of Natural Resources. This analysis identified two open Environmental Repair Program (ERP) sites that are probable PCE sources to each well. The sites include the McGettigan Property located at 2803-2809 University Avenue (**#02-13-321347**), a former dry cleaning site, and Klinke Dry Cleaners at 4518 Monona Drive (**#02-13-551928**), an active dry cleaner that has been in business for over 60 years. The review also identified another active dry cleaner, located at 2875 University Avenue (**#02-13-551964**); this site has been remediated and subsequently granted site closure with residual contamination and placed on the GIS registry with continuing obligations.

The review of the case files for these two open ERP sites indicates that high concentrations of PCE, two and three orders of magnitude above the Enforcement Standard [5μg/L], are present in the bedrock groundwater and are probable sources of PCE contamination at each well. There is no indication that the contamination plume from either site has been delineated laterally or vertically. Furthermore, there is no evidence that any remedial action has begun at these ERP sites to either clean up the site or mitigate transport of groundwater contamination from the source. The proximity of each well, particularly Well No. 6, to these open sites warrants urgent action to remediate the sites and eliminate current and future impacts of the contamination on Madison's two municipal wells.

The Water Utility requests that the following actions are begun immediately and without delay:

1) Monitor shallow groundwater for chlorinated solvents, including PCE, at offsite locations
2) Delineate the vertical and horizontal extent of the contaminant plume
3) Conduct a remedial options study to identify alternatives for treating the groundwater
4) Implement a remediation alternative with the objectives of both cleaning up the site and drawing the contaminant plumes away from the Madison production wells.

Groundwater contamination at each of these ERP sites has been known for many years. Now is the time to expedite, without delay, the process of remediating these sites with the immediate goal of eliminating the impact of PCE contamination from these sources on Madison's municipal wells.

A copy of the consultant report is included with this request for action. Please contact either me or Water Quality Manager Joe Grande, at 261-9101, if you have any questions about the report and its conclusions.

Thank you in advance for your prompt consideration of our requests. We look forward to accelerated action on the investigation and remediation of these known contamination sites, your effort to expedite the process, and cleaner, safer drinking water for our citizens.

Sincerely,

T. Heff

Tom Heikkinen
General Manager

cc: Joseph Grande, Water Quality Manager
Joe Demorett, Water Supply Manager
Doran Viste, Assistant City Attorney
Dave Barkhahn, DNR, System Engineer
Mike Schmoller, DNR, Project Manager (Klinke Dry Cleaners Monona, #02-13-551928)
Wendell Wojner, DNR, Project Manager (McGettigan Property, #02-13-321347)

Enclosure:

Assessment of the Source of Tetrachloroethene Contamination at Madison Unit Wells 6 and 9; RJN Environmental Services, LLC report dated December 16, 2015.

RJN Environmental Services, LLC
Surface Water Studies
Groundwater Studies
Site Investigations

December 16, 2015

Mr. Joseph Grande, Water Quality Manager
City of Madison Water Utility
119 E. Olin Avenue
Madison, WI 53713

RE: Assessment of the Source of
Tetrachloroethene Contamination
Madison Unit Wells 6 and 9

Dear Mr. Grande:

Pursuant to RJN Environmental Services, LLC's (RJN's) approved proposal, RJN has assessed potential sources of tetrachloroethene (PCE) contamination present in City of Madison Water Utility's (the Utility) Unit Wells 6 and 9. This assessment was essentially a three-step process. A Radius Map Report was obtained for both wells through Environmental Database Resources, Inc. (EDR); capture zones for the two wells were simulated using the new Dane County groundwater flow model, developed by the Wisconsin Geological and Natural History Survey, in conjunction with the US Geological Survey; and the files for potential sources were reviewed at the Wisconsin Department of Natural Resources (WDNR).

The new Dane County flow model is a significant improvement over the previous model in that the grid spacing is significantly reduced, and additional layers have been added, resulting in better resolution vertically and laterally.

The process used for all simulations of capture was to run the model at the desired pumping rate to establish the groundwater flow conditions, and then use the MODPATH particle tracking function to define the capture. For this, a "circle" of particles was placed at the well, and MODPATH was run in reverse mode, for the defined time limit. Pursuant to Madison's wellhead protection practices, simulations were run for 5, 50 and 100 years. Finally, because the legally-protected wellhead protection areas in the City's zoning ordinance is defined by the 5-year capture zone at the well's full capacity, this was also simulated.

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Environmental Fate of Tetrachloroethene

In general, it is accepted that PCE degrades in accordance with a first-order decay process. A reverse first order decay calculation was calculated, using the equation[1]:

$$C = C_0e^{-kt}$$

Where:

C = the concentration at time t
C_0 = the initial concentration
K = ln 2/Half life
t = time of concentration calculation

Using the high-end tabulated half-life of 4.5 years[2], and assuming a concentration at the well of 5 µg/L, the concentrations versus time shown on Figure 1 were plotted. As indicate above, based on the history of the use of PCE, it is feasible that a source could date back as much as 100 years. However, the solubility of PCE in water is 15 mg/L. Assuming the source would not extend further than the level of solubility, we end up with a likely maximum range of about 65 to 70 years. Consequently, a 70-year capture zone was also simulated for each of the model runs.

Unit Well 6

Capture Zones and Potential Contaminant Sources

The production zone of Unit Well 6 is simulated in model layers 10, 11 and 12, which represent the Wonewoc fracture zone, and the Eau Claire and Mount Simon formations, respectively. At the request of the Utility, Unit Well 6 was simulated at two different pumping rates, based on historical use: 0.68 million gallons per day (MGD) and 1.65 MGD. These rates were simulated because they represent the average daily pumping rates when the well is used seasonally (0.68 MGD) and year-round (1.65 MGD). The full capacity for Unit Well 6 is 3.46 MGD, which was also simulated. Figure 2 shows the simulated capture zones, for the timeframes summarized above, for a pumping rate of 0.68 MGD. Also shown on Figure 2 are the potential contaminant sources, as plotted in the EDR Radius Map Report. The potential contaminant sources are summarized in Table 1.

Figure 3 shows the simulated capture zone with a simulated pumping rate of 1.65 MDG. As the figure indicates, at this larger pumping rate, the capture zone is drawn north, toward Lake Mendota. Additionally, it shows that some layers (10 and 11) are drawn in a different direction than the main production layer, model layer 12. This kind of resolution was not possible in the earlier model, which simulated the well's production zone in a single model layer. The potential contaminant sources plotted on Figure 3 are also summarized in Table 1.

---

[1] *Chemistry for Environmental Engineering*, Claire Sawyer and Perry McCarty, 1978.

[2] *Handbook of Environmental Degradation Rates*, Philip H. Howard, et al., 1991.

Finally, Figure 4 shows the 5-year capture zone with the well pumping at a rate of 3.456 MGD, as well as the potential sources within it.

Discussion of Potential Contaminant Sources

Two potential sources of PCE, one an open site, and one closed, are within a 5-year time of travel in both the 0.68 MGD and the 1.65 MGD simulations. The WDNR has issued closure to the Klinke Cleaners site (item 12 on the map); however, due to its proximity to Unit Well 6 it could be a historic source.

The McGettigan site, located immediately west of the well, is an open dry cleaner site. The detected concentrations of PCE in groundwater at that location (220 µg/L) are over 40 times the Enforcement Standard of 5 µg/L, and that detection is in bedrock. The concentration, combined with the depth of impact and its extreme proximity to Unit Well 6 make it very likely that a pumping well would draw PCE in with very little attenuation.

Unit Well 9

Capture Zones and Potential Contaminant Sources

The production zone for Unit Well 9 is represented by model layers 7 through 12, which represent the Tunnel City fracture zone, Lower Tunnel City Formation, Wonewoc Formation, Wonewok fracture zone, the Eau Claire Formation and the Mount Simon Formation. Unit Well 9 operates year-round, so rather than scenarios based on seasonal use, the capture zones for simulated pumping rate of 1.27 (average for years 2010 through 2014), and a rate of 1.48 MGD (average for years 2005 through 2009) were simulated. These capture zones are plotted on Figures 5 and 6, respectively. As with Unit Well 6, the rates were selected based on average day seasonal and year-round rates, respectively. The two plots are very similar, with only a slightly larger capture zone at 1.48 MGD. The 5-year capture zone at full capacity (2.45 MGD) is plotted on Figure 7.

Discussion of Potential Contaminant Sources

Although numerous sites with a contamination history are present in the Stoughton Road area, the single source of potential PCE contamination is the Klinke Cleaners site, located approximately 2,500 feet west of Unit Well 9. Figure 8 shows the simulated flow path from the Klinke site to Unit Well 9. The simulated travel time for this flow is 41 years. Based on a review of the Klinke website, it appears that the facility has been an active dry cleaning operation since at least the 1950s, or approximately 60 years.

Historically, PCE has been found in groundwater at the Klinke site at concentrations as high as 8,930 µg/L. Based on a first-order decay estimate, PCE could arrive at Unit Well 9 at a concentration of 10 to 20 µg/L, from a starting concentration of 8,930 µg/L. It should be noted that a bedrock investigation has commenced at the Klinke site; however, data from that work have not yet been submitted to the WDNR.

Conclusions and Recommendations

Capture zones were simulated for Unit Wells 6 and 9 using the new Dane County groundwater flow model. Model runs for both sites indicated active sites that are likely sources of the PCE found in the wells. Despite being active sites for years (22 years for the Klinke site (on Monona Drive) and 13 years for the McGettigan site), there is no indication in the files of remedial actions having been taken.

In light of the likelihood of these sites having impacted City of Madison water supplies, RJN recommends that the Madison Water Utility enter into discussions with the WDNR, encouraging them to take action both with respect to more clearly define the impacts from the two sources, and to initiate remedial actions with the immediate goal of eliminating the contaminants from the two wells.

Sincerely,
RJN Environmental Services, LLC

Robert Nauta, PG
Principal and Owner

Cc: Lori Huntoon – Huntoon Environmental Consulting, LLC

TABLES

TABLE 1
POTENTIAL CONTAMINANT SOURCES
UNIT WELL 6

MAP SITE	EDR SITE	NAME	DESCRIPTION	STATUS
1	I	UW Madison Waisman Center	SCHWIMS	Operating
			AST	In use
2	39	UW Hospitals & Clinics	ERP	Closed
			SCHWIMS	Operating
			LUST	Closed
3	22	UW System Environment Health & Safety	Diesel AST	Not in use
4	F	US Veterans Administration Hospital	CERCLIS	Not listed
			UST	5 closed/ removed; 5 in use
			AST	3 closed/ removed; 3 in use
			SCHWIMS	Operating
5	6	Angelica Johnson	Fuel oil UST	Closed/Removed
6	A	Car Care Clinic	Waste oil UST	Closed/Removed
			SCHWIMS	Operating
			CESQG, LQG	No violations found
7	C	Twentieth Century Markets, Inc.	UST	Closed/Removed
8	16	Picketts 76 Service	LUST	Closed
			SCHWIMS	Operating
			Multiple USTs	Closed/Removed
9	17	Carrie Appartments	4 fuel oil USTs	Closed/Removed
10	G	Dick Pierce	UST	Closed/Removed
		Suzanne Voss	UST	Closed/Removed
		Voss Estate	LUST	Closed
11	B	Spirit Mini-Mart	6 USTs	3 removed, 3 in use
		Vista U-Pump	LUST	Closed
		McGettigan Property	DERF	Open
			SCHWIMS	Closed
12	E	Klinke Cleaners	4 petroleum USTs	Closed/Removed
			SCHWIMS	Active
			Petroleum LUST	Closed
			ERP	Closed
13	E23	UW Health University Station Clinic	SCHWIMS	Operating
14	30	Party Port	4 petroleum USTs	Closed/Removed
15	29	Sarko/Rorhobach	Fuel oil UST	Closed/Removed

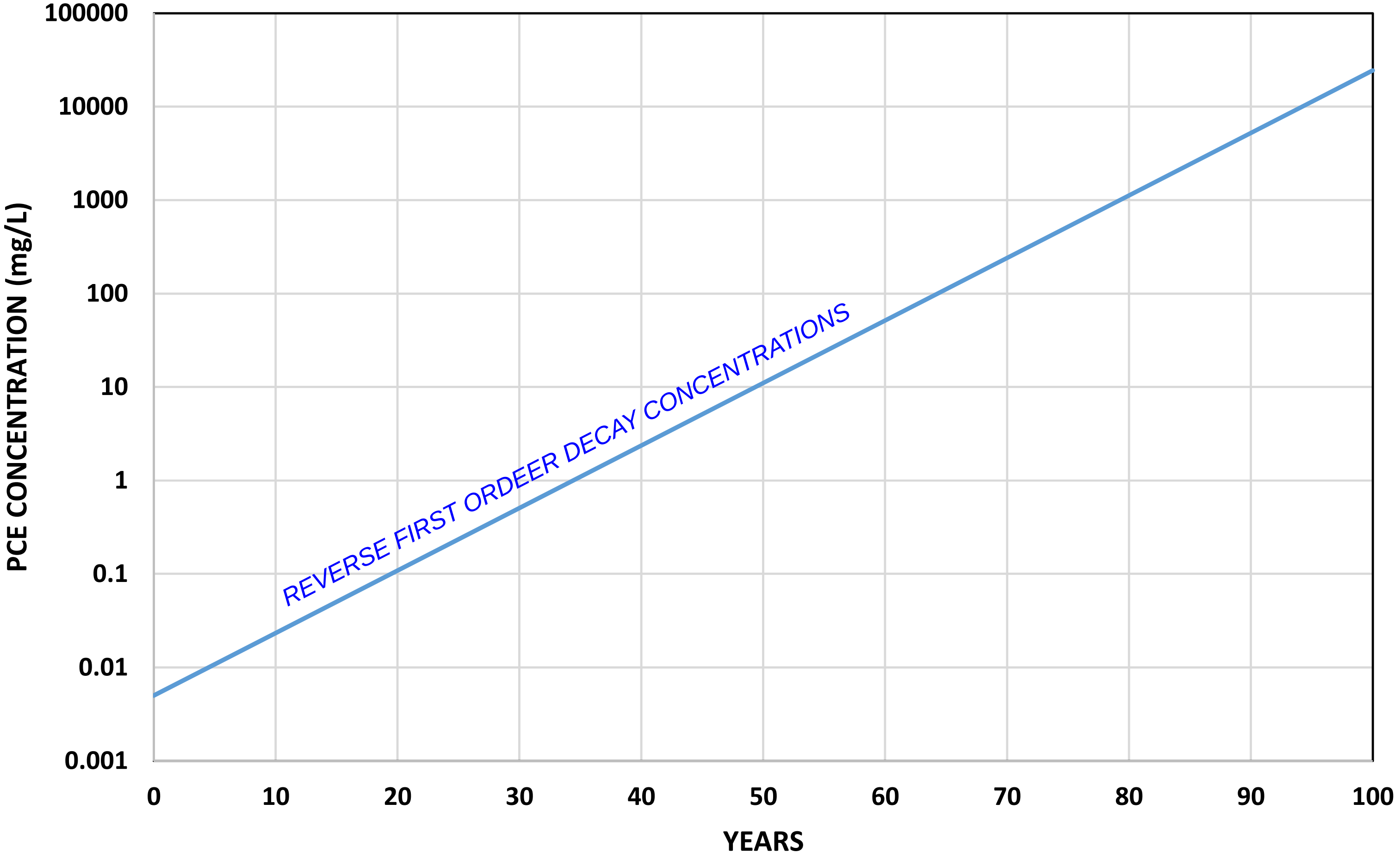
TABLE 1
POTENTIAL CONTAMINANT SOURCES
UNIT WELL 6

16	L	Shorewood Service Center	Petroleum LUST	Closed
		Shorewood Commons	Petroleum & PCE release	Open
17	53	Ideal Vault Company	ERP	Closed
18	55	Shorewood Hills Village Landfill	ERP	Closed
			SCHWIMS	Unknown
19	54	Hilldale Firestone Tire & Service	ERP	Closed
			SCHWIMS	Open

TABLE 2
PIOTENTIAL CONTAMINANT SOURCES
UNIT WELL 9

MAP SITE	EDR SITE	NAME	DESCRIPTION	STATUS
1	4	407 West Lakeview	UST	Closed/removed
2	27	Christianson Property	ERP	Closed
3	25	Klinke Dry Cleaners	ERP - DERF	Open
4	24	Allis Elementary School	LUST	Closed
5	17	Bark River Culvert & Equipment Co.	LUST	Closed
6	8	307 East Lakeview Avenue	UST	Closed/removed
7	2	4902 Buckeye Road	UST	Closed/removed
8	3	4716 Camden Road	UST	In use
9	A	Town of Blooming Grove	LUST	Closed
			UST	Closed/removed
10	9	Checker Auto Parts	CESQG	No violations found
			SCHWIMS	Operating
11	10	Car Corp of Madison, Inc.	SCHWIMS	Unknown
12	B	Sherwin Williams	SCHWIMS	Operating
		Royal T Promotions	SCHWIMS	Closed
13	16	Universal Presentation Concepts	SCHWIMS	Operating
14	11	Barrs Kawasaki	SCHWIMS	Unknown
15	C	PDQ	SCHWIMS	Operating
			LUST	Closed
			SCHWIMS	Closed
			LUST	Closed
			UST	Closed/removed
			Spills	Closed
16	23	East Clinic	SCHWIMS	Operating
17	18	Nicolet Instrument Audiodiagnostics	SCHWIMS	Closed
18	21	KLS Lubriquip Inc.	SCHWIMS	Closed
19	26	Monona Investments Property	ERP	Closed
20	D	Boumatic, Inc.	SCHWIMS	Operating
			LUST	Closed
			Spills	Closed
		Sani Matic Systems	ERP	Closed
			SCHWIMS	Operating

FIGURES

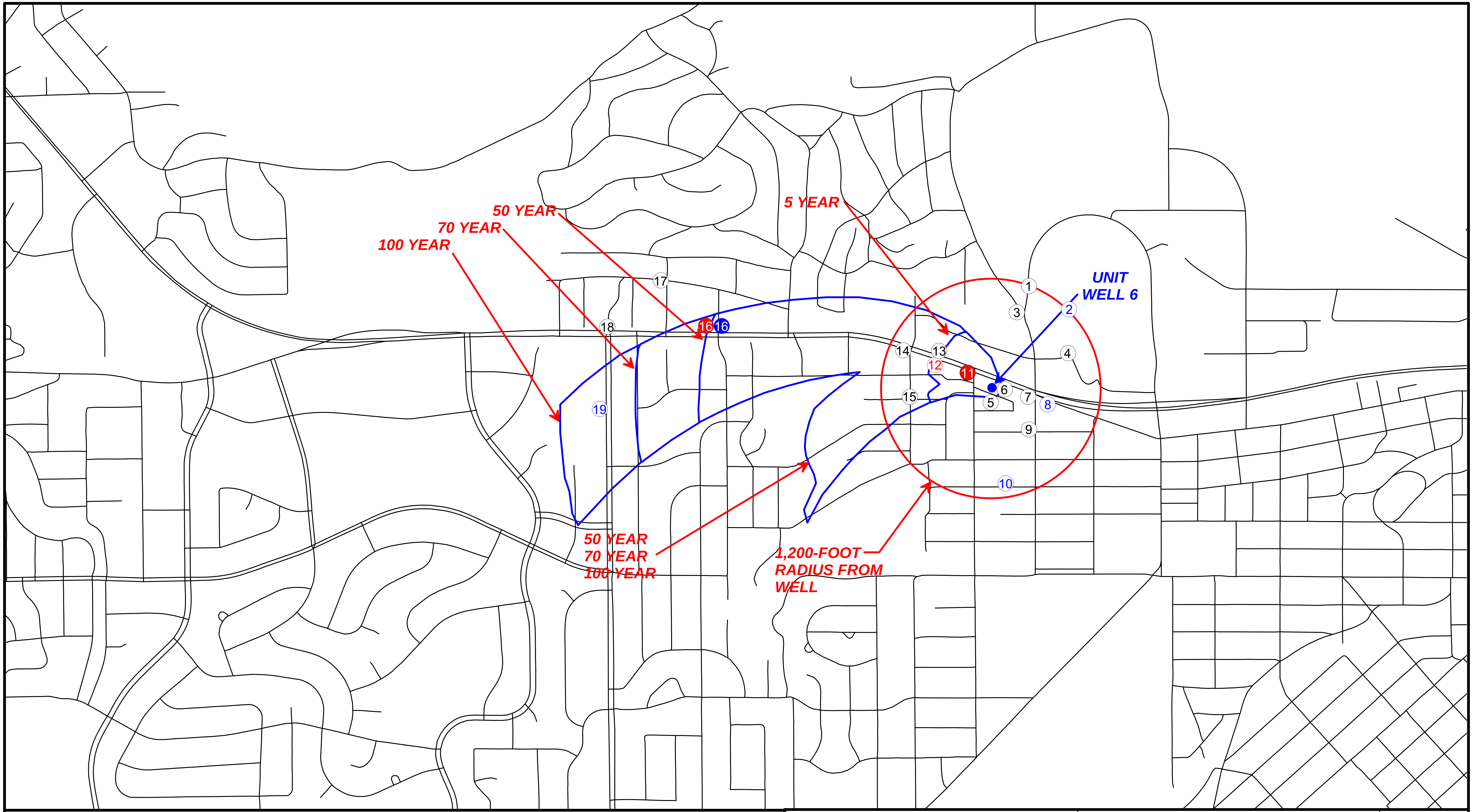


Madison Water Utility

CITY OF MADISON
WATER UTILITY
REVERSE FIRST ORDER DECAY OF PCE

FIGURE
1

DRAWN BY	PROJ. No.	DATE	FILE
RN	15-204	9 DEC 15	CONCENTRA



NORTH

FEET
0 500 1000

KEY TO SYMBOLS

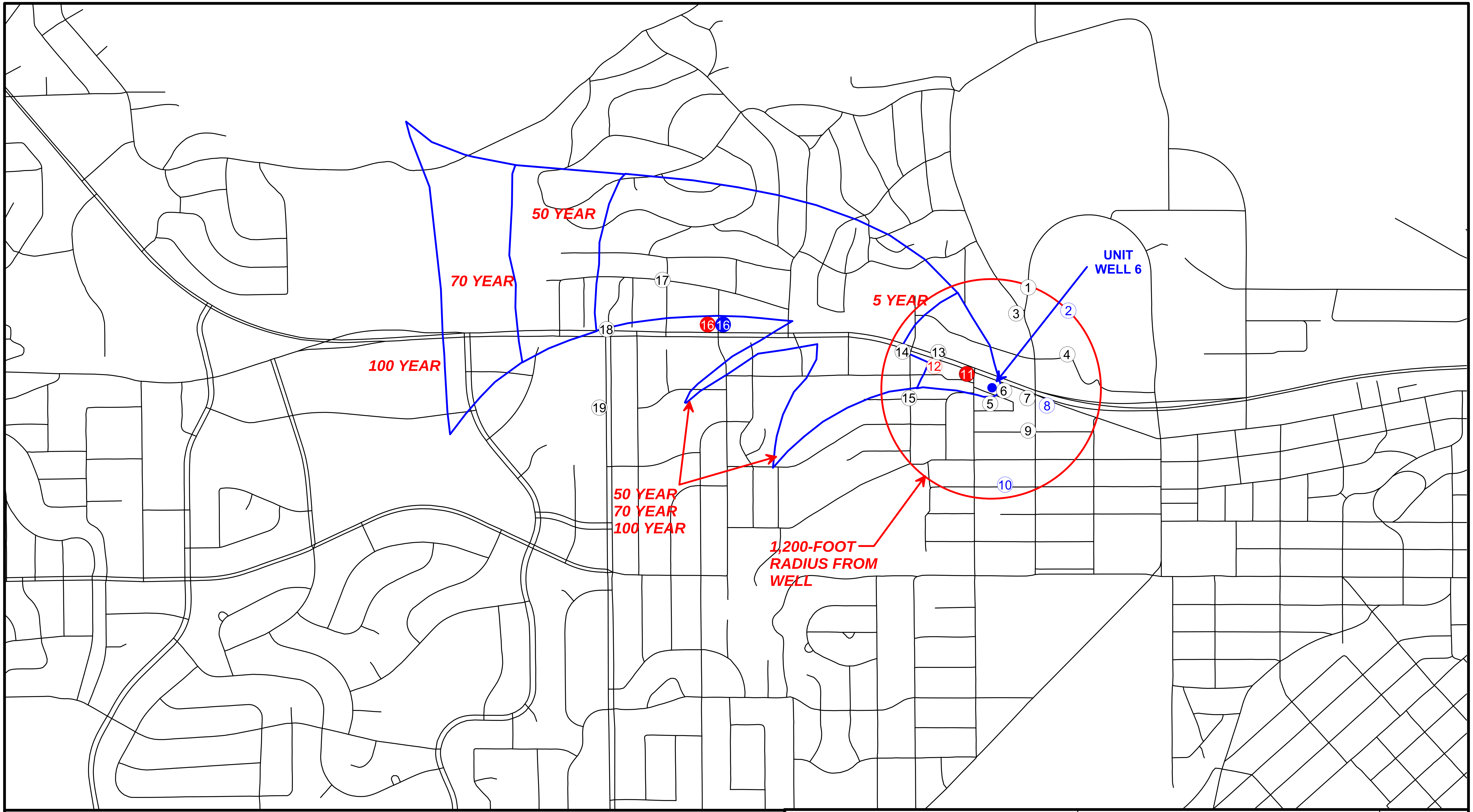
X SITE IN DATABASE - NO RELEASES
X PETROLEUM RELEASE - OPEN
X PETROLEUM RELEASE - CLOSED
X CHLORINATED RELEASE - OPEN
X CHLORINATED RELEASE - CLOSED

Madison Water Utility

CITY OF MADISON WATER UTILITY
WELL 6 CAPTURE ZONES
PUMPING AT 0.82 MGD

FIGURE
2

DRAWN BY	PROJ. No.	DATE	FILE
RN	15-204	10 DEC 15	WELL 6 0.82 MGD



NORTH

FEET
0 500 1000

KEY TO SYMBOLS

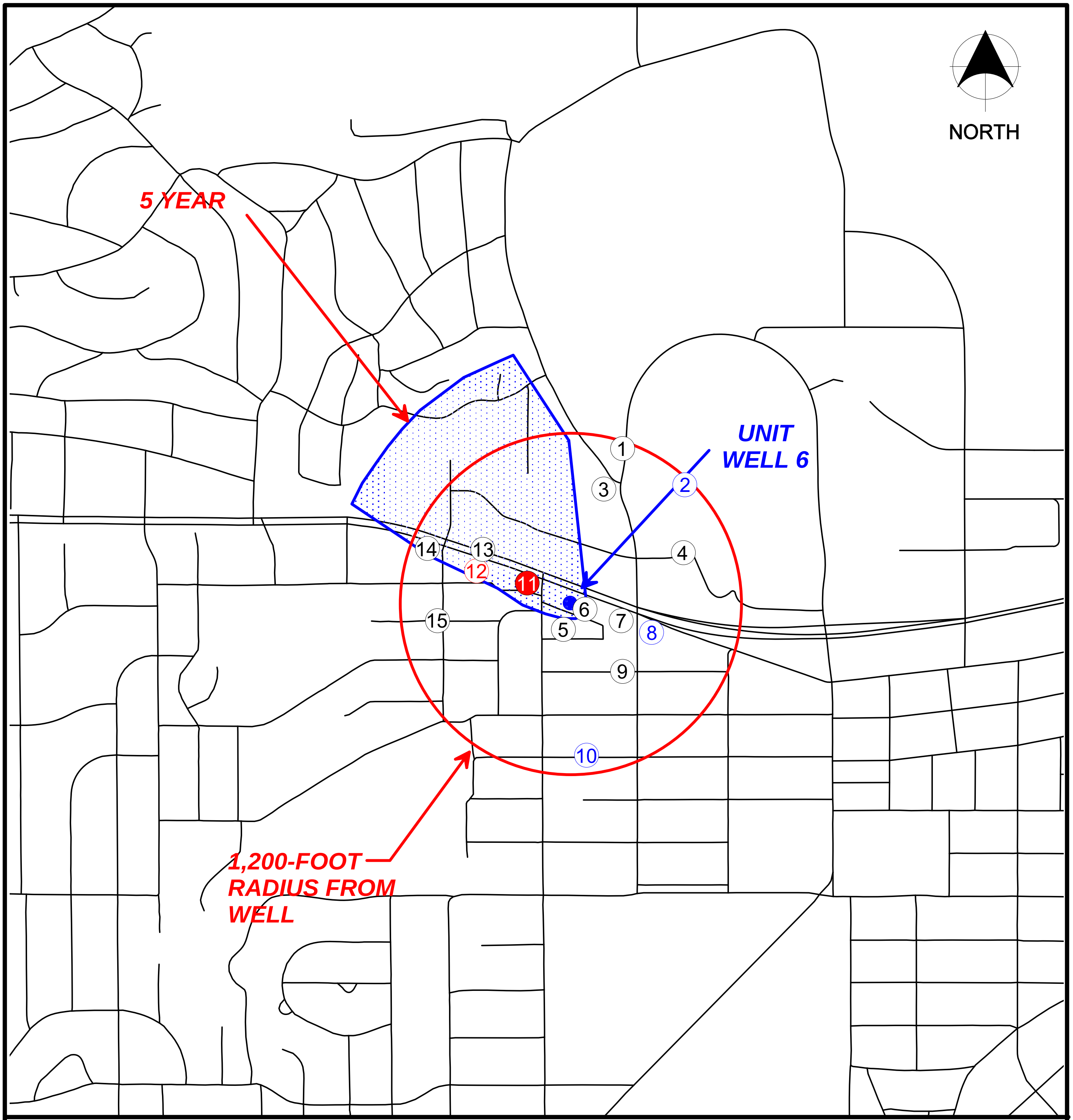
ⓧ	SITE IN DATABASE - NO RELEASES	ⓧ	CHLORINATED RELEASE - OPEN
ⓧ	PETROLEUM RELEASE - CLOSED	ⓧ	CHLORINATED RELEASE - CLOSED

Madison Water Utility

CITY OF MADISON WATER UTILITY
WELL 6 CAPTURE ZONES
PUMPING AT 1.65 MGD

FIGURE
3

DRAWN BY	PROJ. No.	DATE	FILE
RN	15-204	10 DEC 15	WELL 6 1.65 MGD



KEY TO SYMBOLS

FEET
0 500 1000

Ⓧ SITE IN DATABASE - NO RELEASES

Ⓧ PETROLEUM RELEASE - CLOSED

⊗ CHLORINATED RELEASE - OPEN

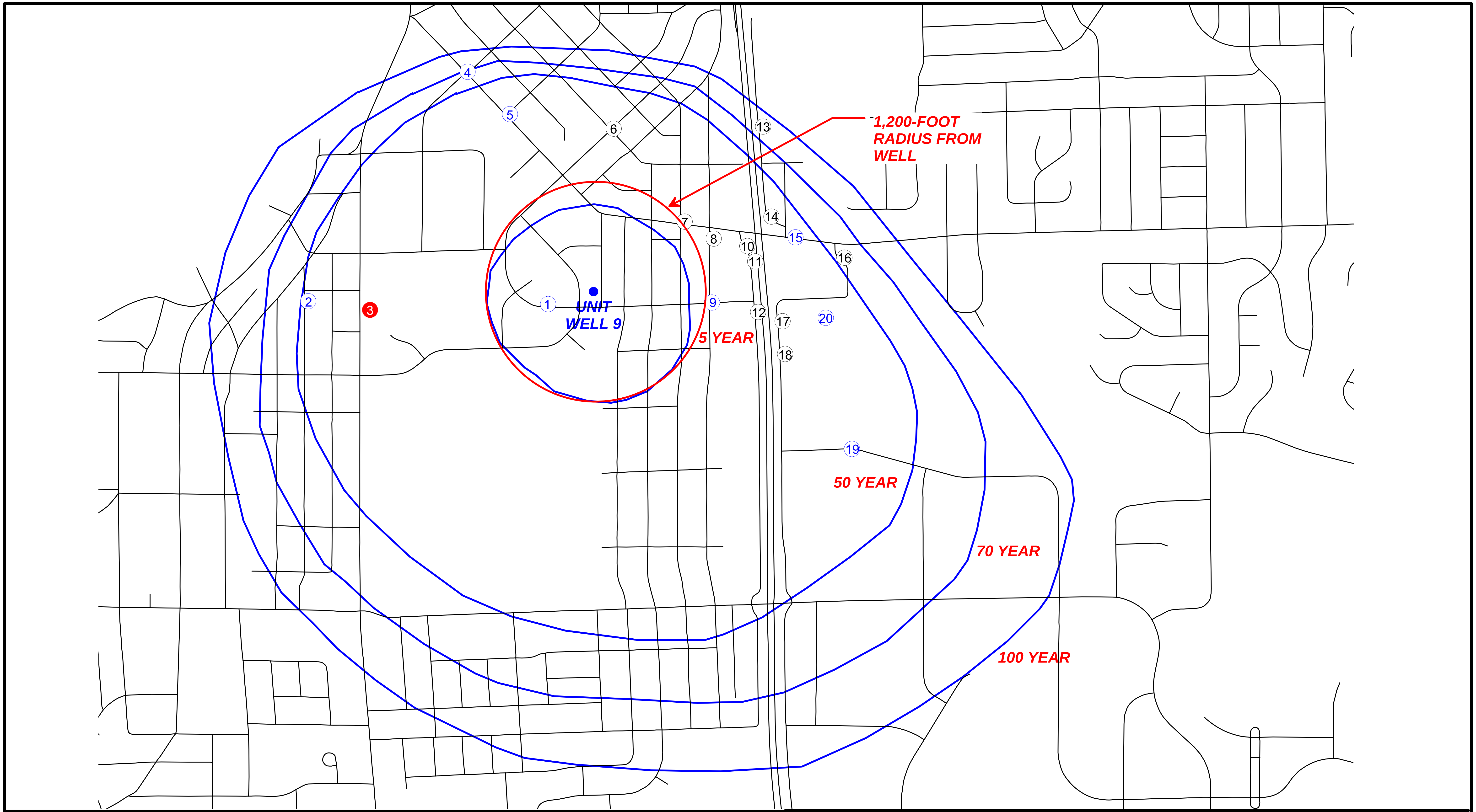
Ⓧ CHLORINATED RELEASE - CLOSED

Madison Water Utility

CITY OF MADISON WATER UTILITY
WELL 6 5-YR CAPTURE ZONE
PUMPING AT FULL CAPACITY

FIGURE
4

DRAWN BY	PROJ. No.	DATE	FILE
RN	15-204	14 DEC 15	WELL 6 FULL CAP



NORTH

FEET
0 500 1000

KEY TO SYMBOLS

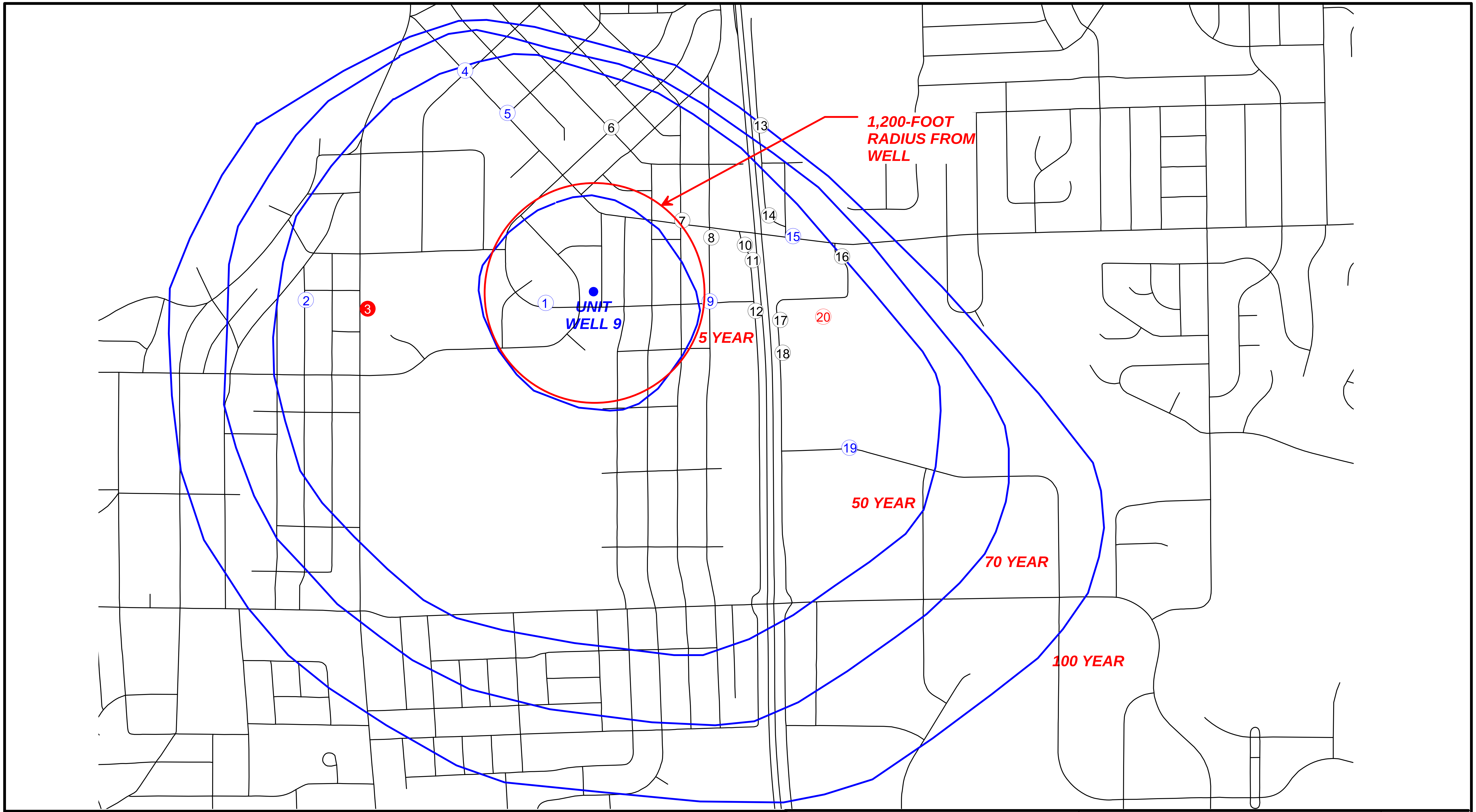
- Ⓧ SITE IN DATABASE - NO RELEASES
- Ⓧ PETROLEUM RELEASE - CLOSED
- ⊗ CHLORINATED RELEASE - OPEN
- Ⓧ CHLORINATED RELEASE - CLOSED

Madison Water Utility

CITY OF MADISON WATER UTILITY
WELL 9 CAPTURE ZONES
PUMPING AT 1.27 MGD

FIGURE
5

DRAWN BY	PROJ. No.	DATE	FILE
RN	15-204	23 NOV 15	WELL 9 1.27 MGD



NORTH

FEET
0 500 1000

KEY TO SYMBOLS

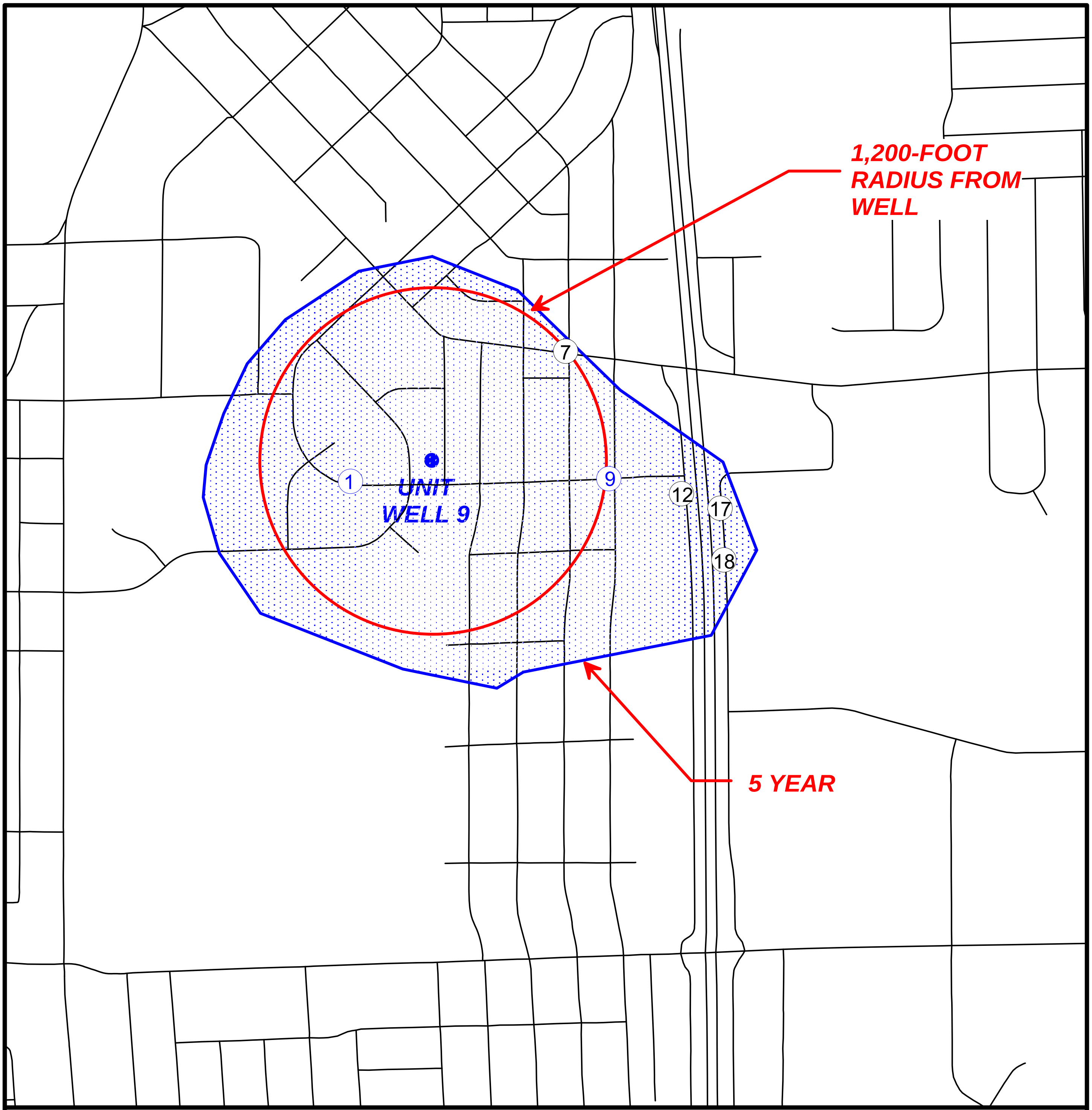
⊗ SITE IN DATABASE - NO RELEASES
⊗ PETROLEUM RELEASE - CLOSED
⊗ CHLORINATED RELEASE - OPEN
⊗ CHLORINATED RELEASE - CLOSED

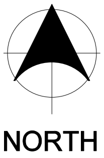
Madison Water Utility

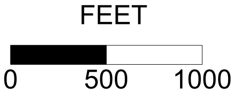
CITY OF MADISON WATER UTILITY
WELL 9 CAPTURE ZONES
PUMPING AT 1.48 MGD

FIGURE
6

DRAWN BY	PROJ. No.	DATE	FILE
RN	15-204	23 NOV 15	WELL 9 1.48 MGD







KEY TO SYMBOLS

ⓧ SITE IN DATABASE - NO RELEASES

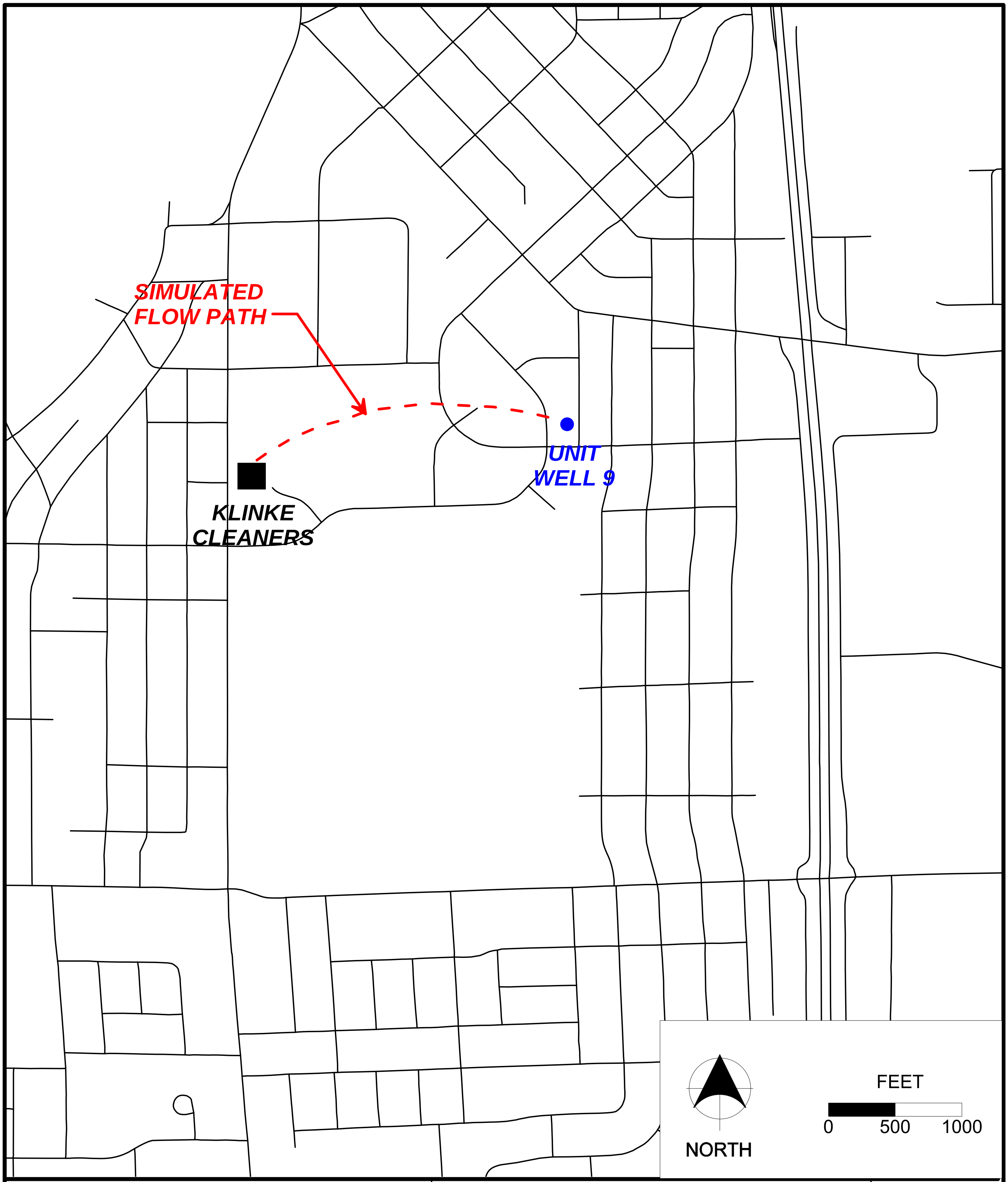
ⓧ PETROLEUM RELEASE - CLOSED

Madison Water Utility

CITY OF MADISON WATER UTILITY
WELL 9 5-YR CAPTURE ZONE
PUMPING AT FULL CAPACITY

FIGURE
7

DRAWN BY	PROJ. No.	DATE	FILE
RN	15-204	14 DEC 15	WELL 9 FULL CAP



Madison
Water Utility

CITY OF MADISON WATER UTILITY
TRAVEL PATH TO WELL 9
FROM KLINKE CLEANERS

FIGURE
8

DRAWN BY	PROJ. No.	DATE	FILE
RN	15-204	23 NOV 15	KLINKE FLOW