Non-Diversion Alternative Using Existing Water Supply With Treatment
City of Waukesha Water Supply
Waukesha, Wisconsin

July 9, 2015

Submitted to:

Clean Wisconsin and Milwaukee Riverkeeper
(on behalf of the Compact Implementation Coalition)

Prepared by:
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Compact Implementation Coalition's Non-Diversion Solution

Executive Summary

The Compact Implementation Coalition (CIC) collectively represents tens of thousands of Wisconsinites working to protect our Great Lakes. The CIC has a long history beginning with ensuring the adoption of a strong Great Lakes Compact and aiding the Department of Natural Resources (DNR) in the implementation of administrative rules.

For the last five years, the City of Waukesha's ongoing request to divert Great Lakes water has raised numerous concerns about Waukesha's respect for the Great Lakes Compact and for the overall health of the Great Lakes region. The need for multiple versions of the city's application, all lacking sufficient information and evidence to support its request, demonstrates Waukesha's lack of real effort in evaluating all reasonable alternatives before requesting water from the Great Lakes as required under the Great Lakes Compact. By its own words, Waukesha has made it clear that its intent to divert Great Lakes water out of the Great Lakes Basin is a preferred option; it is not born out of current need and it is not a last resort. Further, Waukesha has manufactured a "need" by pulling in portions of communities who do not need or want a new water supply, who have not demonstrated water conservation and who may never ask for water from the diversion.

Since Waukesha has not met the legal and technical requirements set forth in the Great Lakes Compact, the CIC felt it was in the best interest of the Great Lakes region to have two independent engineering firms conduct an independent analysis of Waukesha's alternative water supplies.

The CIC retained GZA GeoEnvironmental, Inc. (GZA) and Mead & Hunt, Inc. to evaluate the City of Waukesha's water supply alternatives included in its application. The CIC also asked GZA and Mead & Hunt to evaluate alternative water supplies based on Waukesha's existing water service supply area since the proposed expanded service area included in its application does not legally adhere to the Great Lakes Compact.

The consultants excluded the neighboring communities of the City of Pewaukee and towns of Delafield, Genesee and Waukesha from the analysis. GZA also averaged the City of Waukesha's actual historical water use data to forecast future demand rather than cherry picking the largest year of consumption as Waukesha did when forecasting future industrial need. GZA and Mead & Hunt used the same exact assumptions found in the City of Waukesha's application when considering cost, the extent to which conservation measures will be implemented in the future, population growth, and how much water the City of Waukesha is expected to use any given day.

The findings, formally compiled in the accompanying Non-Diversion Solution report, conclude that Waukesha can use its existing deep and shallow water wells to provide ample clean and healthy water to their residents now and in the future if they simply invest in additional water treatment infrastructure to ensure the water supply meets state and federal standards going forward. The Non-Diversion Solution costs dramatically less than a diversion, avoids a regulatory morass and secures independence for Waukesha residents, protects public health, and minimizes environmental impact.

The CIC is confident that the Non-Diversion Solution is a better way forward for the City of Waukesha, its residents, and the Great Lakes region as a whole.

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The Compact Implementation Coalition, collectively representing tens of thousands of Wisconsinites, has a long history of working on the Great Lakes Compact. From ensuring the adoption and implementation of a strong Great Lakes Compact to aiding the Department in the promulgation of administrative rules to implement the Compact, it has consistently advocated for the strongest protections available for the Great Lakes, in keeping with the spirit and the letter of the Compact.

Members of the Coalition include:

- *Clean Wisconsin*
- *Midwest Environmental Advocates*
- *Milwaukee Riverkeeper*
- *National Wildlife Federation*
- *River Alliance of Wisconsin*
- *Waukesha County Environmental Action League*
- *Wisconsin Wildlife Federation*
- *Peter McAvoy, of counsel*

The coalition wishes to thank the Charles Stewart Mott Foundation and the Joyce Foundation for their generous funding in support of this work.

The CIC is encouraging any concerned citizens to stay apprised of any further developments by visiting www.protectourgreatlakes.org

GZA
GeoEnvironmental, Inc.

Engineers and Scientists

July 9, 2015
File No. 20.0154335.00

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Madison, Wisconsin 53703
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Milwaukee, Wisconsin 53202
Attention: Ms. Jennifer Bolger Breceda, Executive Director

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Re: Non-Diversion Alternative Using Existing Water Supply With Treatment
City of Waukesha Water Supply
Waukesha, Wisconsin

Dear Mr. Meyer and Ms. Bolger Breceda:

In accordance with our June 17, 2015 conference call with representatives of the Wisconsin Department of Natural Resources (WDNR), GZA GeoEnvironmental, Inc. (GZA) has performed a review of water demand forecasts related to the evaluation of water supply alternatives for the City of Waukesha, Wisconsin. GZA is pleased to submit this summary of our evaluation to Clean Wisconsin and Milwaukee Riverkeeper (collectively, the "Client").

In the Draft Technical Review for the City of Waukesha's Proposed Diversion of Great Lakes Water for Public Supply with Return Flow to Lake Michigan, issued on June 25, 2015, the WDNR states the following:

- The City of Waukesha is without adequate supplies of potable water due to the drawdown in the deep sandstone aquifer and the presence of radium in its current groundwater water supply, and has no reasonable water supply alternative in the Mississippi River basin (MRB); and

- All of the proposed MRB water supply alternatives are similar in cost to the Lake Michigan alternative, yet none is as environmentally sustainable or as protective of public health as the proposed Lake Michigan water source.

As presented herein, the Non-Diversion alternative, which allows for the continued use of the City of Waukesha's ("City") existing well infrastructure with new radium treatment, represents the most cost-effective and technically feasible alternative to meet the existing and future water supply demands for the City. This alternative was developed by the Compact Implementation Coalition ("Coalition") following a thorough review of the declining water demands since 1970, and groundwater level rebound in the deep sandstone aquifer since 2000. It is protective of both human health and the environment. Most importantly, the engineering cost analyses, which were developed by Mead & Hunt, Inc. (Mead & Hunt) using conservative engineering and the principal assumptions used by the City, confirm the non-diversion alternative represents about one-half of the cost of the diversion alternative on a 50-year net present worth basis.

BACKGROUND

The City submitted an Application for Lake Michigan Supply to the WDNR in May 2010, proposing to use Lake Michigan water with return flow to meet its long range water supply planning needs. The Application was based on the City's eligibility to apply for a new Great Lakes diversion with return flow in accordance with the Great Lakes-St. Lawrence River Basin Water Resources Compact ("Compact"). With extensive review of the 2010 application and request from WDNR for additional evaluation, the City submitted a revised Application for a Lake Michigan Diversion with Return Flow in 2013.[1] The revised application included an evaluation of six water supply alternatives: the continued use of the existing deep and shallow wells was referenced as Alternative 1 and the proposed diversion from Lake Michigan was referenced as Alternative 2. As discussed in the City's revised application Volume 2,[2] the City proposed an average water demand of 10.1 million gallons per day (mgd) and a peak water demand of 16.7 mgd.

Based on our discussions, it is understood that Client has reviewed the Compact and other related information and, as stated by the Coalition, has determined that the water demand forecasts and water supply alternatives proposed by the City are legally inconsistent with the Compact for two primary reasons. First, whereas the Compact requires that an applicant seeking a diversion must first demonstrate "the Community within a Straddling County…is without adequate supplies of potable water."[3] Waukesha's proposed Water Service Supply Area (WSSA) includes portions of neighboring communities, including the City of Pewaukee and the Towns of Delafield, Genesee and Waukesha, which have demonstrated *no need*, imminent or otherwise, for additional supplies of potable water.[4] Second, the inclusion of these neighboring communities in Waukesha's proposed WSSA contravenes the conservation requirements of both the regional Compact and Wisconsin's implementing statute;[5]

[1] CH2MHill, 2013, Application Summary, City of Waukesha Application for a Lake Michigan Diversion with Return Flow.

[2] CH2MHill, 2013, City of Waukesha Water Supply Service Area Plan, Volume 2 of 5.

[3] Compact, Art. 4, sec. 4.9.3.a.; see also Wis. Stat. 281.346(4)(e)1.a, providing that "[t]he community is without adequate supplies of potable water."

[4] We do understand, through communications with our Client based on their communication with WDNR staff, that there may be a relatively small number of individual parcels in one or more locations adjacent to Waukesha's current water supply service area where existing water quality concerns may suggest hooking up to water utility service would be advantageous. This alternative could allow for those connections.

[5] Compact Art. 4, sec.4.9.4.a: "[t]he need for all or part of the proposed Exception cannot be reasonably avoided through the efficient use and conservation of existing water supplies"; see also Wis. Admin. Code NR 852, providing an applicant for a diversion under the Great Lakes Compact must implement specified conservation efficiency measures *before* submitting an application for a diversion.

specifically, none of these communities, or portions thereof, have initiated, much less met, required conservation and efficiency parameters. Accordingly, as requested by the Client, we have based the City's water demand forecasts and water supply alternatives exclusively on the City's existing WSSA.

In accordance with our proposal dated May 25, 2015, and our subsequent discussions, GZA has performed the following scope of work:

- Reviewed water demand forecasts for the existing WSSA and the City without expanding to include neighboring communities;
- Reviewed the existing radium data and, with technical support provided by Mead & Hunt, evaluated the potential of meeting radium water quality standards with treatment and blending; and
- Reviewed information related to the rebound and sustainability of the deep sandstone aquifer.

GZA reviewed the following documents and available data for the evaluation of water demand forecasts and consideration of water supply alternatives:

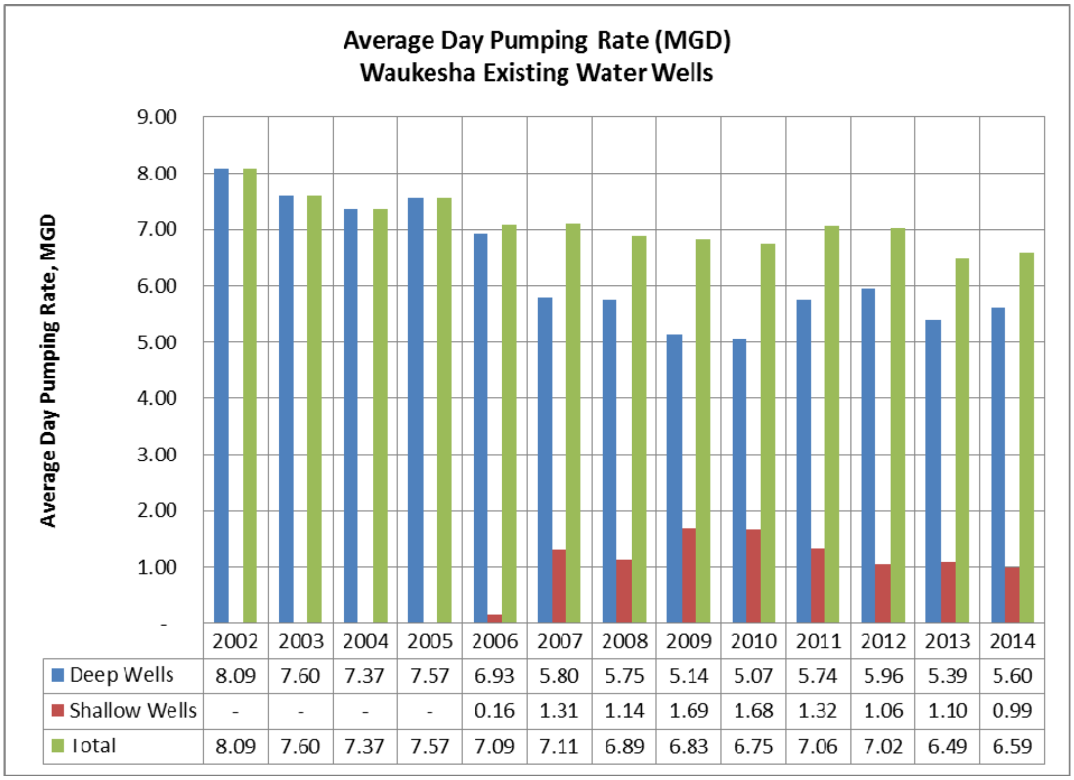
- Average day pumping rates from 2002 to 2014 (Waukesha Water Utility data);
- The City's Revised Application of 2013;
- An Analysis of the City's Diversion Application (Nicholas, 2013);[6]
- Radium data for the City's wells (downloaded from the WDNR);
- Proposed water supply alternative and cost estimates provided by Mead & Hunt,[7] who was previously retained by Client;
- Select Southeastern Wisconsin Regional Planning Commission (SEWRPC) and United States Geological Survey (USGS) reports; and
- Formal meetings with the WDNR on March 26 and June 17, 2015.

The following provide a summary of our review and evaluation.

[6] Nicholas, Jim, February 2013, "An Analysis of the City of Waukesha Diversion Application."
[7] Mead & Hunt, July 2015, "City of Waukesha 6.7 MGD Water Demand Alternative."

AVERAGE DAY PUMPING RATE

The average day pumping rate data for individual City of Waukesha wells from 2002 to 2014, are summarized in the attached Table 1, and grouped by deep water wells and shallow wells, as shown in Figure 1 below.



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Deep Wells	8.09	7.60	7.37	7.57	6.93	5.80	5.75	5.14	5.07	5.74	5.96	5.39	5.60
Shallow Wells	-	-	-	-	0.16	1.31	1.14	1.69	1.68	1.32	1.06	1.10	0.99
Total	8.09	7.60	7.37	7.57	7.09	7.11	6.89	6.83	6.75	7.06	7.02	6.49	6.59

Figure 1 – Average Day Pumping Rate, City of Waukesha Water Wells

As shown in Figure 1, the total average day pumping rate decreased from approximately 8.1 mgd to 7.1 mgd over the period from 2002 to 2006. Since 2006, the total average day pumping rate fluctuated from approximately 6.5 mgd to 7.1 mgd. During this same period of time, the estimated population in the City grew from 66,237 in 2002, to 71,697 in 2012 (Appendix of Application, Volume 2), indicating a general trend of declining per capita water use since 2006.

According to the City's Application, Volume 3, the City commits to expand its water conservation and efficiency measures, targeting an additional total water use reduction of approximately 0.5 mgd by 2030, and 1 mgd by 2050.

With the installation and initial operation of three shallow aquifer wells in 2006, the pumping rates of the deep aquifer wells decreased, ranging from approximately 5.1 mgd to 6.0 mgd over the period from 2007 to 2014, and the pumping rates of the shallow aquifer wells ranged from approximately 1 mgd to 1.7 mgd over the period from 2007 to 2014.

As indicated above, the average day pumping rate decreased and the population of the City increased over the period from 2002 to 2012, indicating a general trend of declining per capita water use. In addition, the average day pumping rate of the deep aquifer wells decreased since the operation of three shallow aquifer wells in 2007.

WATER DEMAND FORECASTS

The City's Application water demand forecasts were based on the following assumptions:

1. The WSSA, by 2030, will be expanded to include areas beyond the City's existing WSSA, including parts of the City of Pewaukee and the Towns of Genesee, Waukesha and Delafield;

2. Population will grow at a rate of 0.5% per year;

3. The average water usage from 2002 to 2012 was used in the water demand forecasts, including 44 gallons per capita day (gpcd) for residential customers, 33 gpcd for commercial and 4 gpcd for public customers;

4. For industrial customers, a value of 1,297 gallons/acre/day, which is equivalent to industrial water use intensity in the year 2000, was used;

5. The maximum day demand is 1.66 times greater than average day demand;

6. Unaccounted for water was projected at 8% of total water pumping; and

7. The City will continue expanding the conservation program to meet the City's 10% water saving target, with specific goals of 0.5 mgd by 2030, and 1 mgd at ultimate buildout.

GZA's evaluation is focused on assumptions 3 and 4, namely the assumed gpcd for residential, commercial, public and industrial water usage.

<u>Industrial Water Uses</u>

As discussed in Appendix C of the City's Application, Volume 2, the Application uses the industrial usage of year 2000 (1,297 gallons/acre/day) for water demand forecast, while the average industrial usage from 2008 to 2012 was 642 gallons/acre/day. It appears that the City considered the SEWRPC Industrial Usage Projection of 1,500 gallons/acre/day[8] and decided to use the 2000 usage for future projection.

[8] SEWRPC, December 2010, "A Regional Water Supply Plan for Southeastern Wisconsin."

As of 2010, approximately 1,452 acres of land within the City were developed for industrial use and it was estimated that the total industrial acreage will be approximately 1,832 acres at the ultimate buildout[9] of an expanded WSSA. The additional industrial acreage, approximately 380 acres, consists of 191.1 acres of undeveloped land zoned for industrial use in the City, 37.6 acres of developed industrial land in the Town of Genesee, 81.5 acres of undeveloped land zoned for industrial uses in the Town of Waukesha and 70.2 acres of developed industrial land in the Town of Waukesha (City's Application, Volume 2).

According to the City's Application, Volume 2, Appendix C, the total developed industrial land was approximately 1,395 acres in the City in 2000, and increased to 1,452 acres in 2010. However, the industrial water usage decreased from 660.4 million gallons per year in 2000, to 326.3 million gallons per year in 2010, or 1,297 gallons/acre/day in 2000 to 616 gallons/acre/day in 2010, indicating decreasing industrial water usage per acre per day by more than 50%.

Similarly, a decreasing trend was observed for industrial water usages if measured by gpcd. As shown in Table 2, Historical Per Capita Consumption, copied from Attachment C, Appendix C of Application Volume 2, industrial consumption was approximately 27.9 gpcd in 2000, but decreased since then, and the average industrial usage from 2008 to 2012 was 13.3 gpcd, a decrease of more than 50% of that in 2000. The City's water demand forecast for industrial uses for 2030 is equivalent to 27.4 gpcd; for 2050, it is 24.3 gpcd. Both of those estimates are significantly higher than the actual industrial average of 13.3 gpcd from 2008 to 2012.

Historical GPCD

The historical, total gpcd data shown in the attached Table 2 is plotted in Figure 2 below. Overall, the total gpcd for Waukesha shows a linear decreasing trend from 1970 to 2012, with an R Squared value, a statistical measure of how close the data are to the fitted regression line, of 0.96. The City's forecast is equivalent to 108 gpcd for 2030, and 105 gpcd for 2050, which is equivalent to the total gpcd in 2003 or 2004, and ignores the decreasing water demand trend from 2003 to 2012. Therefore, the City's demand forecast is not consistent with the historical trends of declining water use in all land use categories, as shown on Table 2, and the continued trend of declining water use over the period from 2008 to 2014, the most recent data available.

[9] CH2MHill, 2013, City of Waukesha Water Supply Service Area Plan, Volume 2 of 5.

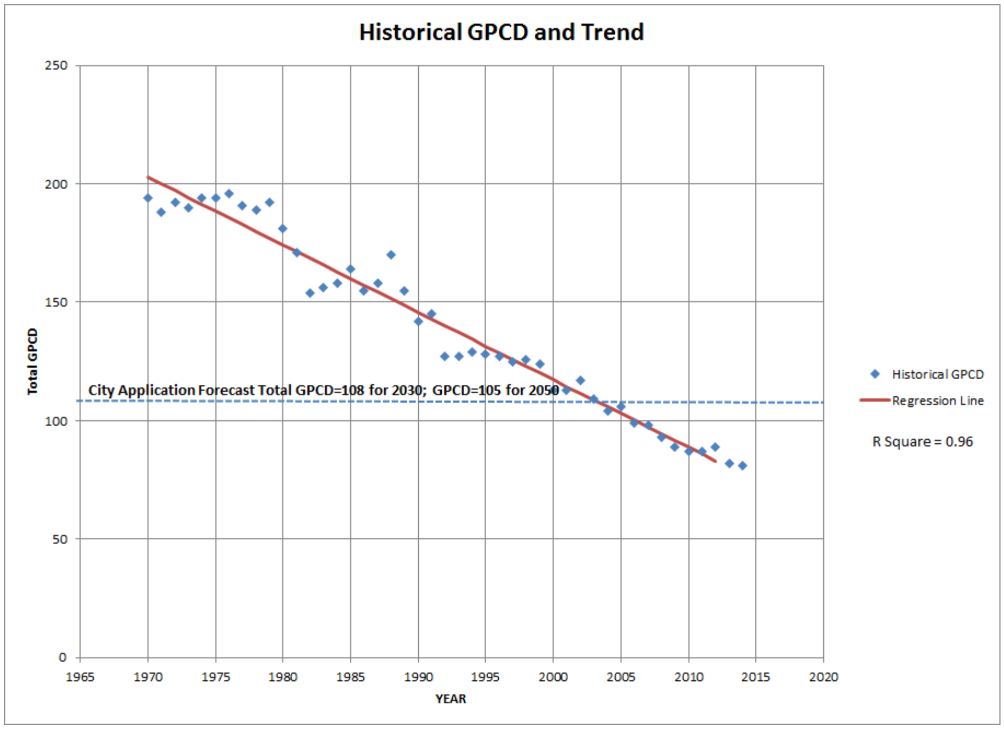


Figure 2: Historical GPCD and Trend

<u>Proposed Water Demand Forecast</u>

To simplify the forecast approach, we utilized gpcd for industrial, residential, commercial and public sectors, as discussed in Nicholas, 2013. This approach also has the benefit of having historical water usage data for all of the user categories over the years. To utilize data most representative and conservatively expected of the observed trend in decreasing water demand, GZA proposed to use five recent years of available water consumption data (from 2008 to 2012). As previously indicated and presented on Table 2, the continued decline in water use was also observed in 2013 and 2014, the most recent data available. The data used by GZA is considered conservative, as it does not include the additional decline in 2013 and 2014.

Land Use	Average GPCD (2008-2012)
Residential	40.3
Commercial	31.6
Public	3.9
Industrial	13.3
Total:	**89.1**

Based on the above land use distribution and the City's estimate of unaccounted water and effects of planned conservation measures, the estimated water demand for 2030 is as follows:

Projection	City (Existing WSSA)
2030 Population	71,105
Total Water Usage (89.1 GPCD), mgd	6.3
Unaccounted Water (8%), mgd	0.504
Conservation 10% or 0.5 mgd, whichever is less	-0.5
Total Average Day Demand, mgd	**6.3**
Maximum Day (1.66 Factor), mgd	**10.5**

The water demand for ultimate buildout of the existing WSSA is estimated as below:

Projection	City (Existing WSSA)
Ultimate Buildout Population	76,330
Total Water Usage (89.1 GPCD), mgd	6.8
Unaccounted Water (8%), mgd	0.544
Conservation 10% or 1 mgd, whichever less	-0.68
Total Average Day Demand, mgd	**6.7**
Maximum Day (1.66 Factor), mgd	**11.1**

As previously indicated and presented in the attached Table 2, the gpcd for the most recent years of 2013 and 2014, declined even further from the 2008 to 2012 average, confirming the conservative estimate used by GZA.

WATER SUPPLY ALTERNATIVE

Based on the above water demand forecasts for the existing WSSA at the ultimate buildout, Mead & Hunt of Marquette, Michigan evaluated the existing water wells in the City and proposed the following alternative consistent with the above analysis, including GZA's future demand forecasts:[10]

[10] Mead & Hunt, July 2015, "City of Waukesha 6.7 MGD Water Demand Alternative."

Water Source	Demand (msg)		Supply Wells	Treatment Facilities	Transmission Facilities
	Avg. 6.7 mgd	Max. 11.1 mgd			
Deep Confined Aquifer (existing wells)	5.7 mgd	9.6 mgd	7 existing wells; Well Nos. 3, 5, 6, 7, 8, 9, 10	3 new reverse osmosis treatment plants at Well Nos. 6, 8 and 10. Existing hydrous manganese oxide treatment at well 3.	Improvement for the 4.3 miles of existing distribution piping system. 7.0 miles of new piping for blending.
Shallow Aquifer (existing wells)	1.0 mgd	1.5 mgd	3 existing wells; Well Nos. 11, 12, 13	Existing groundwater treatment plant for iron and manganese removal for wells 11 and 12	

This water supply alternative utilizes the City's existing deep aquifer wells and shallow aquifer wells, the existing treatment plants at Well Nos. 3, 11 and 12, with three new reverse osmosis (RO) treatment plants at Well Nos. 6, 8 and 10. Well No. 2, expected to be abandoned in the near future, is not included. The existing distribution piping system will be improved and a new piping system, approximately 7 miles long, will be constructed to transmit water between the deep wells for blending and distribution.

RADIUM CONCENTRATIONS

Radium is present in the existing deep water wells (see Attachment 1 for plots of radium levels before treatment). Some of the deep wells complied with the radium water quality standard of 5 picocuries per liter (pCi/L), while others exceeded it. As discussed in Mead & Hunt's July 7, 2015 report,[11] the three new RO treatment plants proposed for the three largest existing deep wells will treat the well water for radium, total dissolved solids and gross alpha. With continued blending of water from all the wells outside of the distribution system, the proposed alternative is expected to meet water quality standards.

GZA performed a statistical evaluation of the pre-treatment total radium concentrations (sum of radium-226 and radium-228) and post-treatment total radium concentrations for the Waukesha water supply wells, and estimated the 95% upper confidence level

[11] Mead & Hunt, July 7, 2015, "City of Waukesha 6.7 MGD Water Demand Alternative." (See Attachemnt 2)

(UCL) on the mean of the pre-treatment radium concentrations and post-treatment radium concentrations for each deep aquifer well, using United States Environmental Protection Agency (USEPA) statistical software ProUCL.[12] 95% UCLs are generally used as exposure concentrations for human health risk assessment by the USEPA.[13] For the wells where new RO treatment plants will be installed, the post-treatment total radium concentrations are estimated to be 10% of the pre-treatment 95% UCLs, assuming a RO removal efficiency of 90%.[14] For Well No. 3, where the existing hydrous manganese oxide treatment will be continued, the post-treatment total radium concentrations are expected to be the same as the 95% UCL of the post-treatment total radium concentrations. To demonstrate the ability to comply with the radium standard, the historical annual pumping rates from 2002 to 2014 were considered for all wells and the blended radium concentrations calculated in consideration of the proposed treatment at Well Nos. 3, 6, 8 and 10. As shown in Table 3, the blended radium concentrations would be less than the drinking water standard of 5 pCi/L, especially when increasing pumping rates at Well Nos. 3, 6, 8 and 10 from 2008 to 2014. This evaluation indicates that a combination of treatment at select wells and blending with the remaining wells represents a feasible technology to reduce radium concentrations and meet water quality standards for the existing water well system.

COST ESTIMATE

Mead & Hunt provided a cost estimate for the proposed alternative. The capital costs and operation and maintenance costs are summarized below, with comparison to the Lake Michigan Diversion alternative proposed by the City.

Water Supply Alternative	Capital Cost ($ mil)	Annual O&M Cost ($ mil)	20-yr. Present Worth Cost ($ mil, 6%)	50-yr. Present Worth Cost ($ mil, 6%)
Lake Michigan with Return Flow (City Application)	207	8.0	299	334
Proposed Alternative (Ave 6.7 mgd, Max 11.1 mgd)	87.7	5.5	150.8	173.6

The proposed alternative provides water to the City from the existing water wells, with existing and new treatment facilities to meet water quality standards. Since no

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[12] USEPA, September 2013, "ProUCL Version 5.0.00 Technical Guidance," EPA/600/R-07/041.

[13] USEPA, July 2004, "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), Final," EPA/540/R/99/005.

[14] According to a USEPA document, the average RO removal efficiency is expected to be greater than 90%. See USPEPA, July 2005, "A Regulators' Guide to the Management of Radioactive Residuals from Drinking Water Treatment Technologies," EPA 816-R-08-004.

additional wells are needed, no additional impacts on private water wells nor environmental impacts to wetlands and surface waters are expected. The cost for the proposed alternative is significantly less than the Lake Michigan with Return Flow and other alternatives, as evaluated in the City's application.

GROUNDWATER SUSTAINABILITY

Groundwater sustainability in the deep sandstone aquifer is one of the critical factors in the evaluation of the City's water supply alternatives. As stated in USGS Circular 1186 (USGS, 1999),[15] groundwater sustainability is defined as:

> "development and use of ground water in a manner that can be maintained for an indefinite time without causing unacceptable environmental, economic, or social consequences."

Similar to the USGS definition, SEWRPC defined sustainability as:

> "the condition of beneficially using water supply resources in such a way that the uses support the current and probable future needs, while simultaneously ensuring that the resource is not unacceptably damaged by such a beneficial use."

and:

> "unacceptable damage is defined as a change in an important physical property of the groundwater or surface water system—such as water level, water quality, water temperature, recharge rate, or discharge rate—that approaches a significant percentage of the normal range of variability in that property. Impacts that are 10 percent or less of the annual or historic period of record range for any property will be considered acceptable, unless it can be shown that the cumulative effect of the change will cause a permanent change in an aquatic ecosystem by virtue of increasing the extremes of that property to levels known to be harmful."[16]

In a March 13, 2008 letter from SEWRPC to the Illinois State Water Survey,[17] it was further clarified that "[i]n the specific case of the deep sandstone aquifer, the term sustainability is being interpreted to mean that the potentiometric surface in that aquifer is maintained at current levels or raised based upon use and recharge conditions within Southeastern Wisconsin." According to SEWRPC's definition and interpretation for the deep sandstone aquifer, both the SEWRPC's modeling effort in 2005 (SEWRPC

[15] USGS, 1999, "Sustainability of Ground-Water Resources." USGS Circular 1186, Page 2.
[16] SEWRPC, December 2010, "A Regional Water Supply Plan for Southeastern Wisconsin." Volume I, Page 311.
[17] Evenson, Philip C., March 13, 2008, a letter to Mr. Derek Winstanley, D. Phil, Chief, Illinois State Water Survey (downloaded from http://www.isws.illinois.edu/wsp/watermgmtoptns.asp).

Model)[18] and the rising groundwater elevation data measured in a USGS monitoring well and Waukesha's pumping wells from 2000 to 2012, indicate that the deep sandstone aquifer is sustainable under the current (and our projected future) level of water demand.

The SEWRPC Model indicated pre-development groundwater elevation in the deep sandstone aquifer near the City pumping center was approximately 800 feet (SEWRPC Model, Figure 7, page 23); predicted drawdown in 2000 was approximately 450 feet near the pumping center in the City (SEWRPC Model, Figure 6B, Page 21). The predicted groundwater elevation in the deep sandstone aquifer in 2000 is inferred to be approximately 350 feet mean sea level (MSL), 150 feet higher than the top of the sandstone aquifer, which is approximately 200 feet above MSL in the City area,[19] as illustrated in the SEWRPC Model, Figure 2 (Page 8). The SEWRPC model results also indicated that if overall pumping remains constant at year 2000 rates and locations, little additional drawdown will occur in the deep aquifer system over the subsequent 20 years although the cone of depression will continue to spread laterally. The predicted, additional drawdown in 2020, if the 2000 pumping rate were maintained, is less than 16 feet, or approximately 4% of the 2000 drawdown in the area of the City of Pewaukee and the Village of Elm Grove, two adjacent communities to the City.

Recent water use and groundwater level data further indicate the groundwater level in the deep sandstone aquifer has not only stabilized, but is also rebounding. The total groundwater use, including both shallow and deep aquifers, for the seven counties has decreased from 96.26 mgd in 2000, to 95.38 mgd in 2005.[20] Separate regional pumping rates for the shallow aquifer and deep aquifer are not available, but it is believed that some other communities may have switched to shallow aquifer pumping, as the City later did, and have relied on shallow aquifer wells to meet part of their water demand. Groundwater level data from a USGS observation well located near the City well field indicated the groundwater level in the deep sandstone aquifer has rebounded approximately 100 feet to an elevation of approximately 450 feet MSL.

[18] SEWRPC, June 2005, "Simulation of Regional Groundwater Flow in Southeastern Wisconsin, Report 2: Model Results and Interpretation, Technical Report #41."

[19] Foley, F.C., Walton, W. C. and Drescher, W. J., 1953, "Ground-Water Condition in the Milwaukee Waukesha Area, Wisconsin," Plate 7, and Plate 8.

[20] SEWRPC, December 2010, "A Regional Water Supply Plan for Southeastern Wisconsin." Volume I, Table 29.

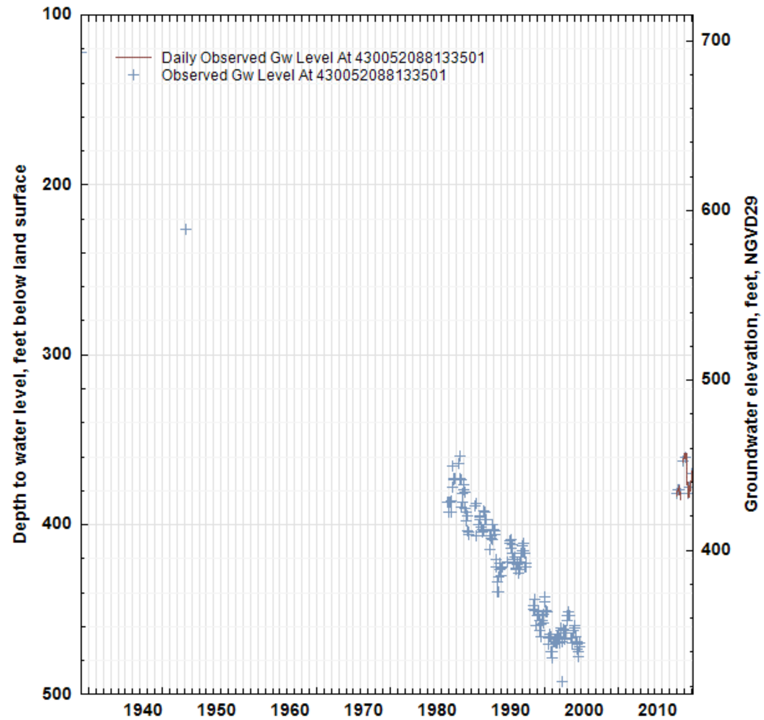


Figure 3: Groundwater Level Data, USGS Monitoring Well ID 430052088133501

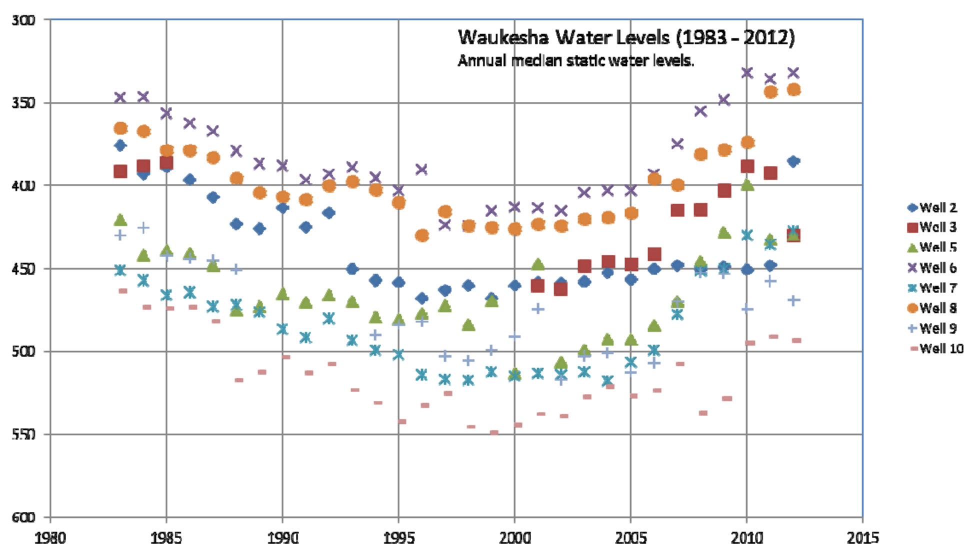


Figure 4: Groundwater Level Data, City of Waukesha Deep Aquifer Wells

As shown in Figure 4, groundwater levels in the City's deep pumping wells rebounded approximately 50 feet to 115 feet, with an average of approximately 80 feet, from 2000 to 2012. Based on approximate ground surface elevations at the well locations, groundwater elevations are estimated to range from approximately 390 feet to 505 feet

MSL in the deep aquifer wells in 2012, with an average of approximately 450 feet MSL, which is approximately 250 feet higher than the top of sandstone aquifer.

In summary, both the SEWRPC Model and the groundwater elevation data from 2000 to 2012, indicate that the groundwater elevation in the deep sandstone aquifer would be generally stabilized if the 2000 pumping rate were maintained, or raised if the deep aquifer pumping rate were less than the 2000 pumping rate. If the 2000 pumping rate were maintained, the additional drawdown in the deep sandstone aquifer is expected to be less than 4% of the historical drawdown in the subsequent 20 years. If the future pumping rates are less than the 2000 pumping rate, as the 2000 to 2012 data showed, the groundwater elevation in the deep sandstone aquifer is expected to rise. Based on this analysis, the deep sandstone aquifer appears to offer a sustainable water supply to meet the proposed water demand forecast. In addition, with this proposed water supply alternative, no additional impact to the surface water and wetlands are expected because no additional wells are proposed.

SUMMARY AND CONCLUSIONS

The non-diversion alternative represents the most cost-effective and technically feasible alternative to meet the existing and future water supply demands for the City. This alternative is protective of both human health and the environment and represents about one-half of the cost of the diversion alternative on a 50-year net present worth basis. Based on the above evaluation, GZA provides the following summary and conclusions:

- The City of Waukesha’s Application has not incorporated the declining per capita trend evident in the historical water use data across customer classes;

- The predominant decline in demand appears to be derived principally by a lower demand by industrial users and the data shows that usage has been declining in residential and commercial uses as well;

- The declining water use and the City’s reliance on shallow aquifer wells to satisfy part of the water demand has resulted in a rebound of water levels in the deep aquifer in the vicinity of Waukesha’s deep aquifer well field. This condition, when combined with appropriate water demand forecasting for the City, will result in a sustainable water supply alternative for the City;

- Under this alternative, no additional water wells are proposed with no additional impact to surface waters and wetlands;

- Radium in the deep aquifer appears manageable and can meet the water quality standard by using RO treatment combined with blending; and

- The estimated cost for the proposed water supply alternative is approximately 50% of the City’s Lake Michigan Diversion with Return Flow alternative.

With the additional water use and groundwater elevation data since the 2005 SEWRPC Model, GZA recommends revisiting the groundwater flow model using actual pumping rates from 2000 to 2014, and re-evaluating the predictive scenario with revised pumping rates based on data from 2001 to 2014. This will create a stronger groundwater management tool for WDNR and regional water users and more confident forecasting in the future.

We appreciate the opportunity to be of service to you. Please feel free to contact the undersigned at (414) 831-2540 with any questions.

Very truly yours,

GZA GeoEnvironmental, Inc.

Jiangeng (Jim) Cai, P.E.
Senior Consultant

James F. Drought, P.H.
Principal Hydrogeologist

John C. Osborne, P.G.
Senior Principal
District Office Manager

J:\154300to154399\154335 Fox River\Report\FINAL 154335.00 Non-Diversion Alternative Report_City of Waukesha Water Supply 7-9-15.doc

Attachments: Tables 1, 2 and 3
Attachment 1
Attachment 2

TABLES

TABLE 1
Average Day Pumping Rates at City of Waukesha Water Wells

Year	Well 2	Well 3	Well 5	Well 6	Well 7	Well 8	Well 9	Well 10	Well 11	Well 12	Well 13	Deep well total	Shallow well total	Total	Source
2002	463,841	334,104	825,430	1,381,825	1,352,395	1,282,879	1,225,712	1,224,786				8,090,972	-	**8,090,972**	City Application
2003	446,107	793,071	518,764	1,067,364	1,040,474	1,057,096	1,141,740	1,538,008				7,602,624	-	**7,602,624**	City Application
2004	309,634	743,538	594,885	1,183,721	1,164,273	949,803	1,090,721	1,337,675				7,374,250	-	**7,374,250**	City Application
2005	170,110	573,523	544,290	1,434,058	848,107	879,455	1,450,849	1,671,685				7,572,077	-	**7,572,077**	City Application
2006	327,441	512,879	494,389	1,171,063	942,068	804,860	1,269,682	1,404,849	44,769	116,238	-	6,927,231	161,007	**7,088,238**	City Application
2007	514,345	745,216	484,592	617,260	955,671	1,318,490	187,008	972,970	431,888	879,200	-	5,795,552	1,311,088	**7,106,640**	City Application
2008	117,855	1,295,432	27,617	43,964	144,719	1,168,019	34,809	2,913,604	376,719	763,262	-	5,746,019	1,139,981	**6,886,000**	City Application
2009	299,918	1,268,134	408,181	354,164	605,238	789,773	-	1,414,411	272,548	716,718	703,797	5,139,819	1,693,063	**6,832,882**	City Application
2010	56,214	1,160,540	69,742	44,277	251,101	720,734	7,660	2,755,523	243,123	571,792	866,616	5,065,791	1,681,531	**6,747,322**	City Application
2011	22,603	865,307	205,638	858,419	448,444	1,053,882	8,447	2,273,063	208,677	491,984	621,962	5,735,803	1,322,623	**7,058,426**	City Application
2012	-	905,211	177,529	353,929	206,340	1,183,671	10,137	3,118,745	119,600	339,740	600,214	5,955,562	1,059,553	**7,015,115**	WDNR Web Site
2013	-	1,002,997	565,493	131,784	424,704	1,182,712	17,468	2,069,340	66,819	269,699	761,403	5,394,499	1,097,921	**6,492,419**	WDNR Web Site
2014		2,155,762	342,723	519,302	529,253	1,225,819	96,279	733,395	23,156	336,645	631,477	5,602,533	991,278	**6,593,812**	WDNR

Unit: gallons per day

Table 2
Historical Per Capita Consumption
Waukesha Water Utility
Waukesha, Wisconsin

Year	Estimated Population	Gallons Per Capita Per Day				
		Residential	Commercial	Industrial	Public	Total Sales
1970	39,695	56.8	19.1	106	11.7	194
1971	40,762	59.8	18.8	97.3	11.3	188
1972	41,829	57.7	18.8	102.5	11.3	192
1973	42,896	62.3	20.7	93.6	12.3	190
1974	43,963	63.9	20.5	95.8	12.9	194
1975	45,030	64.1	20.1	97.0	11.4	194
1976	46,097	72.3	18.6	91.5	11.4	196
1977	47,164	71.0	18.5	88.8	10.8	191
1978	48,231	68.8	18.9	89.5	10.9	189
1979	49,298	56.2	34.0	89.5	10.2	192
1980	50,365	54.8	33.2	82.4	9.7	181
1981	51,024	53.1	32.5	74.2	9.7	171
1982	51,684	50.7	30.9	61.9	9.2	154
1983	52,343	53.0	32.7	58.9	9.9	156
1984	53,002	51.3	32.3	65.4	8.7	158
1985	53,662	53.4	32.5	67.9	9.3	164
1986	54,321	49.4	32.6	63.9	8.7	155
1987	54,980	50.6	33.2	63.9	9.3	158
1988	55,639	58.3	35.7	66.3	9.3	170
1989	56,299	52.8	36.3	56.8	8.3	155
1990	56,958	49.8	34.8	49.6	7.7	142
1991	57,613	52.5	36.0	45.9	8.5	145
1992	58,268	49.9	37.4	35.0	4.8	127
1993	58,923	47.3	37.9	37.7	4.4	127
1994	59,578	49.5	38.9	35.4	4.8	129
1995	60,232	49.0	39.0	34.8	5.4	128
1996	60,887	48.9	38.7	34.3	5.4	127
1997	61,542	48.5	36.6	34.9	5.2	125
1998	62,197	48.9	36.9	35.1	5.1	126
1999	63,027	48.4	36.9	31.4	7.7	124
2000	64,825	45.1	35.9	27.9	4.6	113
2001	65,324	47.3	36.7	24.6	4.8	113
2002	66,237	49.0	37.8	25.3	4.9	117
2003	66,807	48.2	36.7	18.9	4.9	109
2004	66,816	45.8	35.0	17.8	5.0	104
2005	67,466	48.5	35.5	17.4	4.9	106
2006	68,117	43.3	34.5	17.1	4.4	99
2007	68,767	43.3	33.7	16.1	4.4	98
2008	69,417	41.7	32.7	15.1	3.9	93
2009	70,068	41.2	31.5	12.7	3.9	89
2010	70,718	39.4	31.1	12.6	3.6	87
2011	70,867	38.8	31.1	13.2	3.8	87
2012	71,697	40.2	31.6	12.8	4.4	89
2013	71,172	37.7	30.3	10.3	3.6	82
2014	70,847	36.7	30.2	10.5	3.6	81
Average (2008-2014)		39.4	31.2	12.4	3.8	86.8

Source: Table 2 of Attachment C, Appendix C of "City of Waukesha Water Supply Service Area Plan, Volume 2."
2013-2014 Data downloaded from http://psc.wi.gov/

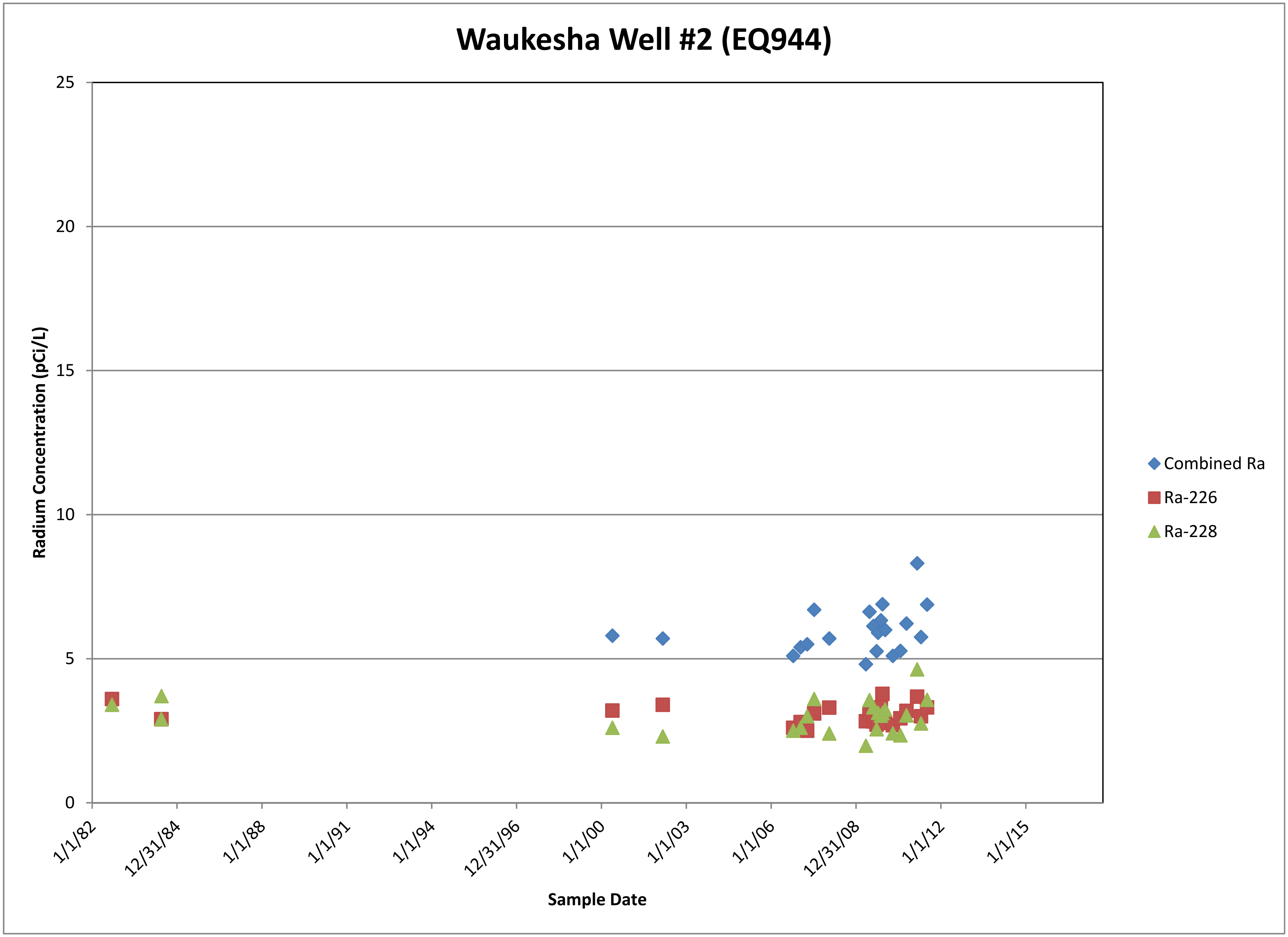
Table 3
Estimated 95% UCLs of Pre-treatment Radium Concentrations, and Post-Treatment Radium Concentrations
Blended Radium Concentrations

Year	Well 2	Well 3	Well 5	Well 6	Well 7	Well 8	Well 9	Well 10	Blended Concentration if Pumping at Previous Annual Rate, pCi/L
Pre-Treatment Radium Concentration (95 UCL), pCi/L	6.273	21.05	8.461	10.48	5.75	9.879	11.82	11.41	
Proposed Treatment Technology	None	Existing HMO	None	RO	None	RO	None	RO	
Post-Treatment Radium Concentration (Existing 95% UCL for Well 3, 90% Removal for RO at Wells 6, 8 and 10), pCi/L	6.3	3.963	8.5	1.0	5.8	1.0	11.8	1.1	
Annual Pumping Rate (MGD)									
2002	0.464	0.334	0.825	1.382	1.352	1.283	1.226	1.225	**4.65**
2003	0.446	0.793	0.519	1.067	1.040	1.057	1.142	1.538	**4.44**
2004	0.310	0.744	0.595	1.184	1.164	0.950	1.091	1.338	**4.50**
2005	0.170	0.574	0.544	1.434	0.848	0.879	1.451	1.672	**4.52**
2006	0.327	0.513	0.494	1.171	0.942	0.805	1.270	1.405	**4.67**
2007	0.514	0.745	0.485	0.617	0.956	1.318	0.187	0.973	**3.63**
2008	0.118	1.295	0.028	0.044	0.145	1.168	0.035	2.914	**2.07**
2009	0.300	1.268	0.408	0.354	0.605	0.790	0.000	1.414	**3.23**
2010	0.056	1.161	0.070	0.044	0.251	0.721	0.008	2.756	**2.17**
2011	0.023	0.865	0.206	0.858	0.448	1.054	0.008	2.273	**2.18**
2012	0.000	0.905	0.178	0.354	0.206	1.184	0.010	3.119	**1.93**
2013	0.000	1.003	0.565	0.132	0.425	1.183	0.017	2.069	**2.79**
2014	0.000	2.156	0.343	0.519	0.529	1.226	0.096	0.733	**3.25**

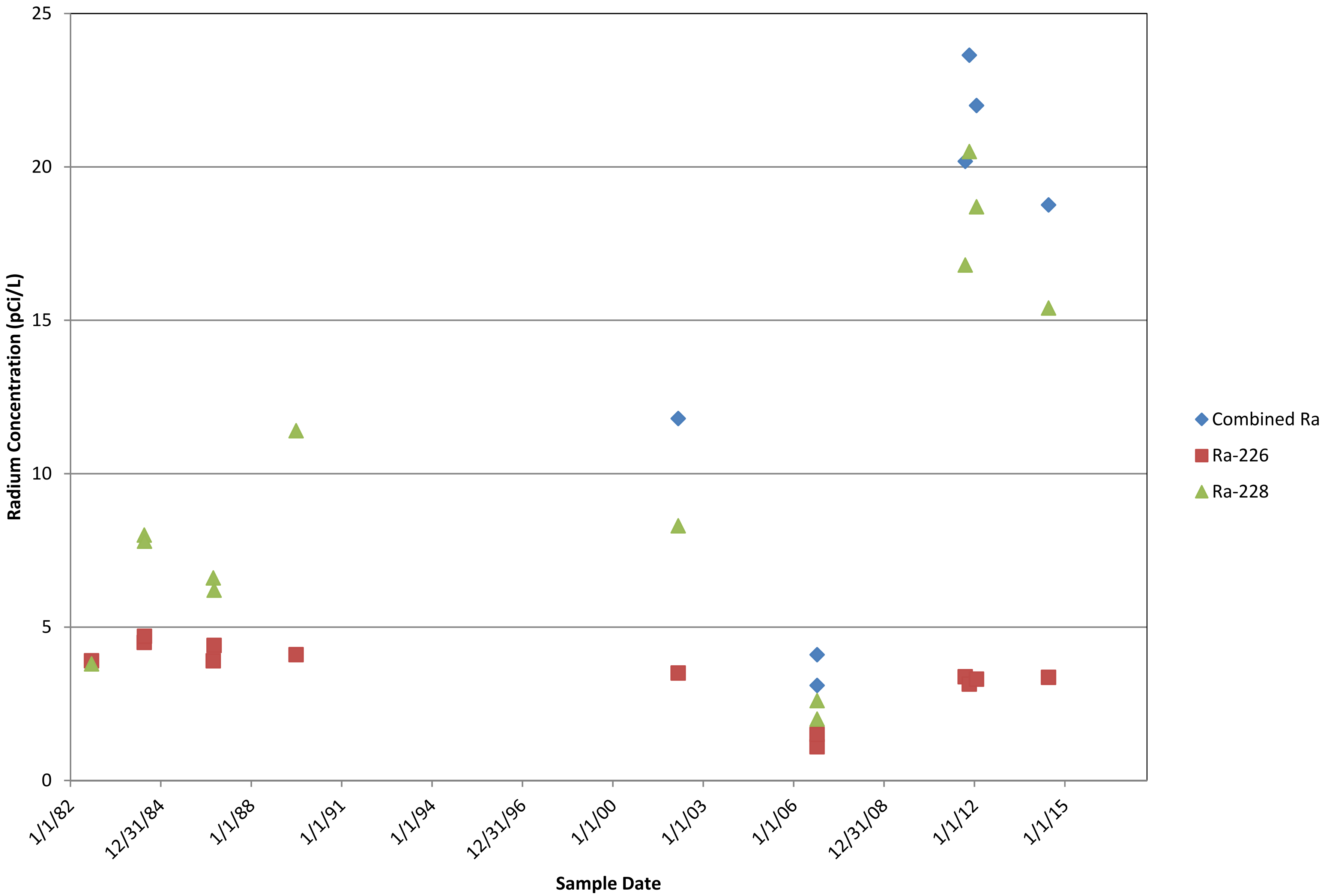
Note: RO denotes reverse osmosis; HMO denotes hydrous manganese oxide treatment.
The Maximum Contaminant Levels (MCLs) for combined radium is 5 pCi/L.

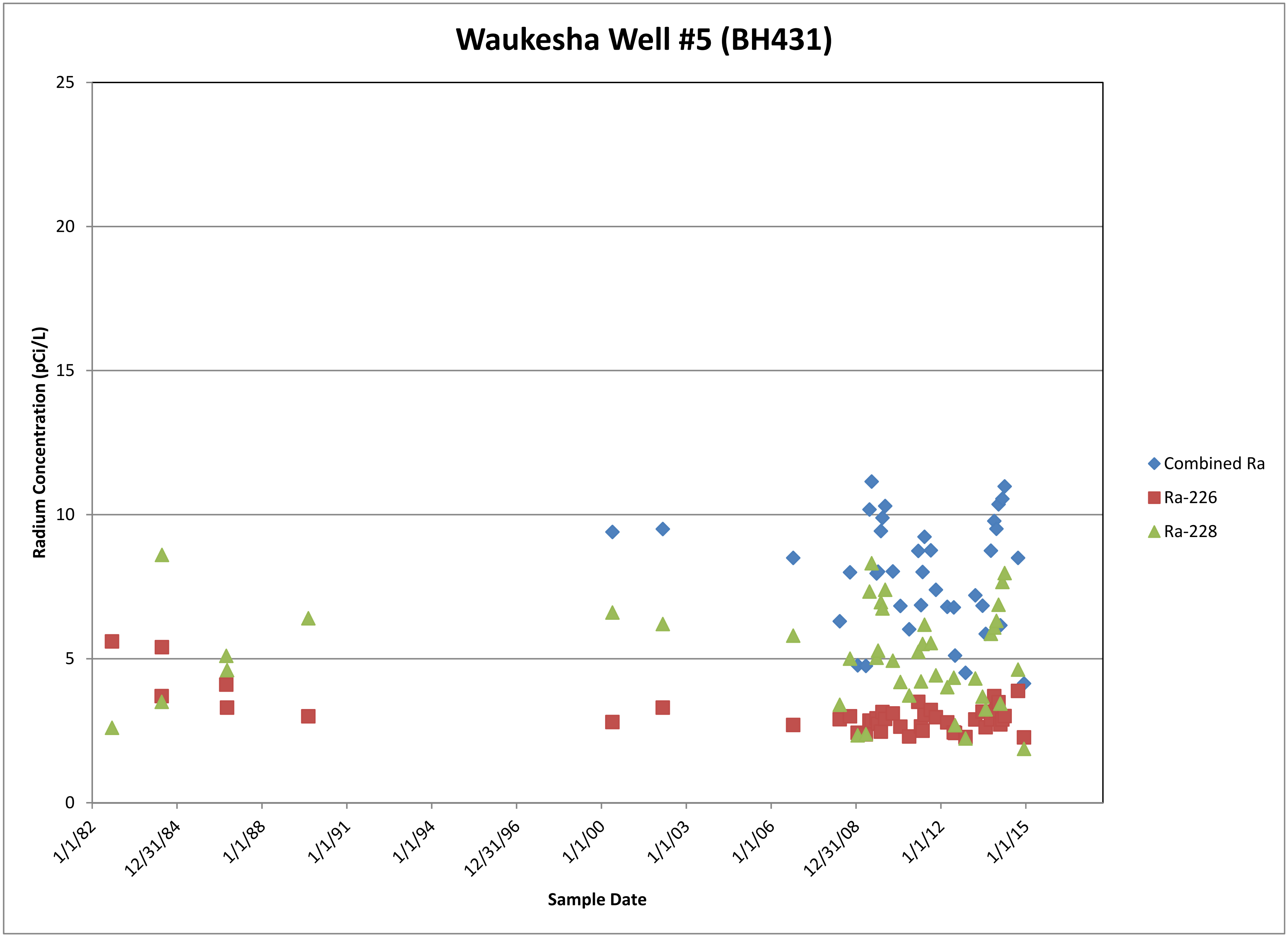
ATTACHMENT 1

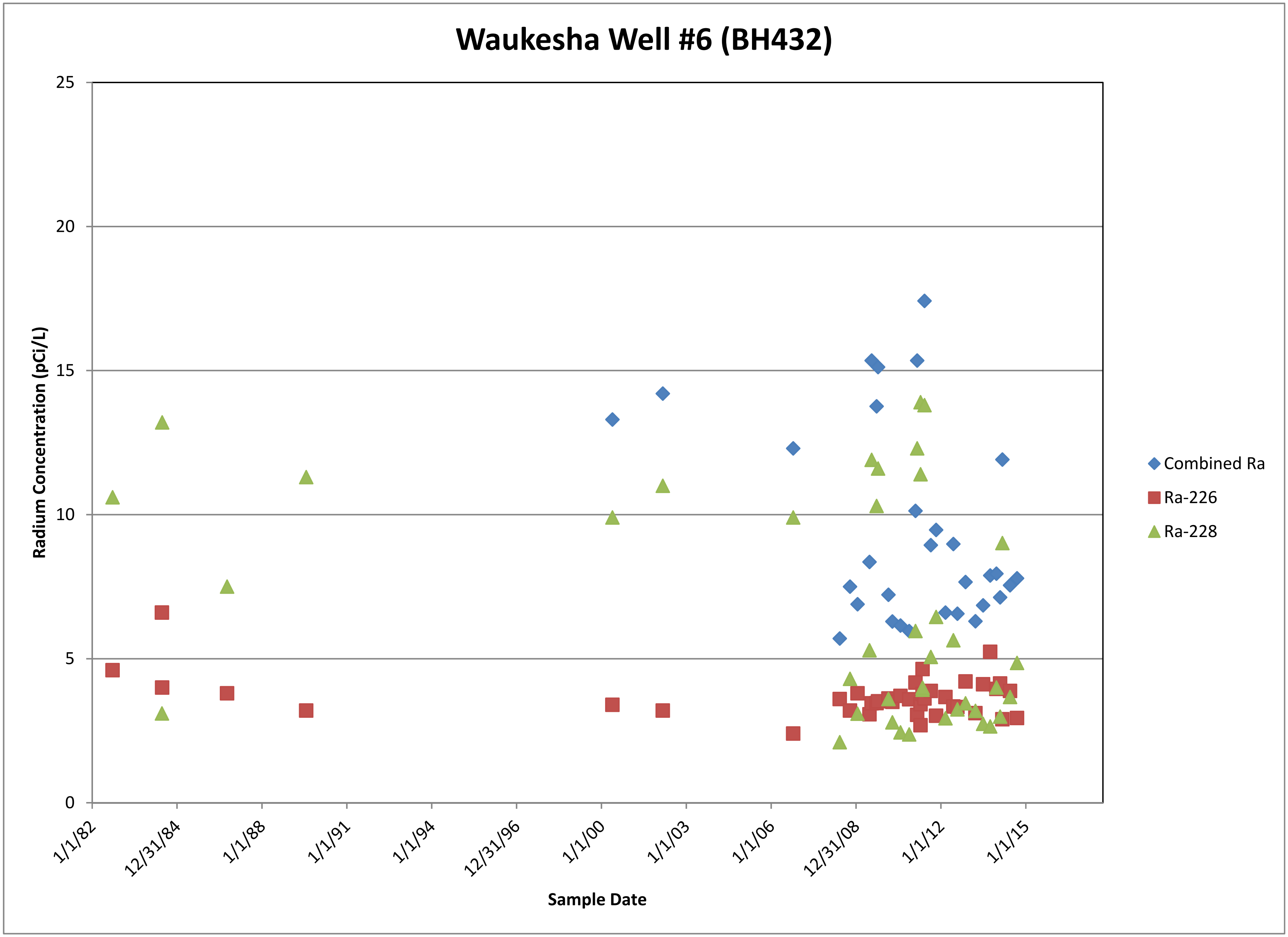
Plots of Pre-Treatment Radium Levels


Waukesha Well #2 (EQ944)
Radium Concentration (pCi/L)
25
20
15
10
5
0
1/1/82
12/31/84
1/1/88
1/1/91
1/1/94
12/31/96
1/1/00
1/1/03
1/1/06
12/31/08
1/1/12
1/1/15
Sample Date
Combined Ra
Ra-226
Ra-228

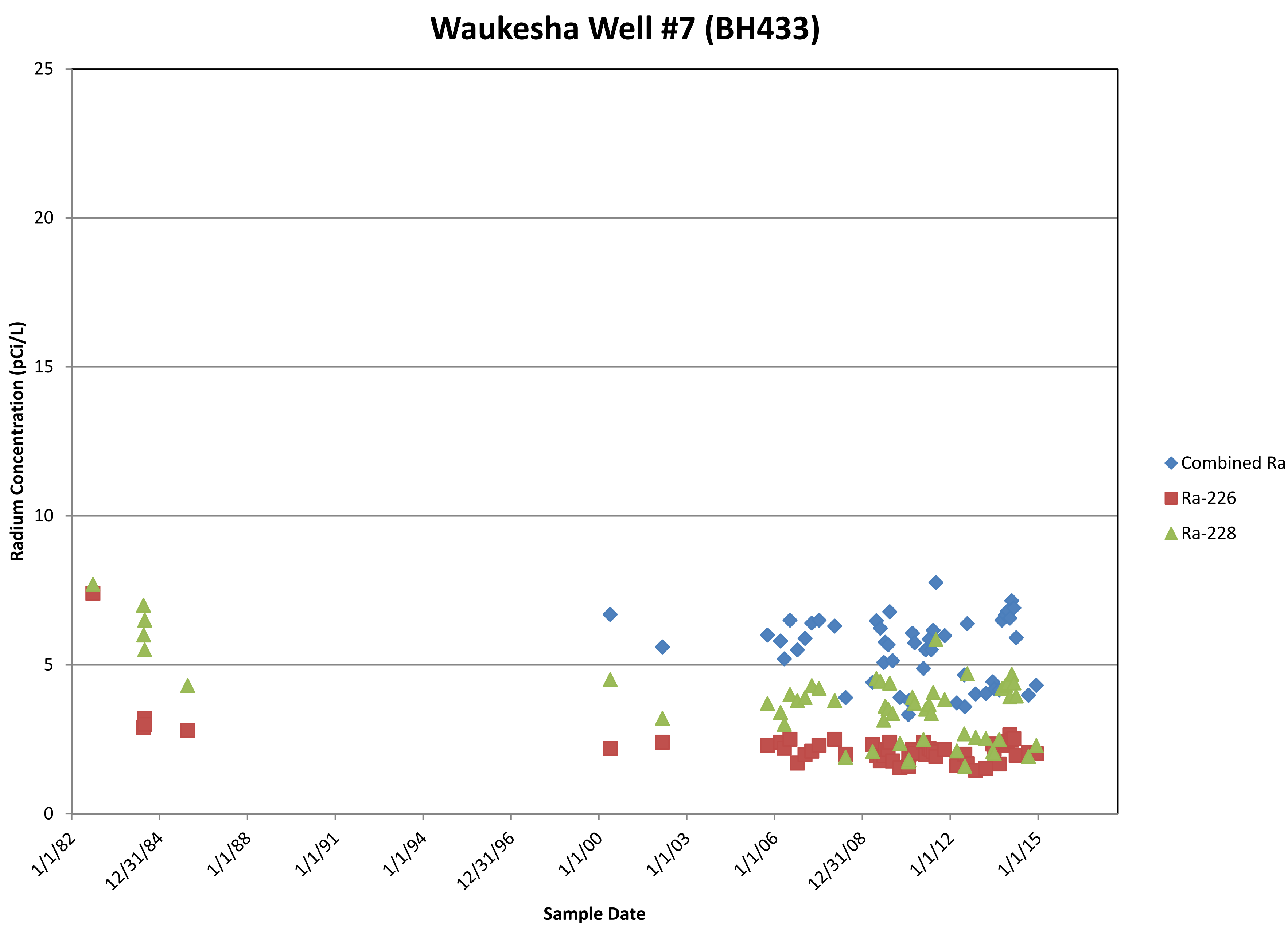
Waukesha Well #3 (BH429)

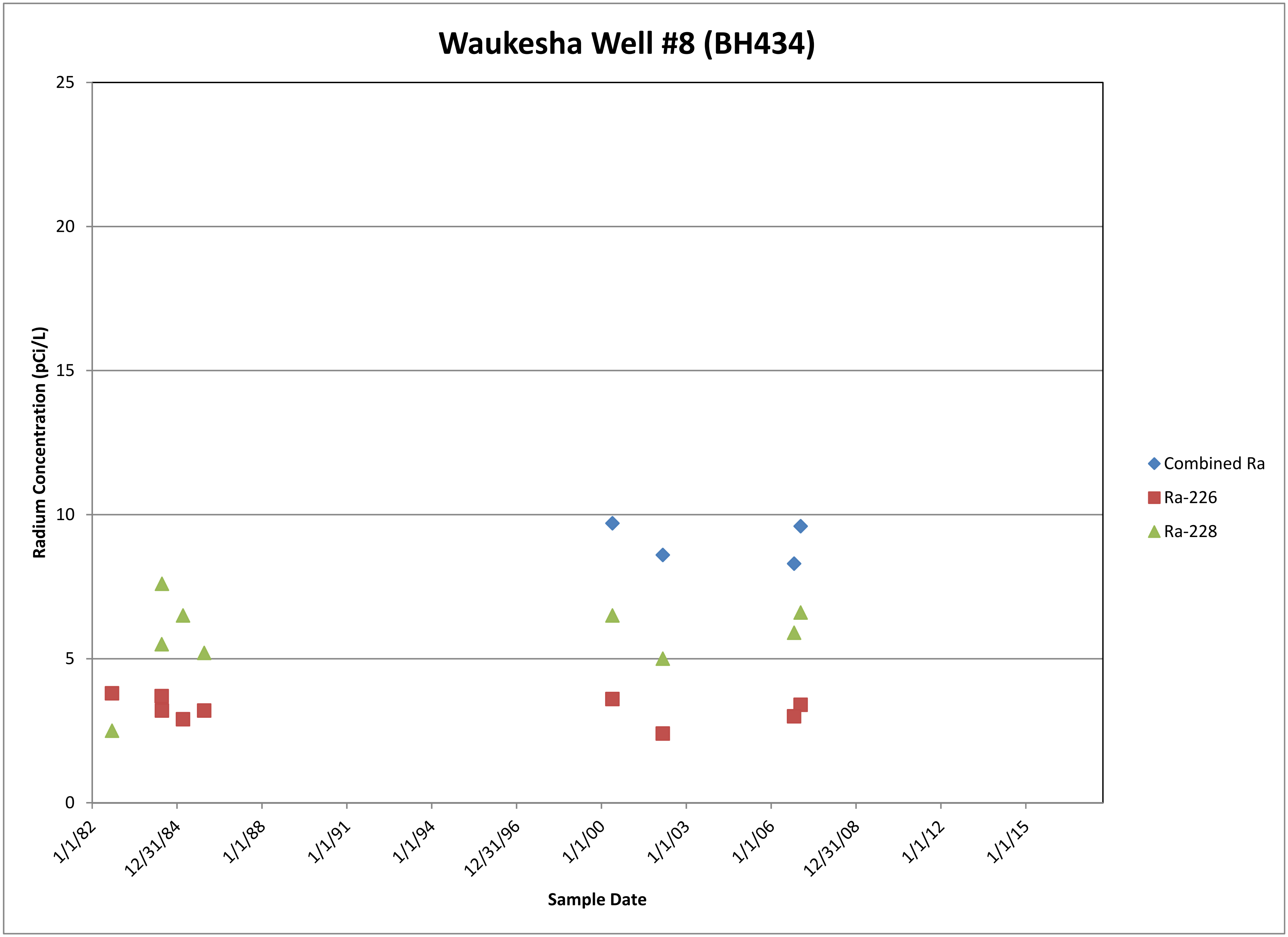


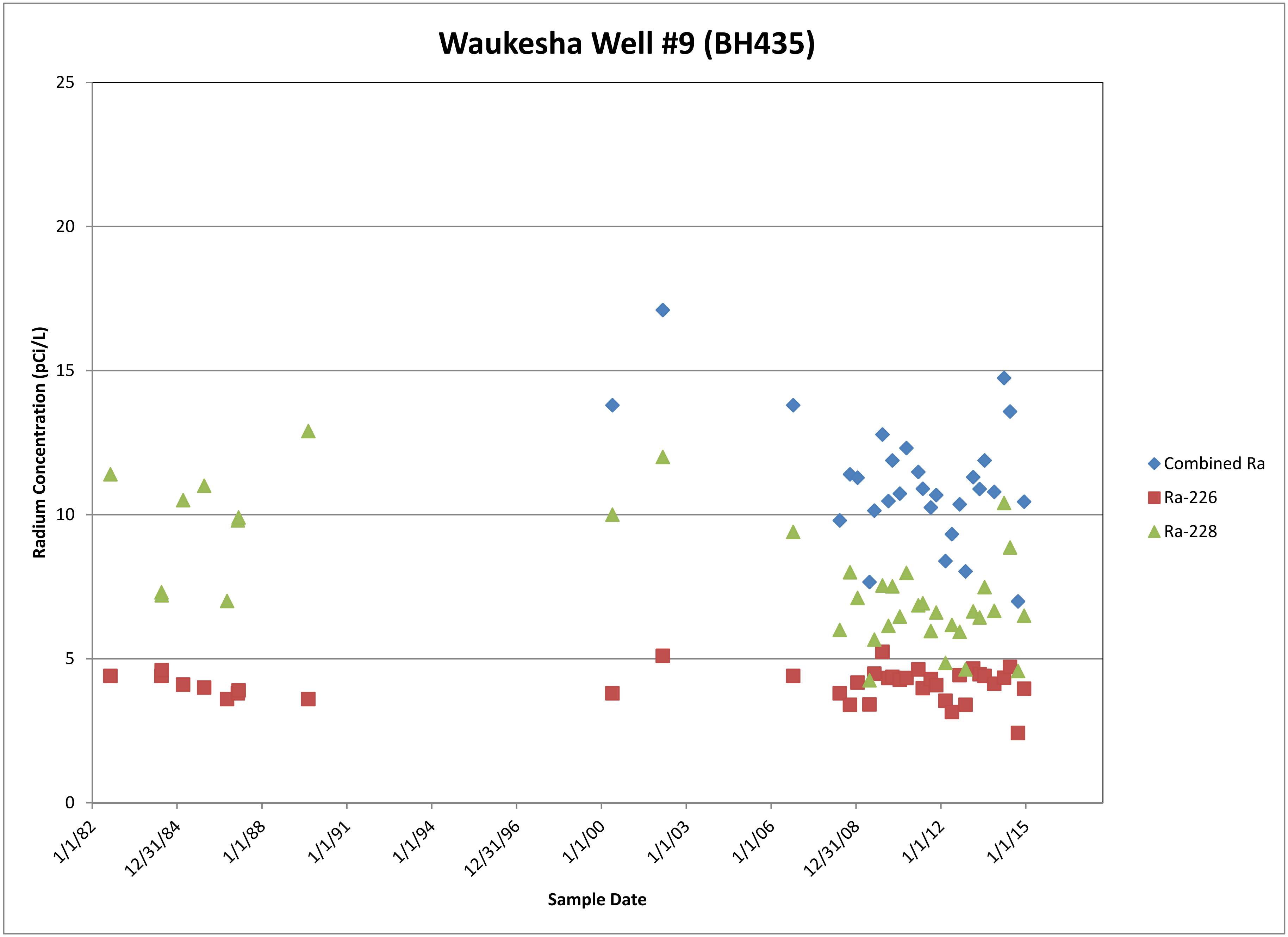

Waukesha Well #5 (BH431)
Radium Concentration (pCi/L)
25
20
15
10
5
0
1/1/82
12/31/84
1/1/88
1/1/91
1/1/94
12/31/96
1/1/00
1/1/03
1/1/06
12/31/08
1/1/12
1/1/15
Sample Date
Combined Ra
Ra-226
Ra-228



Waukesha Well #6 (BH432)
Radium Concentration (pCi/L)
0
5
10
15
20
25
1/1/82
12/31/84
1/1/88
1/1/91
1/1/94
12/31/96
1/1/00
1/1/03
1/1/06
12/31/08
1/1/12
1/1/15
Sample Date
Combined Ra
Ra-226
Ra-228


Waukesha Well #7 (BH433)
Radium Concentration (pCi/L)
25
20
15
10
5
0
1/1/82
12/31/84
1/1/88
1/1/91
1/1/94
12/31/96
1/1/00
1/1/03
1/1/06
12/31/08
1/1/12
1/1/15
Sample Date
Combined Ra
Ra-226
Ra-228


Waukesha Well #8 (BH434)
Radium Concentration (pCi/L)
25
20
15
10
5
0
1/1/82
12/31/84
1/1/88
1/1/91
1/1/94
12/31/96
1/1/00
1/1/03
1/1/06
12/31/08
1/1/12
1/1/15
Sample Date
Combined Ra
Ra-226
Ra-228


Waukesha Well #9 (BH435)
Radium Concentration (pCi/L)
25
20
15
10
5
0
1/1/82
12/31/84
1/1/88
1/1/91
1/1/94
12/31/96
1/1/00
1/1/03
1/1/06
12/31/08
1/1/12
1/1/15
Sample Date
Combined Ra
Ra-226
Ra-228

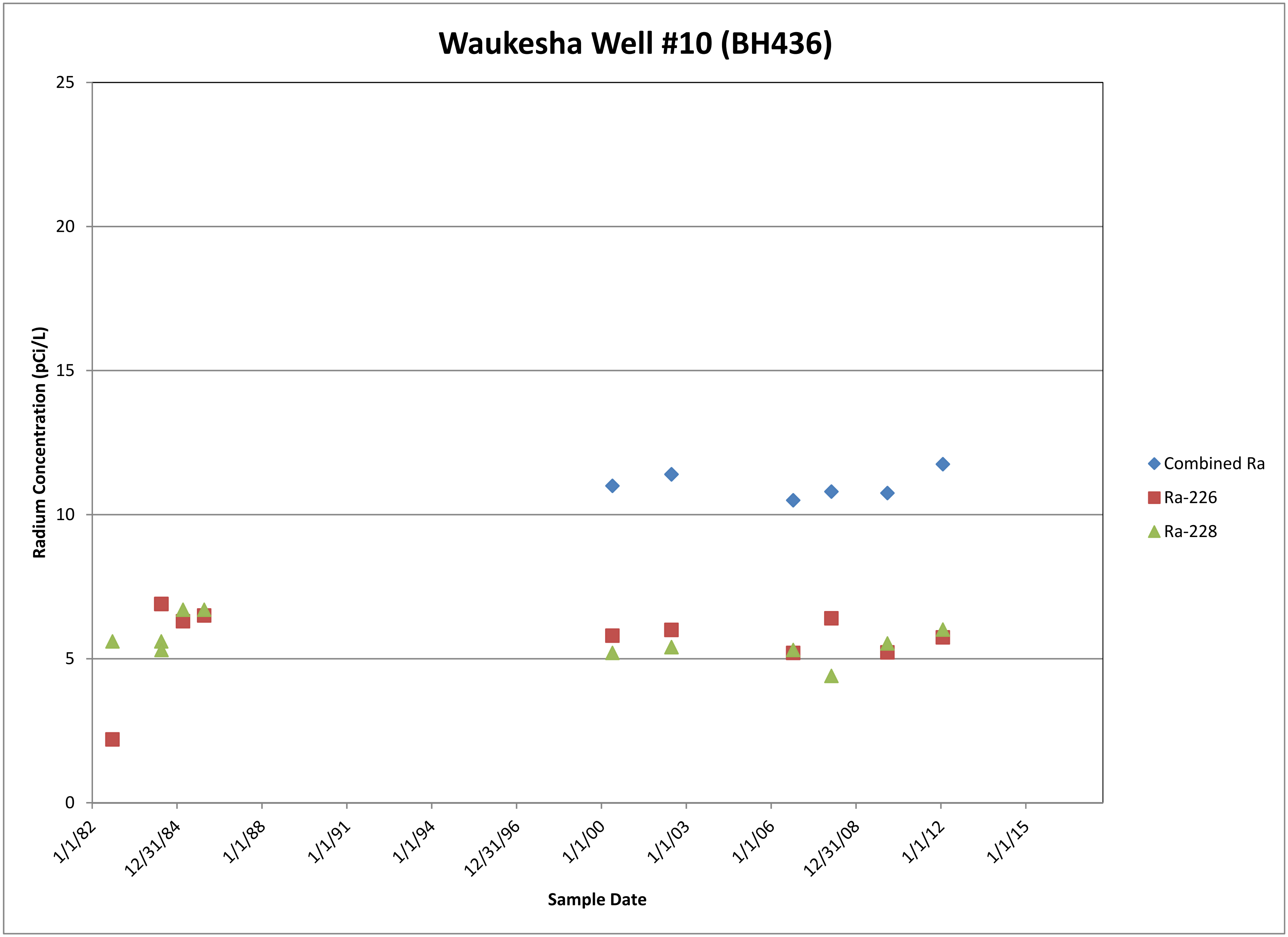

Waukesha Well #10 (BH436)
Radium Concentration (pCi/L)
25
20
15
10
5
0
1/1/82
12/31/84
1/1/88
1/1/91
1/1/94
12/31/96
1/1/00
1/1/03
1/1/06
12/31/08
1/1/12
1/1/15
Sample Date
Combined Ra
Ra-226
Ra-228

Table 3
Estimated 95% UCLs of Pre-treatment Radium Concentrations, and Post-Treatment Radium Concentrations
Blended Radium Concentrations

Year	Well 2	Well 3	Well 5	Well 6	Well 7	Well 8	Well 9	Well 10	Blended Concentration if Pumping at Previous Annual Rate, pCi/L
Pre-Treatment Radium Concentration (95 UCL), pCi/L	6.273	21.05	8.461	10.48	5.75	9.879	11.82	11.41	
Proposed Treatment Technology	None	Existing HMO	None	RO	None	RO	None	RO	
Post-Treatment Radium Concentration (Existing 95% UCL for Well 3, 90% Removal for RO at Wells 6, 8 and 10), pCi/L	6.3	3.963	8.5	1.0	5.8	1.0	11.8	1.1	
Annual Pumping Rate (MGD)									
2002	0.464	0.334	0.825	1.382	1.352	1.283	1.226	1.225	**4.65**
2003	0.446	0.793	0.519	1.067	1.040	1.057	1.142	1.538	**4.44**
2004	0.310	0.744	0.595	1.184	1.164	0.950	1.091	1.338	**4.50**
2005	0.170	0.574	0.544	1.434	0.848	0.879	1.451	1.672	**4.52**
2006	0.327	0.513	0.494	1.171	0.942	0.805	1.270	1.405	**4.67**
2007	0.514	0.745	0.485	0.617	0.956	1.318	0.187	0.973	**3.63**
2008	0.118	1.295	0.028	0.044	0.145	1.168	0.035	2.914	**2.07**
2009	0.300	1.268	0.408	0.354	0.605	0.790	0.000	1.414	**3.23**
2010	0.056	1.161	0.070	0.044	0.251	0.721	0.008	2.756	**2.17**
2011	0.023	0.865	0.206	0.858	0.448	1.054	0.008	2.273	**2.18**
2012	0.000	0.905	0.178	0.354	0.206	1.184	0.010	3.119	**1.93**
2013	0.000	1.003	0.565	0.132	0.425	1.183	0.017	2.069	**2.79**
2014	0.000	2.156	0.343	0.519	0.529	1.226	0.096	0.733	**3.25**

Note: RO denotes reverse osmosis; HMO denotes hydrous manganese oxide treatment.
The Maximum Contaminant Levels (MCLs) for combined radium is 5 pCi/L.

ATTACHMENT 2

Mead & Hunt, July 7, 2015

"City of Waukesha 6.7 MGD Water Demand Alternative."

Mead &Hunt
102 W. Washington Street, Suite 213
Marquette, Michigan 49855
906-273-1568
meadhunt.com

July 7, 2015[1]

Mr. Ezra Meyer
Water Resources Specialist
Clean Wisconsin
634 West Main Street, Suite 300
Madison, WI 53703

Subject: Waukesha 6.7 mgd Water Demand Alternative

Dear Mr. Meyer:

In accordance with our revised scope of work that you requested in May, Mead & Hunt (M&H) has evaluated the City of Waukesha, Wisconsin (City) groundwater well sources necessary to provide a 6.7 million gallon per day (mgd) average demand water service to the City. This 6.7 mgd water demand has been forecast by GZA in a June 9, 2015 memo as the future 50-year demand for the City of Waukesha's current water supply service area only, with no expanded service area to include adjacent communities as proposed in the Application. Based on the GZA water demand forecasts of 6.7 mgd average demand and 11.1 mgd maximum daily demand for the City, we have evaluated which wells should be included in the City water source to provide those demands, and we have estimated the total project capital cost and the annual operation and maintenance (O&M) cost for that alternative, referred to as Alternative 1C – Existing Deep and Shallow Wells for 6.7 mgd Average Day. This memo is an amendment to the report "CITY OF WAUKESHA'S APPLICATION FOR DIVERSION OF LAKE MICHIGAN WATER PHASE 2: RECOMMENDATIONS FOR AN ALTERNATIVE WATER SUPPLY", prepared by Mead & Hunt and dated April 6, 2015 (Report). It reflects significant new information brought to light in the intervening time by GZA's investigations on behalf of Clean Wisconsin and its coalition partners.

For Alternative 1C, the seven existing Waukesha deep aquifer wells, numbers 3, 5, 6, 7, 8, 9, and 10, would be used to provide 5.7 mgd of the 6.7 mgd average day demand, and 9.6 mgd of the 11.1 mgd maximum day demand. The existing shallow aquifer wells, numbers 11, 12, and 13, would provide 1.0 mgd for average day and 1.5 mgd for maximum day. These well flows represent similar pumping rates for the wells to those flows listed for the wells for Alternatives 1A and 1B in Figure 5 of the Report.

[1] Amended August 27, 2015

Alternative 1C includes three new reverse osmosis (RO) treatment plants for the deep wells 6, 8, and 10, as provided for Alternatives 1A and 1B in the Report. The existing treatment for wells 3, 11, and 12 is proposed to be continued in Alternative 1C. Seven miles of new transmission pipeline between deep wells 5, 6, 7, 8, and 9 would be included in Alternative 1C, to provide blending of the treated and untreated deep wells before pumping water into the Waukesha water system.

All of these recommendations mirror Waukesha's own assumptions in the 2013 diversion application, specifically those detailed in connection with the Water Utility's Alternative 1: Deep Confined Aquifer and Shallow Aquifer.

For example, to facilitate direct, apples-to-apples comparison with the alternatives detailed in the Application, we base this analysis on Waukesha's assumption that the Water Utility and the City's wastewater treatment plant could deal with any waste streams resulting from the current and proposed new drinking water treatment technologies that would be necessary to meet applicable drinking water quality standards. Mead & Hunt did not evaluate the reasonableness of that assumption on Waukesha's part, nor did we estimate costs for treatment of possible waste streams Waukesha may have not included.

It bears mention that Mead & Hunt would not necessarily recommend reverse osmosis treatment for Waukesha's existing deep aquifer wells. Were Waukesha Water Utility our client, we would evaluate the many available options for treatment of radium and other water quality parameters. Reverse osmosis is a tried and true treatment technology[2], and we are aware that at least one Wisconsin water utility has employed RO for its drinking water treatment purposes[3]. We are also aware that many of Wisconsin's forty plus utilities managing for radium compliance use a combination of blending and treatment with technologies other than RO[4]. For purposes of this analysis, we took Waukesha's own assumptions in its application as our own to facilitate realistic side-by-side comparisons.

[2] The United States Environmental Protection Agency notes that "Reverse osmosis has been identified by EPA as a "best available technology"(BAT) and Small System Compliance Technology (SSCT) for uranium, radium, gross alpha, and beta particles and photon emitters. It can remove up to 99 percent of these radionuclides, as well as many other contaminants (e.g., arsenic, nitrate, and microbial contaminants)." http://cfpub.epa.gov/safewater/radionuclides/radionuclides.cfm?action=Rad_Reverse%20Osmosis.

[3] Waupun Utilities: http://www.ati-ae.com/resources/tech-talk/188-waupun-ro.html and http://www.waupunutilities.com/media/power_point_on_water_plant.ppt.

[4] http://dnr.wi.gov/files/pdf/pubs/dg/dg0008.pdf: Wisconsin Department of Natural Resources, 2014. And http://www.sehinc.com/awards/2007/brookfield-square-water-treatment-facility-receives-several-awards.

Deep Well Treatment Plant			
3 RO plants for Wells 6,8,10 @ 5.35 mgd	5,350,000	$4.57	$24,460,000
including land built in 2020			**$24,460,000**
Distribution System Improvements			
4.3 mi of 16", 24", and 30" pipes	22,500	$413	$9,289,000
7.0 mi of 16" pipe for blending	36,960	$323	$11,938,000
			$21,227,000
		Subtotal	**$45,687,000**
3% markup for Bonds & Insurance			$1,371,000
5% markup for Mob/Demob			$2,284,000
8% markup for Contractors Overhead			$3,655,000
4% markup for Contractors profit			$1,827,000
		Subtotal	**$9,137,000**
25% Contingency			$13,706,000
		Subtotal Markups and Contingency	**$22,843,000**
		Total Project Construction Costs	**$68,530,000**
8% allowance for engineering and design			$5,482,000
12% allowance for permitting, legal and admin.			$8,224,000
8% allowance for engr services during construction			$5,482,000
		Subtotal Other Project Costs	**$19,188,000**
		Total Project Capital Cost	**$87,718,000**

FIGURE 1: Alternative 1C: Existing Deep and Shallow Wells — Capital Costs

The Alternative 1C capital cost estimate is $87,718,000, as shown in Figure 1. This cost is much less (50% less) than the $176,287,000 capital cost estimate for Alternative 1A in the Report. The Alternative 1C annual O&M cost estimate is $5,471,000 per year, 20% less than the $6,821,000 per year estimate for Alternative 1A in the Report. The Alternative 1C annual O&M cost is shown in Figure 2. The total present worth of the Alternative 1C costs are

$150,787,000 for 20 years and $173,584,000 for 50 years , 58% and 60% of the Alternative 1A 20- and 50-year costs, respectively, as presented in the Report. The present worth costs are also shown in Figure 2.

Source of Supply	Units	Quantity	Unit Cost	$/year
Deep Well pumping/maintenance	$/1000 gal	2,190,000	$0.35	$728,000
Shallow Well Pumping/Maintenance	$/1000 gal	365,000	$0.14	$51,000
			Total	**$779,000**
Treatment/Pumping				
Deep Wells 6,8,10 starting in 2020	$/1000 gal	1,460,000	$0.61	$891,000
Shallow Wells	$/1000 gal	365,000	$1.09	$398,000
Residuals	$/1000 gal	128,000	$4	$512,000
			Total	**$1,801,000**
Home Softening				
Salt/Equipment/Replacement	$/person/yr	13,683	$209	$2,860,000
			Total	**$2,860,000**
Transmission				
Operation and Maintenance	$/lf/year	59,460	$0.52	$31,000
			Total	**$31,000**
	Alternative 1C Total		**O&M($/yr)**	**$5,471,000**
PRESENT WORTH OF O&M (6%, 20 yrs)	$63,069,000			
PRESENT WORTH OF O&M (6%, 50 yrs)	$85,866,000			
Total Present Worth (6%, 20 years)	$150,787,000			
Total Present Worth (6%, 50 years)	$173,584,000			

FIGURE 2: Alternative 1C: Existing Deep and Shallow Wells — O&M Costs

Alternative 1C includes facilities that are predicted to be capable of meeting the Waukesha Water Utility's 50-year water system demands for the existing City Water Supply Service Area. The alternative provides water to the City from its existing wells, with existing and new treatment facilities to meet the radium water quality standards. The potential for environmental impacts to private wells, tributary streams, and wetlands would be zero in this scenario because no new wells are included. The capital costs for Alternative 1C are significantly less than 1A, 1B and the proposed diversion alternative, and present worth costs are also less than other alternatives. Alternative 1C is very feasible, as it incorporates existing wells, with new radium treatment plants and less piping than other alternatives.

Please advise if you have any questions or require further information. Thank you for the opportunity to be of service.

Sincerely,

Donald DeGrand
Senior Engineer
Mead & Hunt

CC: Jiangeng Cai, GZA GeoEnvironmental, Inc.