



Pilot Study Report

for

Z-88™ Radium Treatment Process



conducted for

**Gilbert-Summit Rural Water District
Gilbert, South Carolina**

October 28, 2005

Executive Summary

This radium removal pilot study was conducted for Gilbert-Summit Rural Water District in Gilbert, South Carolina. The raw water source for this pilot study was taken prior to any treatment, or the addition of any chemicals, and therefore operated only when the well was operating. Water from the well is treated with blended phosphate, fluoride and chlorine before it enters the distribution system. Naturally occurring radionuclides in the Gilbert-Summit Water District's raw water source exceed current Maximum Contaminant Levels (MCL's) for combined radium.

Gilbert-Summit Rural Water District selected Water Remediation Technology's (WRT) Z-88™ Radium Removal Process as a possible cost effective solution for their radium problem. WRT provided a 1.5 GPM (gallons per minute) pilot plant, which was delivered and installed on May 24, 2005.

The purpose of this pilot study is to demonstrate the effectiveness of the treatment process on this water, establish design parameters for the full scale system and meet regulatory piloting requirements.

The pilot unit has successfully met radium compliance at all times during the pilot study. Based on the data received at the time this report was written, the pilot plant had been in operation for 119 days and effectively reduced the level of radium (Figure 1) to less than the MCL.

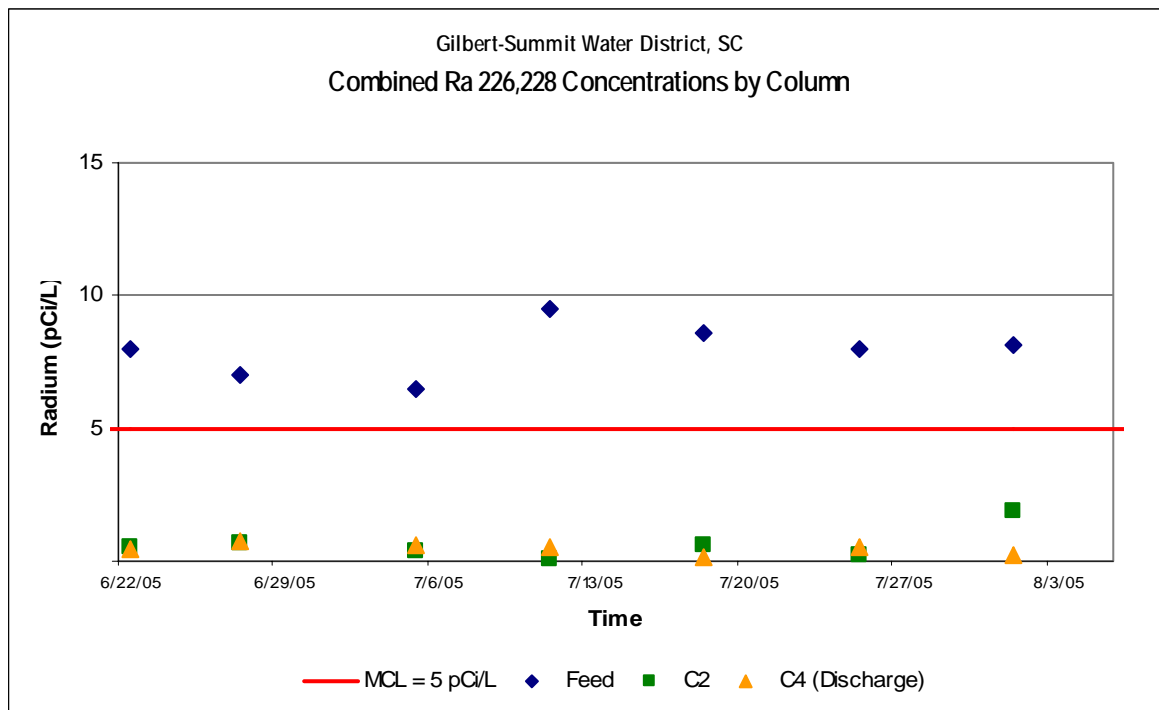


Figure 1

The results are also shown in Table 1. The average feed concentration of combined radium, 8.0 pCi/L, (pico Curies per Litre) was reduced to 0.5 pCi/L after column 4 and has yet to exceed 0.7 pCi/L; well below the MCL.

Table 1. Radium levels in feed and discharge water.

	Feed (pCi/L)	Discharge @ Column 4 (pCi/L)
Radium MCL	NA	5.0
Average	8.0	0.5
Highest Value	9.5	0.7
Lowest Value	6.5	0.2

Application Information

The Gilbert-Summit Rural Water District is located in Gilbert, South Carolina, approximately 25 miles southeast of Columbia. The Gilbert-Summit Rural Water District provides water for the community of about 1,100 residential homes.

Technology Overview

Water Remediation Technology's (WRT) Z-88™ Radium Treatment Process utilizes Z-88™ patent pending treatment media in a series of up flow treatment vessels to remove radium 226 and 228 from drinking water. The water is moved through the treatment system using the water pressure generated from the well source. No chemicals are added to the water for the treatment process. After the media is loaded with radium, it is removed from the circuit and permanently disposed of in a licensed facility. WRT designs, manufactures and provides the equipment and produces the media used in the facility. The handling and exchange of new media to replace spent media, as well as the shipping and disposal into licensed disposal sites, is handled by WRT. The Z-88™ process media is ANSI/NSF Standard 61 certified for use in drinking water.

Equipment Overview

The pilot equipment was installed in a self-contained mobile trailer. The treatment train used for this pilot study consists of four 4" diameter by 4' vertical height columns, each containing 25" of Z-88™ process media. The columns in the pilot unit are clear for visual observation of the media and process. The source water enters the unit through a ¾" diameter hose, passes through a control valve and flow meter, and enters the bottom of the first column. All columns operate in an up-flow mode, with the flow exiting the top of the first column, then following the same flow path through columns 2 through 4 in series (see Figure 3). The last component in the system is a safety filter. Sample ports are located prior to the first column, and after each of the columns in the series.

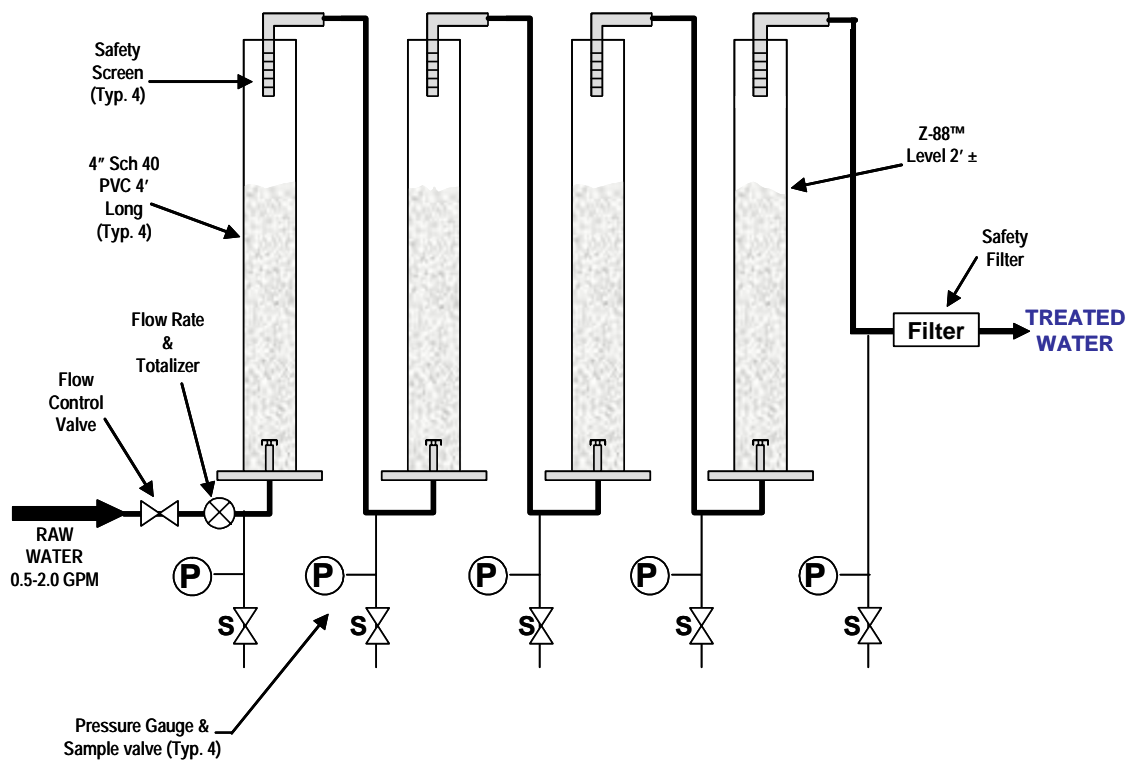


Figure 3. Typical Process Flow Diagram

The pilot unit operating data is used to establish the Empty Bed Contact Time (EBCT) and Hydraulic Loading Rate (HLR) suitable for a full scale system. The purpose of the short columns in the pilot plant is to allow more data to be collected and faster evaluation of the radium loading on the Z-88™ media.



Gilbert-Summit Rural Water District's Z-88™ pilot site.





Statement of Purpose

The feed levels during the pilot study in the raw water were as high as 9.5 pCi/L for radium. Historical water quality data for this site document average levels exceeding the Environmental Protection Agency (EPA) mandated MCL's.

The purposes of this pilot study are to:

- Demonstrate the ability of the WRT Z-88™ Radium Treatment Process to consistently and effectively reduce the radium level to below the MCL on this specific water.
- Demonstrate the reliability and ease of operation of the WRT Process.
- Comply with regulatory piloting requirements.
- Develop design criteria for the full-scale facility.

Delivery and Installation of Pilot Unit

The pilot unit was delivered and installed on May 24, 2005. Due to the self-contained design of the pilot trailer, set up consisted of securing the trailer and connecting the water source and discharge line. The pilot study began the same day. Data was collected for 119 days prior to writing this report.

Operator training for pilot unit operation, monitoring and sampling was conducted on the day of installation, and a schedule for sampling was established. Samples were collected from ½" valves located in the feed line and after discharge from each respective test column, at sample intervals.

Analytical

The radium samples were sent to Benchmark Analytics in Center Valley, Pennsylvania and the gross alpha, uranium, radon and inorganic samples were sent to ACZ Laboratories in Steamboat Springs, Colorado. Both are National Environmental Laboratory Accreditation Program certified laboratories. Methods for analysis were:

Radium 226	EPA 903
Radium 228	EPA 904
Gross Alpha	EPA 900.0

Results

The sampling results for radium are shown in Tables 2. Feed samples were collected immediately prior to the first column of Z-88™. Samples C2 and C4 were taken after each respective column, prior to discharge. Analytical laboratory certificates are attached as Appendix A. Figure 1 shows combined radium 226 and 228 levels in the feed water entering the pilot unit, and treated water exiting the pilot unit. The graph shows that the pilot unit successfully reduced the combined radium to below the MCL.

Table 2. Radium Test Results

Ra-226	Column Concentrations (pCi/L)		
Date	Feed	C2	C4
5/24/05			
6/22/05	2.3	0.1	0.1
6/27/05	1.8	0.0	0.1
7/5/05	1.6	0.1	0.1
7/11/05	2.4	0.1	0.2
7/18/05	2.7	0.1	0.1
7/25/05	2.2	0.1	0.1
8/1/05	2.2	0.1	0.2
Ra-228	Column Concentrations (pCi/L)		
Date	Feed	C2	C4
5/24/05			
6/22/05	5.7	0.0	0.4
6/27/05	5.2	0.6	0.7
7/5/05	4.9	0.3	0.5
7/11/05	7.1	0.0	0.4
7/18/05	5.9	0.5	0.0
7/25/05	5.8	0.1	0.5
8/1/05	5.9	1.8	0.1
Ra Combined	Column Concentrations (pCi/L)		
Date	Feed	C2	C4
5/24/05			
6/22/05	8.0	0.1	0.4
6/27/05	7.0	0.7	0.7
7/5/05	6.5	0.4	0.6
7/11/05	9.5	0.1	0.5
7/18/05	8.6	0.6	0.1
7/25/05	8.0	0.2	0.5
8/1/05	8.1	1.9	0.3

Figure 1 below, presents in graph format, the data in Table 2.

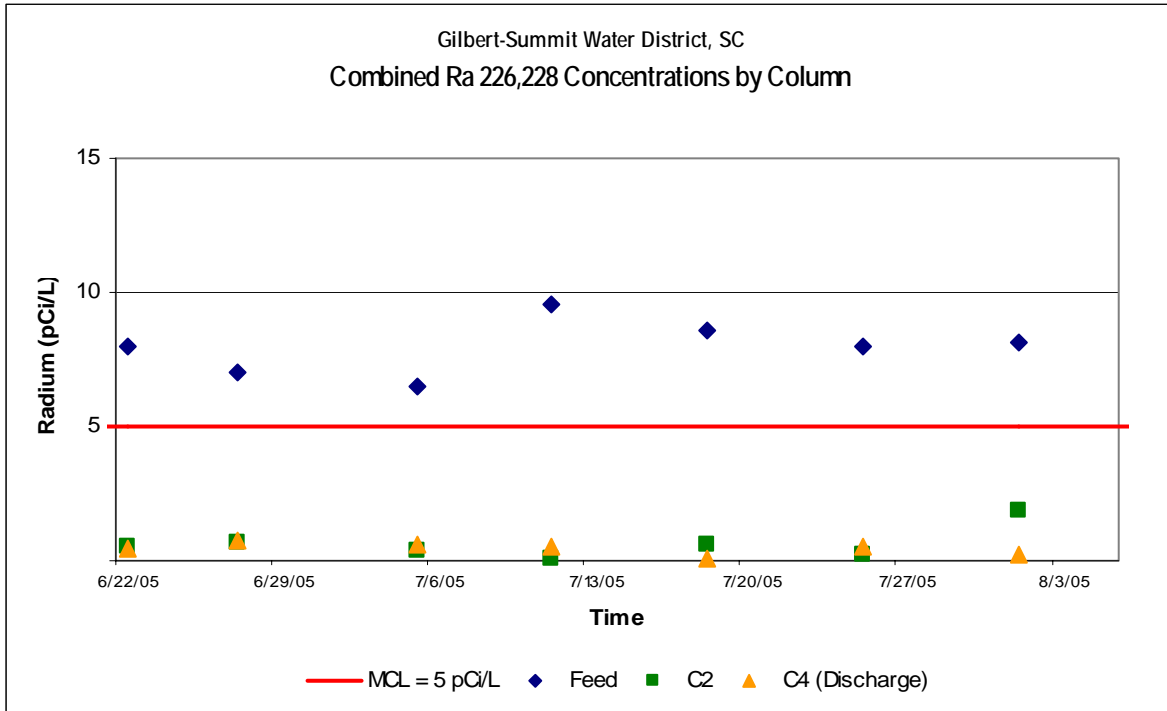


Figure 1

Gross Alpha Results

The gross alpha sampling results are shown in Table 3. Samples were collected immediately prior to the first vessel of treatment media and at discharge. Analytical laboratory certificates are attached as Appendix B. The results clearly show that the treatment system successfully reduced gross alpha to below its respective MCL of 15 pCi/L.

Table 3. Gross Alpha Test Results

Gross Alpha	Column Concentrations (pCi/L)		
Date	Feed	C2	C4
9/20/05	5.8	0.0	0.0

Hydraulic Loading Rate, EBCT

The pilot unit operated at 1.3 gallons per minute, for a HLR of 14.9 gallons per minute per square foot. The pilot unit ran intermittently, only when the well was in operation. The total gallons treated during the pilot study are summarized in Table 4 and Appendix E.

The EBCT at this HLR through four columns, each containing 25 inches of media, is 4.2 minutes.

Table 4. Cumulative treated flow in gallons

Sample Data	Treated Flow in Gallons
5/24/05	0
6/22/05	13,752
6/27/05	20,784
7/5/05	31,727
7/11/05	38,298
7/18/05	48,313
7/25/05	58,599
8/1/05	68,716



Water Quality

A water quality analysis was performed on feed water to the pilot unit and on treated water exiting the WRT pilot unit treatment process to document any changes in water quality through the Z-88™ treatment process. The results of those tests are shown in Table 5. Other than the reduction of gross alpha and radium, there is no significant change to the water quality. Support documentation for Table 5 is attached as Appendix C.

Table 5. Water Quality Data entering and exiting the Z-88™ treatment process

Gilbert-Summit, SC – Water Quality Data			
Item	Pre WRT Process	units	Post WRT Process
Alkalinity	<	mg/L	5
Antimony	<	mg/L	<
Arsenic	<	mg/L	<
Barium	0.0317	mg/L	0.0017
Beryllium	<	mg/L	<
Cadmium	<	mg/L	<
Calcium	3.0	mg/L	1.8
Chromium	0.0004	mg/L	0.0003
Chloride	2	mg/L	2
Copper	0.0284	mg/L	0.0026
Fluoride	0.3	mg/L	<
Hardness	14	mg/L	7
Iron	<	mg/L	<
Lead	0.0056	mg/L	0.0028
Magnesium	1.5	mg/L	0.5
Manganese	0.011	mg/L	0.006
Mercury	<	mg/L	<
Potassium	0.8	mg/L	1.0
Selenium	<	mg/L	<
Silica	5.6	mg/L	6.2
Sodium	1.7	mg/L	5.1
Sulfate	<	mg/L	<
Thallium	<	mg/L	<
Total Dissolved Solids	10	mg/L	20
Uranium	<	mg/L	<
Zinc	0.05	mg/L	0.03

Note: < is below detection levels

Uranium

Samples were collected during this study to evaluate the general level of uranium in the product water. Table 6 contains the uranium test results taken during the pilot study. The MCL for uranium is 0.03mg/L, which equates to approximately 20 pCi/L. The WRT Z-88™ process is not designed to remove uranium. Support documentation for Table 6 is attached as Appendix B.

Table 6. Uranium Test Results

Uranium	Column Concentrations (mg/L)		
Date	Feed	C2	C4
9/20/05	0.0001	<	<

Note: < is below detection levels

Radon

Radon occurs in drinking water as a result of the radioactive decay process of radium. A sample was collected during this study to determine if significant radon was generated by the capture of radium by the WRT media and to evaluate the general level of radon in the product water. Table 7 contains the radon test results which were analyzed on September 20, 2005. It is concluded that the WRT process does not contribute a significant amount of radon to the water. Support documentation for Table 7 is attached as Appendix D.

Table 7. Radon Test Results

Radon	Column Concentrations (pCi/L)	
Date	Feed	C4
9/20/05	71	4



Radiation Safety

The pilot unit is designed to collect naturally occurring radioactive material while in operation. Because of this action, it will gradually become radioactive as the test proceeds. WRT has both predicted and monitored the level of radiation present in numerous demonstrations.

The total amount of radiation that members of the public can be exposed to is 2 mrem per hour and 100 mrem over the course of a year. WRT's maximum measured activity is less than half of the hourly exposure limit. Due to the limited amount of operator attention necessary for the pilot test, the annual exposure limit is also readily met.

WRT has prepared a safety plan for its tests that includes radiation level monitoring, logging time spent in proximity to a test unit, emergency procedures to be followed and an introduction to radiation safety for operators. Operators are instructed in radiation safety before the pilot test is started.

Any full scale system will include appropriate equipment, radiation level monitoring, and a corresponding safety plan approved by regulatory authorities.

Operational Results

An operation log was maintained during the pilot study, and is attached as Appendix E. The pilot unit operated throughout the course of this test without any operational problems.

Conclusion

The WRT Z-88™ Radium Treatment Process consistently reduced combined radium 226 and 228 discharge levels. The pilot unit operated easily and reliably during the study. There were no equipment or operational problems of any kind. Full scale plant design parameters, such as HLR and EBCT requirements, can be determined from the pilot study data collected and will be incorporated into the basis of design.

WRT would like to thank the personnel and staff at Gilbert-Summit Rural Water District for their cooperation and assistance during this test.



Appendices available upon request.