



Pilot Study Report

for

Z-88® Radium Treatment Process



conducted for

Borough of Point Pleasant, New Jersey

May 24, 2006

Executive Summary

This radium removal pilot study was conducted for the Borough of Point Pleasant, New Jersey at the Well No. 8 treatment facility. The raw water source for this pilot study was taken prior to any treatment, or the addition of any chemicals. The pilot unit was run on a continuous basis throughout the study. Water from the well will be treated with lime and chlorine and then aerated for the removal of radon before it enters the distribution system. Naturally occurring radionuclides in the Borough of Point Pleasant's raw water source exceed current Maximum Contaminant Levels (MCL's) for combined radium.

The Borough of Point Pleasant selected Water Remediation Technology's (WRT) Z-88® Radium Treatment Process as a possible cost effective solution for their radium problem. WRT provided a one GPM (gallons per minute) pilot plant, which was delivered and installed on February 13, 2006.

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 reduced combined radium and 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 45 days and effectively reduced the level of radium (Figure 1) to less than the MCL.

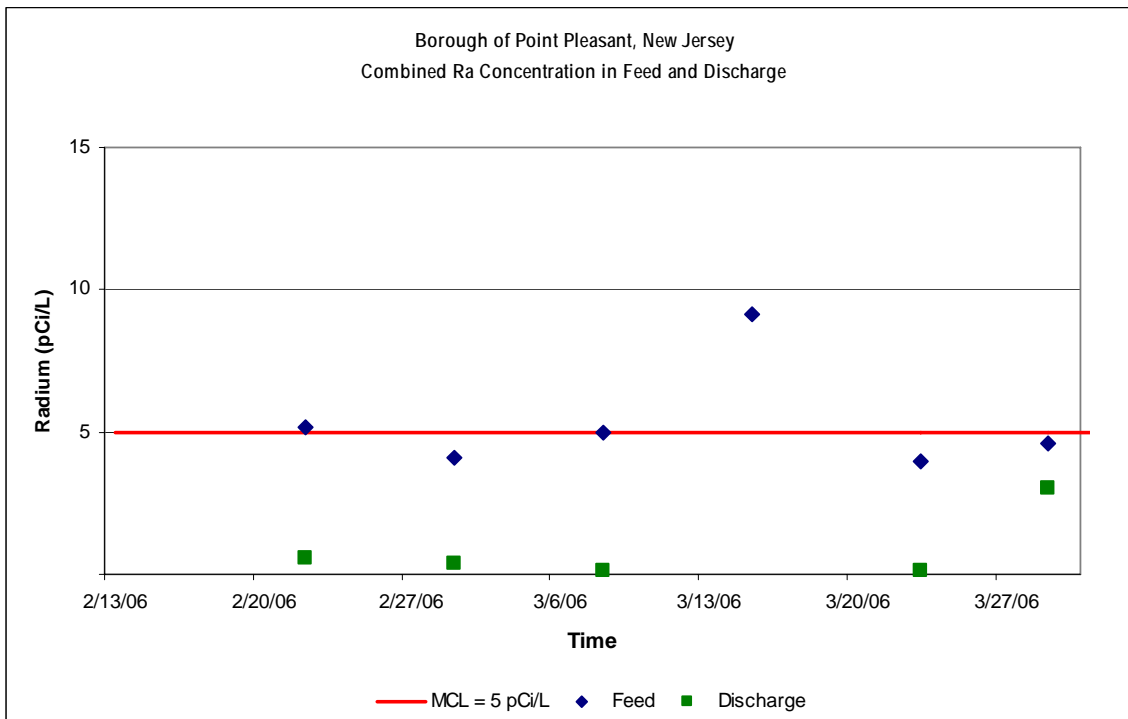


Figure 1

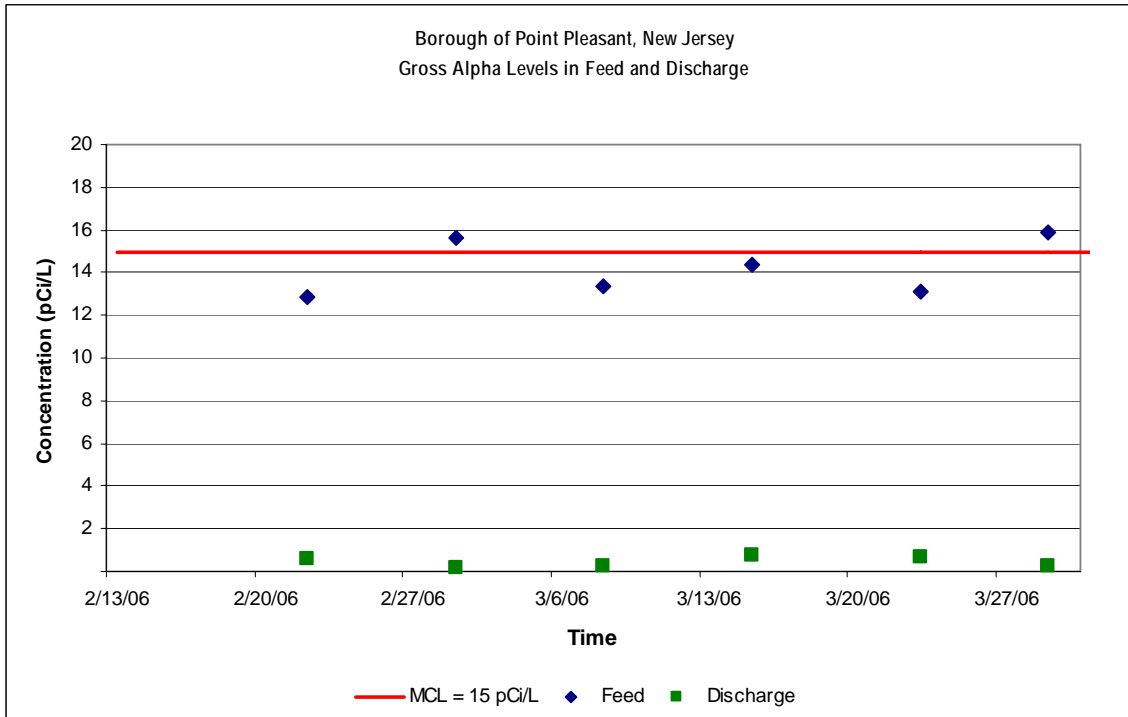


Figure 2

The results are also shown in Table 1. The average feed concentration of combined radium, 5.3 pCi/L, (picoCuries per Litre) was reduced to 0.7 pCi/L after column 4 and had not exceeded 3.0 pCi/L, consistently below the MCL of 5 pCi/L. The average feed concentration of gross alpha is 14.2 pCi/L was reduced to 0.5 pCi/L after column 4 and had not exceeded 0.8 pCi/L, also consistently well below the MCL of 15 pCi/L.

Table 1. Radium and Gross Alpha levels in feed and discharge water.

	Feed (pCi/L)	Discharge @ Column 4 (pCi/L)
Radium MCL	NA	5.0
Average	5.3	0.7
Highest value	9.2	3.0
Lowest Value	3.9	-0.2
Gross Alpha MCL	NA	15.0
Average	14.2	0.5
Highest value	15.9	0.8
Lowest Value	12.8	0.2



Application Information

The Borough of Point Pleasant, New Jersey is approximately 40 miles east of Trenton, NJ in Ocean County. The Borough is a historic community originally regarded as a summer resort but is now a busy year-round community of approximately 19,000 full-time residents. The public water is drawn from the Kirkwood-Cohansey aquifer. The well selected for pilot testing is 8 inches in diameter and 100 feet deep.

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 reduce gross alpha and 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 treatment.

Equipment Overview

The pilot equipment was installed at the Borough of Point Pleasant's Well No. 8. The treatment train used for this pilot study consists of four 4-inch diameter by 4 ft. vertical height columns, each containing 25-inches of Z-88® process media mounted on a frame within the pump house. 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-inch 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.

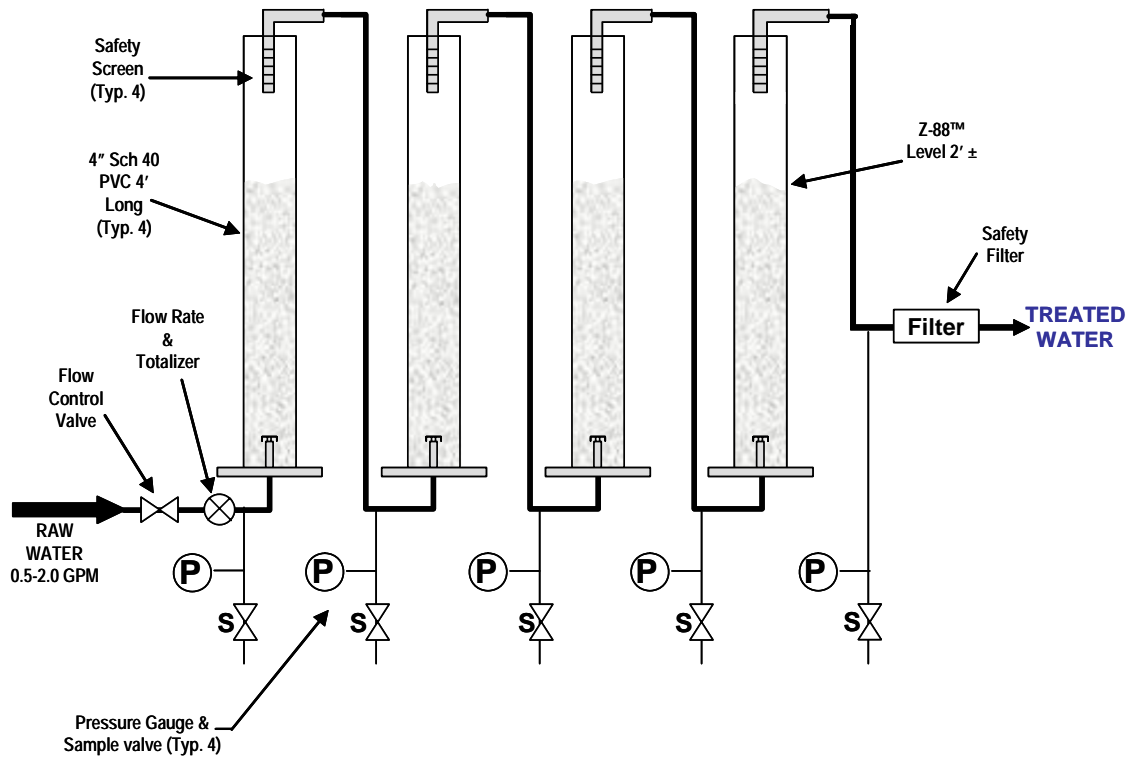
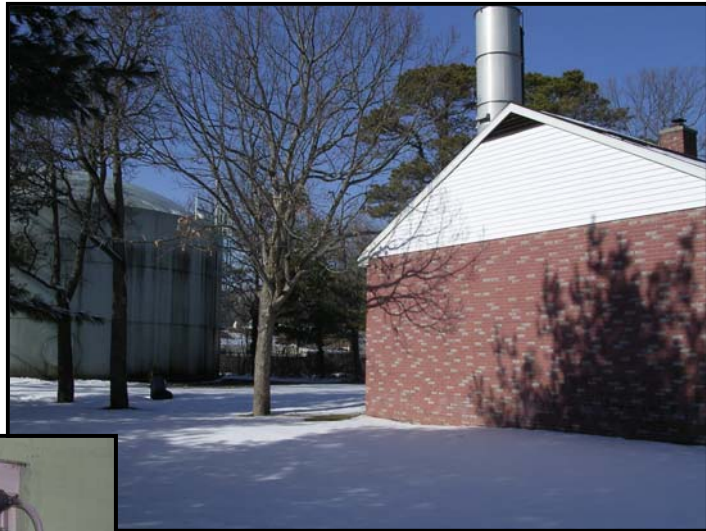


Figure 3. Typical Process Flow Diagram

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

Borough of Point Pleasant's
Z-88® pilot site.





Statement of Purpose

The feed levels during the pilot study in the raw water were as high as 9.2 pCi/L for combined radium. Historical raw water quality data for this well shows average radium concentrations exceeding the EPA MCL. 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 and gross alpha 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 water treatment facility.

Delivery and Installation of Pilot Unit

The pilot unit was delivered and installed on February 13, 2006. Set up consists of mounting the columns to a frame and connecting the water source and a discharge lines. Discharge was routed to a floor drain that is connected to the Borough of Point Pleasant's drainage system. The pilot study began the same day. Data was collected for 45 days prior to the writing of 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 1/2-inch valves located in the feed line and after discharge from each respective test column, at sample intervals.

Analytical

The samples were delivered to pCi/Labs, Inc. for radium, gross alpha, and uranium analysis. Samples were delivered to the Water Supply Element-Bureau of Safe Drinking Water at the New Jersey Department of Environmental Protection and Energy in Trenton, NJ for inorganic analysis and the Environmental and Chemical Laboratory Services/Radioanalytical Services at the New Jersey Department of Health and Senior Services for radon analysis. All three services are National Environmental Laboratory Accreditation Program certified laboratories. Methods for analysis were:

Radium 226	EPA 903.1
Radium 228	NJ 1980
Gross Alpha	NJAC 7:18-6
Uranium	EPA 908.0
Radon	SM7500-RN

Results

The sampling results are shown in Tables 2 and 3. 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. Figures 4 and 5 show combined radium 226 and 228 and gross alpha 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

Radium 226		Column Concentrations (pCi/L)		
Date	Feed	C2	C4	MCL
2/13/06				N/A
2/22/06	2.7	0.1	0.7	N/A
3/1/06	1.4	0.1	0.0	N/A
3/8/06	1.8	0.2	0.7	N/A
3/15/06	2.2	0.2	-0.4	N/A
3/23/06	1.6	0.2	0.4	N/A
3/29/06	2.5	0.3	0.5	N/A
Radium 228		Column Concentrations (pCi/L)		
Date	Feed	C2	C4	MCL
2/13/06				N/A
2/22/06	2.5	0.6	-0.1	N/A
3/1/06	2.7	0.3	0.4	N/A
3/8/06	3.1	1.0	-0.5	N/A
3/15/06	7.0	0.7	0.2	N/A
3/23/06	2.3	0.3	-0.3	N/A
3/29/06	2.1	1.8	2.5	N/A
Combined Radium		Column Concentrations (pCi/L)		
Date	Feed	C2	C4	MCL
2/13/06				5.0
2/22/06	5.2	0.7	0.6	5.0
3/1/06	4.1	0.3	0.4	5.0
3/8/06	5.0	1.2	0.2	5.0
3/15/06	9.2	0.9	-0.2	5.0
3/23/06	3.9	0.5	0.1	5.0
3/29/06	4.6	2.1	3.0	5.0

Figure 4 below, presents in graph format, the data in Table 2.

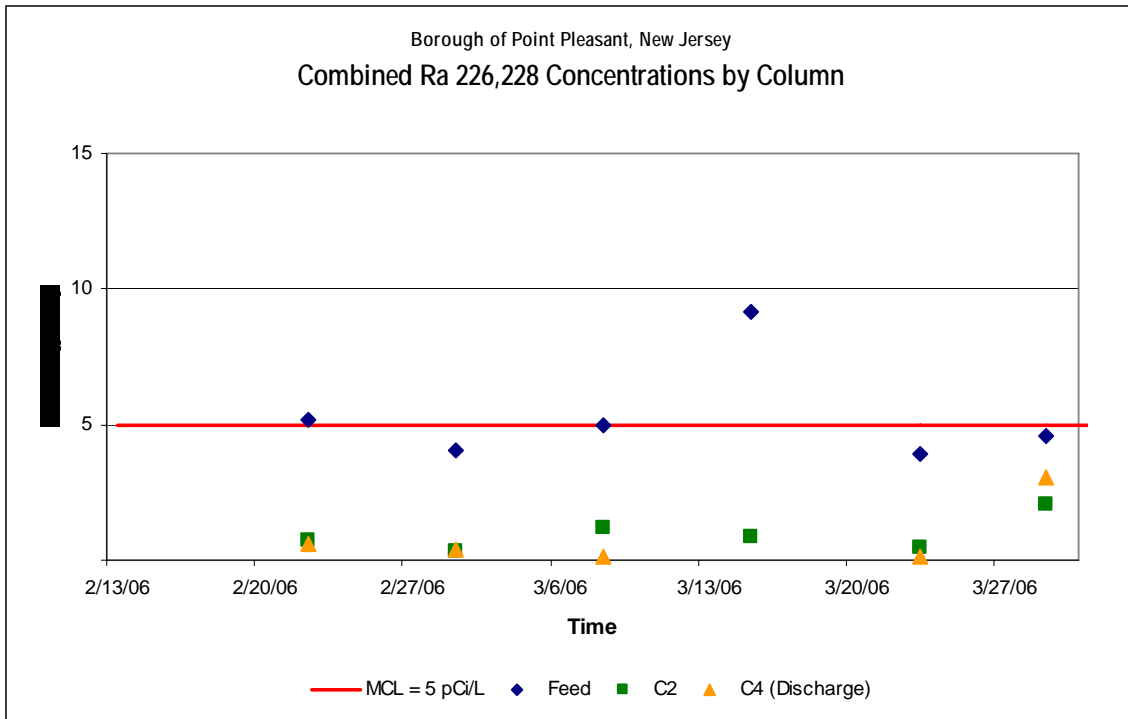


Figure 4

Table 3. Gross Alpha Test Results

Gross Alpha Date	Column Concentrations (pCi/L)			MCL
	Feed	C2	C4	
2/13/06				15.0
2/22/06	12.8	1.0	0.6	15.0
3/1/06	15.6	0.5	0.2	15.0
3/8/06	13.4	0.8	0.2	15.0
3/15/06	14.4	0.6	0.8	15.0
3/23/06	13.1	1.2	0.7	15.0
3/29/06	15.9	0.1	0.2	15.0

All gross alpha analytical data posted in this report were taken from the Private Well Testing Act (PWTA) results as recorded by pCi/Labs, Inc.

Figure 5 below, presents in graph format, the data in Table 3.

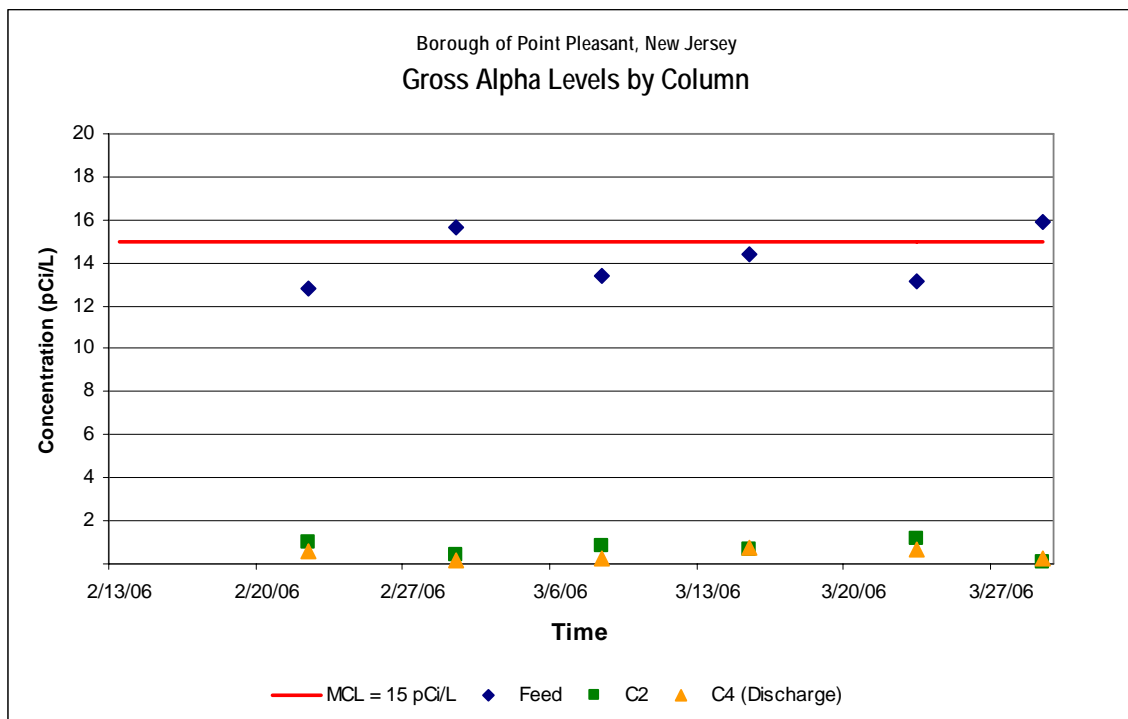


Figure 5

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 D.

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
2/13/06	0
2/22/06	13,164
3/1/06	23,898
3/8/06	34,074
3/15/06	43,704
3/23/06	55,044
3/29/06	62,585

Water Quality

A water quality analysis was performed on feed water to the pilot unit and on treated water exiting the WRT pilot unit 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 B.

**Table 5. Water Quality Data entering and exiting the Z-88® treatment process
Point Pleasant, New Jersey – Water Quality Data**

Item	Pre WRT Process	units	Post WRT Process
Antimony	0.002	mg/L	0.002
Arsenic	0.001	mg/L	0.001
Barium	0.8	mg/L	0.8
Beryllium	0.001	mg/L	0.001
Cadmium	0.001	mg/L	0.001
Chromium	0.001	mg/L	0.001
Cyanide	0.02	mg/L	0.02
Fluoride	0.1	mg/L	0.1
Mercury	0.0004	mg/L	0.0004
Nickel	0.0010	mg/L	0.001
Selenium	0.001	mg/L	0.001
Sodium	39	mg/L	25
Sulfate	29	mg/L	28
Thallium	0.001	mg/L	0.001

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 A.

Table 6. Uranium Test Results

Uranium	Column Concentrations (pCi/L)				
	Date	Feed	C2	C4	MCL
	2/22/06	0.0	-0.7	0.3	20.0
	3/1/06	1.9	-0.1	0.6	20.0

Radon Results

Radon occurs in drinking water as a result of the radioactive decay process of radium and uranium. Samples were 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 taken during the pilot study. These results indicate that the WRT process does not contribute a significant amount of radon to the water. Support documentation for Table 7 is attached as Appendix C.

Table 7. Radon Test Results

Radon	Column Concentrations (pCi/L)	
	Feed	C4
Date		
3/29/06	190.0	260.0

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 D. The pilot unit operated throughout the course of this test without any noted operational problems.

Conclusion

The WRT Z-88® Radium Treatment Process consistently reduced the combined radium 226 and 228 in the feed to acceptable levels in the discharge. 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 the Borough of Point Pleasant and Schoor DePalma Engineers and Consultants for their cooperation and assistance during this test.



Appendices available upon request.