Maximum Contaminant Level Recommendations for Radium in Drinking Water

Basis and Background

New Jersey Drinking Water Quality Institute

May 20, 2002

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State of New Jersey

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Governor

Department of Environmental Protection

Bradley M. Campbell
Commissioner

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October 15, 2002

Commissioner Bradley Campbell
Department of Environmental Protection
P.O. Box 402
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Dear Commissioner:

I am pleased to submit on behalf of the New Jersey Drinking Water Quality Institute its recommendations for the regulation of radium 224 (Ra 224) in drinking water.

The presence of Ra 224 in groundwater in New Jersey was discovered in Ocean County in 1996. While the Department continued to gather data on the presence of Ra 224, the United States Environmental Protection Agency stated that Ra 224 in drinking water was a regional problem and would not proceed with national standard setting. In 1999, former Commissioner Robert Shinn requested that the Institute consider whether a drinking water standard for Ra 224 should be established for New Jersey and whether existing or suggested Federal standards for Ra 226 and Ra 228 are appropriate. This document represents the deliberations of the Institute on these issues.

The recommendations made by the Institute recognize exposures to ambient levels of certain naturally occurring contaminants in other media that are more significant than drinking water exposure. This is reflected in the final recommendations for the regulation of this radionuclide. The final recommendation includes using a test methodology for all gross alpha samples to detect the presence of radium in drinking water. The Institute is pleased that the Department recently adopted this short-term gross alpha testing protocol in the laboratory certification regulations.

Sincerely,

Richard J. Sullivan

Richard J. Sullivan
Chairman

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Maximum Contaminant Level Recommendations for Radium in Drinking Water

Basis and Background

New Jersey Drinking Water Quality Institute

Prepared by Gloria Post
Division of Science, Research and Technology
New Jersey Department of Environmental Protection
May 20, 2002

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Executive Summary

The current federal maximum contaminant level (MCL) for radium addresses two isotopes, radium-226 and radium-228, but does not protect the public from exposure to radium-224, a short lived isotope recently found in New Jersey water supplies. The New Jersey Drinking Water Quality Institute has developed recommendations for modifications of the requirements of the existing radium MCL to reduce risk from exposure to radium-224. The New Jersey Drinking Water Quality Institute has concluded that the USEPA MCL of a gross alpha limit of 15 pCi/L, excluding uranium and radon, is protective to the public for unacceptably high exposure to radium-224 in drinking water, provided that a requirement for rapid (within 48 hour) gross alpha-particle analysis is incorporated. Adoption of an MCL with such requirements has been found to be feasible both analytically and in regard to treatment technology.

Purpose

On June 3, 1999, Chairman Richard Sullivan reconvened the New Jersey Drinking Water Quality Institute at the request of former NJDEP Commissioner Robert Shinn to consider whether a drinking water standard for radium-224 should be established; and whether existing and suggested Federal standards for radium-226 and 228 are appropriate. The New Jersey Drinking Water Quality Institute has adopted the recommendations presented in this Basis and Background document and the attachments. The members of the New Jersey Drinking Water Quality Institute are listed in Appendix I.

1983 New Jersey Safe Drinking Water Act Amendments and the New Jersey Drinking Water Quality Institute

The 1983 amendments to the New Jersey Safe Drinking Water Act, also known as the "A-280 Amendments" (N.J.S.A. 58: 12A-1 et seq.), required that MCLs be adopted for a given list of 22 organic contaminants. Furthermore, these amendments direct the development of MCLs for additional drinking water contaminants selected due to their health effects and occurrence in New Jersey waters, such as metals, base/neutrals, and pesticides.

The 1983 amendments provide for the establishment of the New Jersey Drinking Water Quality Institute, consisting of six ex officio and nine appointed members, to advise NJDEP on drinking water issues. These members represent the public, the academic community, the water purveyors, NJDEP, DHSS, and the Water Supply Advisory Council.

In 1987, the New Jersey Drinking Water Quality Institute provided recommendations for the list of contaminants in the 1983 amendments, and in 1994, it updated these recommendations and provided recommendations for six additional organic contaminants of concern. These recommendations have been adopted by NJDEP to form the basis for enforceable MCLs for most of these contaminants.

The 1983 amendments specifically mention chemical contaminants, not radionuclides. In the September 26, 1994 New Jersey Drinking Water Quality Institute document entitled “Maximum Contaminant Level Recommendations for Hazardous Contaminants in Drinking Water”, the Program Subcommittee (now known as the Treatment/Cost Subcommittee) recommended that N.J.S.A. 58:12A-13(b) be amended to include language that allows that standards for naturally occurring carcinogenic contaminants, such as radon, be based on a risk assessment other than the one in one million lifetime cancer risk for carcinogens (see below). This recommendation was made because the New Jersey Drinking Water Quality Institute recognized that exposure to ambient levels of certain naturally occurring contaminants in other media is more significant than drinking water exposure. There are significant naturally-occurring exposures to radiation from sources other than drinking water, and background exposure to radiation is discussed in detail in Appendix II. The New Jersey Drinking Water Quality Institute continues to concur with this recommendation with respect to the regulation of radium in drinking water.

Factors Considered in Maximum Contaminant Level Development

The 1983 amendments specify that MCLs for carcinogenic compounds are to be developed which "…permit cancer in no more than one in one million persons ingesting that chemical for a lifetime…" "…. within the limits of medical, scientific and technological feasibility." The New Jersey Drinking Water Quality Institute has interpreted technical feasibility to include the levels at which contaminants can be reliably quantitated by analytical methods (practical quantitation limits or PQLs) as well as the capability of treatment methods to remove the contaminants to specified levels. Cost is not a direct consideration in MCL derivation for carcinogens.

In contrast, for non-carcinogens, MCLs are to be derived which eliminate "…all adverse physiological effects from ingestion…" "…within the limits of practicability and feasibility…". Practicability has been interpreted by the New Jersey Drinking Water Quality Institute as permitting the consideration of cost for MCLs for non-carcinogens.

In order to develop MCL recommendations, the New Jersey Drinking Water Quality Institute has established three Subcommittees to address the factors of health effects, analytical limitations, and treatment. The Health Effects Subcommittee (formerly known as the Lists and Levels Subcommittee) evaluates relevant health effects information and uses risk assessment approaches to derive the health based level, known as Health-based Maximum Contaminant Level, which is the goal for the MCL if technological considerations allow. The Testing Subcommittee evaluates available analytical methods and derives the Practical Quantitation Level, the level where quantitation can be achieved with acceptable uncertainty by most laboratories. The Treatment/Cost Subcommittee evaluates the capabilities of drinking water treatment methods to remove the contaminants to the Health-based Maximum Contaminant Level. The final MCL is set at the Health-based MCL if analytical and treatment considerations allow. If the analytical or treatment limits are higher than the health-based level, the MCL is set as close to the Health-based MCL as these considerations permit.

Radium-224

Radium-224 is a naturally occurring isotope which results from the decay of thorium-232 with a relatively short half life of 3.64 days. The isotopes of radium currently regulated in drinking water, radium-226 and radium-228, have much longer half lives, and current regulations allow for holding times of six months, and up to one year for composite samples. When these holding times are used, radium-224 will decay and will remain undetected.

The presence of radium-224 in groundwater in New Jersey was discovered by the New Jersey State radiation laboratories during testing of public water supplies in Ocean County, in March and April 1996. The samples were analyzed in a shorter timeframe than usual, and elevated gross alpha particle levels significantly higher than historical values were observed. Further investigation determined that the elevated gross alpha levels were due to radium-224.

The New Jersey Drinking Water Quality Institute was asked by NJDEP to study the occurrence and effects of radium-224 in drinking water, and to make appropriate recommendations regarding a drinking water standard for this currently unregulated isotope. Each of the three Subcommittees of the New Jersey Drinking Water Quality Institute has evaluated the issues related to radium-224 in drinking water, and has prepared a report of its findings and recommendations. These reports are attached to this document as Appendices I, II, and III, and provide much in depth information summarized briefly herein.

Federal Maximum Contaminant Level for Radium

The USEPA issued a Notice of Data Availability (NODA) on April 21, 2000 and the Final Radionuclides in Water Rule on December 7, 2000. The final rule specifies an MCL of 5 pCi/L for the total of radium-226 and radium-228 and 15 pCi/L for gross alpha, but does not directly address radium-224. Whereas the NODA included a recommendation to analyze the gross alpha within 48 hours to capture the contributions from radium-224, there is no such requirement or recommendation in the final rule, as the USEPA considers radium-224 to be a regional problem.

Occurrence of Radium in New Jersey Water

Through the 1996 – 2000 monitoring period of sample collection and analysis performed by the NJDEP, Bureau of Safe Drinking Water, 23 community water systems out of over 600 community water systems sampled were determined to have exceeded the MCL for gross alpha activity. Five of these systems also exceeded the radium 226 + radium 228 combined MCL of 5 pCi/L. Approximately 100 community water systems, including those that had exceeded the MCL, were placed on quarterly monitoring due to levels of gross alpha activity greater than 7.5 pCi/L.A review of data generated from this monitoring suggests that there is a potential for an additional 20 community water systems with one or more sources (points-of-entry to the water distribution system) that will exceed the gross alpha activity once compliance with the MCL is required at the points-of-entry to the water distribution system (after January 1, 2004). The data show that radium is not generally elevated in surface water sources nor is it elevated in most ground waters.

From the New Jersey occurrence data, the average ratio of radium-226: radium-228: radium-224 can be assumed to be 1:1:1.6. These ratios are used in evaluating the risks of radium in New Jersey drinking water, as discussed below.

Health Effects of Radium and Recommendations of Health Effects Subcommittee

Radium is classified by USEPA as a Group A carcinogen, known to be a human carcinogen from human epidemiological studies. Radium concentrates in bone when ingested, and exposure to radium-224, radium-226, and radium-228 is associated with bone cancer. Radium-226 produces radon gas, and has also been found to cause head carcinomas.

Exposure to each of the three radium isotopes has a different risk factor associated with it, as expressed by the total lifetime cancer incidence risk of 1 pCi/L water. These risks are shown in the table below:

Table 1: Total Lifetime Cancer Incidence Risks of Three Radium Isotopes

Radium Isotope	Concentration (pCi/L)	Total Lifetime Cancer Incidence Risk
Radium 226 (pCi/L)	1	1.96×10^{-5}
Radium 228 (pCi/L)	1	5.31×10^{-5}
Radium 224 (pCi/L)	1	8.51×10^{-6}

These factors, combined with the isotope occurrence ratios given above, were utilized to determine the lifetime cancer risk at the USEPA MCL of 5 pCi/L for combined radium-226 and radium-228. At this radium concentration, the assumed ratio indicates that the three isotopes would be present at 2.5 pCi/L radium-226, 2.5 pCi/L radium-228, and 4 pCi/L radium-224, and the total cancer risk would be 2.2×10^{-4}. The Subcommittee concluded, although these risks do not meet the 1×10^{-6} goal of the 1983 amendments, they are consistent with USEPA's acceptable risk range for radionuclides in air, water, and soil, as well as the recently promulgated New Jersey soil remediation standards for radionuclides, and the contribution from natural background radiation. The Subcommittee further concluded that additional incremental reduction in risk gained by reaching a one in one million risk level in drinking water would not be a significant percentage of the total exposure from all sources of naturally occurring radiation.

The Health Effects Subcommittee concluded that the USEPA MCL of a gross alpha limit of 15 pCi/L, excluding uranium and radon, would protect the public for unacceptably high concentration of radium-224 in drinking water, provided that a requirement for rapid (within 48 hour) gross alpha-particle analysis is incorporated.

Analytical Considerations and Recommendations of the Testing Subcommittee

The Testing Subcommittee evaluated two analytical methods relevant to the detection of radium-224, the "48-hour Rapid Gross Alpha Test Procedure" and a method for direct analysis of radium-224.

The Subcommittee recommended that the USEPA approved methods for gross alpha testing, with modifications known as the "48-hour Rapid Gross Alpha Test Procedure" be adopted in order to regulate the presence of radium-224. The "48-hour Rapid Gross Alpha Test Procedure" also addresses the contributions of unsupported short lived isotopes, such as lead-212, which pose much lower health risks than the radium isotopes (as discussed in detail in the subcommittee reports).

The Subcommittee also recommended that a direct method for identifying and quantifying radium-224 using gamma-ray spectrometry be made available to drinking water laboratories. This method could be used to evaluate new wells and to assess groundwater trends.

Treatment Considerations and Conclusions of Treatment/Cost Subcommittee

The Treatment/Cost Subcommittee concluded that several currently available treatment technologies, including ion exchange, reverse osmosis, and preformed hydrous manganese oxide, can effectively remove radium isotopes from drinking water to levels well below the current USEPA and proposed New Jersey MCLs. The primary issue associated with the selection of treatment alternatives is the disposal of the radioactive waste. The Subcommittee also evaluated the costs of radium removal to customers of large and small water systems, as well as owners of private wells.

Table 2: Summary of Annualized Cost for Radium Removal

Size of Plant (gallons/day) and Population served	Annualized cost*
100,000 500 people	$80,000 - 120,000 total $640 – 960 per person
500,000 2500 people	$145,000 - 220,000 total $232 – 352 per person
1,000,000 5,000 people	$245,000 - 365,000 total $196 – 292 per person
Greater than 1,000,000 10,000 people	$ >350,000 total $24 – 36 per person

*Annualized costs include debt service, capital recovery, maintenance and operation. The operating cost assumes that the radium may be disposed of as a soluble waste via sanitary sewers or septic system not requiring a radium selective complexor or resin.

The two main discharge options available for systems with elevated gross alpha concentrations, sanitary sewer discharge and groundwater discharge, pose many challenges for water systems. Systems using ion exchange (IE) treatment technology may have difficulty meeting all the criteria for discharging into the sanitary sewer as well as *** the groundwater discharge limits. In order to meet the discharge limitations, water treatment wastes may need to be mixed with backwash and rinse wastes or the water treatment plant may need to operate more frequent regeneration cycles. For those locations and water systems where IE and preformed hydrous manganese oxide treatment are not practical, treatment alternatives such as reverse osmosis, a membrane filtration technique, may be the only alternative. Nanofiltration, a low pressure reverse osmosis process, operates at an 80 to 90% recovery, thus except for very poor raw water, radium levels in the waste stream can effectively be maintained within the discharge criteria.

A surface water discharge must meet drinking water standards, which effectively removes this discharge option from consideration. Low level radioactive waste disposal may need to be considered as part of the treatment options at some facilities. Resins to concentrate radium are available that concentrate low level radioactive waste for disposal at a designated facility.

Overall Maximum Contaminant Level Recommendation

The current federal MCL for radium addresses two isotopes, radium-226 and radium-228, but does not protect the public from exposure to radium-224, a short lived isotope recently found in New Jersey water supplies. The New Jersey Drinking Water Quality Institute has developed recommendations for modifications of the requirements of the existing radium MCL to reduce risk from exposure to radium-224. Based on consideration of the information provided above, and in more detail in the three attached subcommittee reports, the New Jersey Drinking Water Quality Institute has concluded that the USEPA MCL of a gross alpha limit of 15 pCi/L, excluding uranium and radon, is protective to the public for unacceptably high exposure to radium-224 in drinking water, provided that a requirement for rapid (within 48 hour) gross alpha-particle analysis is incorporated. Adoption of an MCL with such requirements has been found to be feasible both analytically and in regard to treatment technology.

Appendix I: Members of the New Jersey Drinking Water Quality Institute

(May 20, 2002)

APPOINTED MEMBERS

1. Bruce Chorba
2. Paul La Pierre, P.E., P.L.S., P.P.
3. Ella F. Filippone, Ph.D.
4. David Marino
5. Jean M. Matteo
6. Ed Mullen
7. Tavit Najarian, Ph.D.
8. Kenneth Reuhl, Ph.D.
9. Richard Sullivan

EX OFFICIO MEMBERS

- COMMISSIONER OF ENVIRONMENTAL PROTECTION
  Bradley M. Campbell
  ALTERNATE: Barker Hamill, Bureau Chief, Bureau of Safe Drinking Water, NJDEP

- CHAIRMAN, WATER SUPPLY ADVISORY COUNCIL
  Eugene Golub, Ph.D.

- DIRECTOR, DIVISION OF WATER RESOURCES
  DESIGNEE: Dennis Hart, Administrator, Water Supply Administration, NJDEP

- DIRECTOR, OFFICE OF SCIENCE AND RESEARCH
  DESIGNEE: Leslie McGeorge, M.S.P.H., Assistant Commissioner, Environmental Planning and Science, NJDEP

- COMMISSIONER OF HEALTH
  Dr. Clifton R. Lacy
  DESIGNEE: Stephen W. Jenniss, Director, Environmental and Chemical Laboratory Services, NJDHSS

- DIRECTOR, DIVSN. OF OCCUPATIONAL AND ENVIRONMENTAL HEALTH
  DESIGNEE: Perry Cohn, Ph.D., M.S., Research Scientist, Consumer and Occupational Health Services, NJDHSS

Appendix II: Report of the Health Effects Subcommittee

New Jersey Drinking Water Quality Institute
New Jersey Department of Environmental Protection

Report
on

Radium-224

Prepared for

The New Jersey Drinking Water Quality Institute
Health Effects Subcommittee

November 14, 2001

Bureau of Environmental Radiation

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Radium-224
Health Effects Subcommittee Report
to the Drinking Water Quality Institute

Executive Summary

The Drinking Water Quality Institute (DWQI) was charged with assessing the prevalence and effects of radium-224 (^{224}Ra), and, if appropriate, making recommendations to develop a standard. Radium is a naturally occurring radioactive element that has been detected in both private and public drinking water supplies. ^{224}Ra is a naturally occurring, short-lived (3.64 day half-life) isotope of radium. It is a decay product of thorium-232. The radioactive decay series of uranium-238 and thorium-232 are shown in Figure 1.

The Health Effects Subcommittee has met four times (7/28/00, 11/27/00, 12/18/00, and 3/9/01) since the full Institute meeting of October 18, 1999. The US Environmental Protection Agency (USEPA) issued a Notice of Data Availability (NODA) on April 21, 2000, followed by the Final Radionuclides in Water Rule on December 7, 2000. The final rule specifies an MCL of 5 pCi/L for the total of radium-226 (^{226}Ra) and radium-228 (^{228}Ra) and 15 pCi/L for gross alpha, and does not directly address ^{224}Ra. Whereas the NODA included a recommendation to analyze the gross alpha within 48 hours to capture the contributions from ^{224}Ra, there is no such requirement or recommendation in the final rule. The USEPA considers ^{224}Ra to be a regional problem. The USEPA plans to collect additional national occurrence information for ^{224}Ra in cooperation with the US Geological Survey (USGS). Preliminary data indicate that ^{224}Ra may occur in other Mid-Atlantic States (Focazio et al., 2001).

Given the prevalence of ^{224}Ra in New Jersey drinking water supplies, the Health Effects Subcommittee believes that the contribution to risk from ^{224}Ra should be addressed. The impact of ^{224}Ra on gross alpha-particle activity can be assessed by performing the gross alpha-particle analysis within 48 hours of collection (Parsa, 1998) and comparing these values to the current Maximum Contaminant Level (MCL) for gross alpha of 15 pCi/L.

Occurrence

According to Szabo et al. (1998), radium in New Jersey is most likely to be present in shallow to moderately deep groundwater that was recharged in about the 1960's (the time of greatest fertilizer application), is acidic (pH<5), is located on the Bridgeton Formation outcrop and in areas of current or historical agricultural land use, and has been contaminated with nitrate concentrations of about 5 mg/L or more. The source of the radium in groundwater is naturally occurring radium in the soil and rocks, but the application of fertilizer is believed to have allowed more radium to be solubilized and has enhanced the concentration in the groundwater.

During March and April 1996, testing of public water supplies in Dover Township, Ocean County, NJ showed elevated gross alpha particle levels that were significantly higher than historical values. These elevated gross alpha-particle levels were found to be due to the presence of ^{224}Ra (Parsa, 1998). Occurrence data of gross alpha, ^{226}Ra, ^{228}Ra, and ^{224}Ra are provided in

Appendix II-A. These data include samples collected by the NJ Department of Environmental Protection (NJDEP) and USGS as part of an occurrence study, and analyzed by the NJ Department of Health and Senior Services and the USGS laboratory located in Reston, Virginia. The concentration of ^{224}Ra ranged from 0.05 pCi/L to 17 pCi/L with a median concentration of 2.5 pCi/L. ^{224}Ra had the greatest concentration among the three radium isotopes in 49 out of 90 samples (54 percent).

Health Effects

Radium, biochemically similar to calcium and barium when ingested, concentrates in bone. The health effects of ingested radium are well documented and are largely based upon studies of radium watch dial painters who worked in the early part of this century. These women ingested large amounts of ^{226}Ra and ^{228}Ra when the brushes they were using to apply radium-containing fluorescent paint to watch faces were "pointed" with their tongues, teeth, and lips. In the late 1920s and 1930s, bone sarcomas and head carcinomas were diagnosed among this group, but no statistically significant number of leukemias have been found (Cothern and Rebers, 1990). Bone sarcomas have been observed in patients injected with ^{224}Ra for treatment of ankylosing spondylitis. For pure ^{224}Ra and ^{228}Ra, which do not produce radon-222 (a gas), the risk from head carcinomas is regarded as trivial compared to the risk from bone sarcomas (Mays and Rowland, 1985). Radium is thus a class A carcinogen, that is, a demonstrated carcinogen in human populations.

In estimating the health effects from radionuclides in drinking water, regulatory agencies, including the USEPA, Nuclear Regulatory Commission (USNRC), and the NJDEP use the linear, nonthreshold model which assumes that any exposure to ionizing radiation has a potential to produce deleterious effects on human health, and that the magnitude of the effects are directly proportional to the exposure levels. The extent of such harm can be estimated by extrapolating effects on human health that have been observed at higher doses and dose rates to those likely to be encountered from environmental sources of radiation. The risks associated with radiation exposure are extrapolated from a large base of human data. The regulatory agencies recognize the inherent uncertainties that exist in estimating health impact at the low levels of exposure and exposure rates expected to be present in the environment. They also recognize that, at these levels, the actual health impact from ingested radionuclides will be difficult, if not impossible to distinguish from natural disease incidences, even using very large epidemiological studies employing sophisticated statistical analyses. However, in the absence of other data, these agencies use the linear, nonthreshold model in assessing risks associated with all carcinogens (USEPA, 2000).

Risk Calculation

The USEPA's Federal Guidance Report No. 13 published in 1999, was used to determine the morbidity (cancer incidence) risks associated with radium in drinking water. USGS and NJDEP occurrence data were used to determine the average ratio of ^{226}Ra:^{228}Ra:^{224}Ra. The ratio is 1:1:1.6. The amount of water consumed by an individual is assumed to be 2 L/day and the duration of exposure is 365 days per year for 70 years. The equation for calculating radiological risk is as follows:

Risk = MCL x RC x TWI

Where:
Risk = lifetime cancer risk corresponding to MCL (unitless)
MCL= maximum contaminant level (pCi/L)
RC = risk coefficient from Federal Guidance Report No. 13 (Bq^{-1})[1]
TWI = total water intake (2 L/d x 365 d/y x 70 y)

The Health Effects subcommittee believes that the risks associated with all radium species should be combined so that the total risk is known. The assumed average ratio from the occurrence data is used to determine the concentration of each radium that would meet an acceptable risk level.

Acceptable Risk Level

The A280 amendments to the New Jersey Safe Drinking Water Act state that within certain feasibility limits, the maximum contaminant levels for carcinogens shall permit cancer in no more than one in one million persons ingesting that substance for a lifetime. This statute **specifically addresses chemical contaminants, not radionuclides**. In a September 26, 1994 New Jersey Drinking Water Quality Institute document entitled "Maximum Contaminant Level Recommendations for Hazardous Contaminants in Drinking Water", the Program Subcommittee recommended that N.J.S.A. 58:12A-13(b) be amended to include language that allows that standards for naturally occurring carcinogenic contaminants, such as the radionuclide radon, be based on a risk assessment other than one in one million. The Institute included this statement because it was recognized that exposure to certain naturally occurring contaminants in other media is more significant than drinking water exposure. The Health Effects Committee concurs with that recommendation with respect to the regulation of radium in drinking water. A discussion of the contribution of naturally occurring radioactive materials in the environment to overall exposure is included in this document.

There are differences in the risks among the three radionuclides: radium-228, radium-226 and radium-224. I-1 shows the different risks at 1 pCi/L. In order to achieve a risk of one in one million, considering all the radium isotopes together and assuming the average ratio for New Jersey of 1:1:1.6, the MCLs would be 0.012 pCi/L for ^{226}Ra, 0.012 pCi/L for ^{228}Ra, and 0.019 pCi/L for ^{224}Ra. The Health Effects Subcommittee defers to the Testing Subcommittee regarding the feasibility of detecting the radionuclides at these limits.[2] Table II-2 lists the concentrations of the three radium isotopes at three different risk levels.

[1] Must be multiplied by 0.037 to convert to pCi^{-1}
[2] See memo of November 22, 2000 from Steve Jenniss, Chairman of the Testing Subcommittee to the Health Effects Subcommittee.

Table II-1: Total Lifetime Cancer Incidence Risks of Three Radium Isotopes

Radium Isotope	Concentration (pCi/L)	Total Lifetime Cancer Incidence Risk
Radium 226 (pCi/L)	1	1.96 x 10-5
Radium 228 (pCi/L)	1	5.31 x 10-5
Radium 224 (pCi/L)	1	8.51 x 10-6

Table II-2: Concentrations of Radium 226, Radium 228 and Radium 224 At Three Risk Levels

Radium 226 (pCi/L)	Radium 228 (pCi/L)	Radium 224 (pCi/L)	Total Lifetime Cancer Incidence Risk
0.012	0.012	0.019	1.0×10^{-6}
0.12	0.12	0.19	1×10^{-5}
1.2	1.2	1.9	1×10^{-4}

The total lifetime cancer risk incidence was derived based on a combination of the three radium isotopes listed. The New Jersey risk level goal for drinking water is 1.0×10^{-6}.

When considering other options regarding potential choices for risk levels, the Health Effects Subcommittee examined USEPA approaches for radionuclides in drinking water, site cleanups, and air. The USEPA established a range of 1×10^{-4} to 1×10^{-6} as an acceptable cancer incidence risk in the Notice of Data Availability for radionuclides in drinking water that was published on April 21, 2000. Furthermore, in the Office of Solid Waste and Emergency Response (OSWER) Directive No. 9200.4-18, the USEPA states that cleanups of radiologically contaminated sites should achieve risk levels in the 10^{-4} to 10^{-6} range. However, the USEPA elaborates that under appropriate circumstances, risks of greater than 1×10^{-4} may be acceptable. Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) guidance states the "the upper boundary of the risk range is not a discrete line at 1×10^{-4}, although USEPA generally uses 1×10^{-4} in making risk management decisions. A specific risk estimate around 10^{-4} may be considered acceptable if justified based on site-specific conditions." Other USEPA regulatory programs have developed a similar approach to determining acceptable levels of radionuclide cancer risk. For example, in a Clean Air Act rulemaking establishing National Emission Standards for Hazardous Air Pollutants (NESHAPs) for USNRC licensees, Department of Energy (DOE) facilities, and many other kinds of sites, USEPA concluded that a risk level of "3×10^{-4} is essentially equivalent to the presumptively safe level of 1×10^{-4}." 54 Fed. Reg. at 51677 and 51682 (December 15, 1989). USEPA rejected a risk level of 5.7×10^{-4} as not being equivalent to the presumptively safe level of 1×10^{-4} (in the case of elemental phosphorus plants) in this rulemaking. 54 Fed. Reg. at 51670.

Based on the above, it can be concluded that the USEPA has considered 3×10^{-4} to be an acceptable risk for radionuclides in some media. This risk level is also consistent with the NJDEP's recently promulgated Soil Standards for Radioactive Materials (N.J.A.C. 7:28-12)

which sets 15 millirem per year (mrem/y) as the dose criterion. Fifteen mrem/y results in a risk of 3×10^{-4}.

Natural Background Radiation

In order to put these risk levels into perspective, the contribution from natural background radiation should be considered. The attached bar chart (Figure 2) shows doses from a select number of background sources. The numbers at the end of the bars are the cancer incidence risk levels associated with each dose. Nationally, the average annual effective dose equivalent from natural sources, excluding indoor radon, is 100 mrem/y. The lifetime cancer risk associated with 100 mrem/yr is 2×10^{-3}. If indoor radon at ambient levels is included, the annual effective dose equivalent is about 300 mrem/y (see attached pie chart and Table 1-3 from the Biological Effects of Ionizing Radiation Report Number V, "Health Effects of Exposure to Low Levels of Ionizing Radiation"). The lifetime cancer risk associated with 300 mrem/y is 6×10^{-3}.

Humans are exposed to radionuclides from three main sources: food, air, and drinking water. These naturally occurring radionuclides can be divided into those decaying directly to a stable nuclide and those belonging to one of the radioactive series headed by ^{238}U and ^{232}Th. The only non-series radionuclides of significance are ^{40}K and ^{87}Rb. Because of the large amount of potassium in the body, ^{40}K is the principal naturally occurring source of internal radiation, despite its low isotopic abundance. Because it is an essential element and under close metabolic (homeostatic) control, variations in dietary composition and drinking water have little effect on the body content or on the radiation dose received. The same is true for the cosmogenic radionuclides ^{3}H and ^{14}C (NCRP, 1987).

The contributions of uranium, ^{226}Ra, ^{228}Ra, and ^{210}Pb from various categories of foodstuffs to a "standard" dietary intake are shown in Table II-3. The food intake is assumed to be 1.8 kg daily and the water intake is assumed to be 1.2 liters daily (NCRP, 1987). The values in Table II-3 were corrected for a 2 liter daily water intake.

The data in Table II-3 suggest that the contribution from drinking water is low (from 2%-7%) compared to food consumption in these listed cities. However, if the median concentration of radium in the New Jersey Kirkwood-Cohansey aquifer of 3.85 pCi/L combined ^{226}Ra and ^{228}Ra (Kozinski et al, 1995) is used, the daily intake is increased to 1.9 pCi/L for each radium isotope resulting in a contribution of up to 87% from drinking water, because the radium concentration there is higher than in the cities listed in the table.

Because of the short half-life of ^{224}Ra, there would likely be no contribution from ingested food, except at best, home grown vegetables and vegetables picked and eaten on the same day, so most of the contribution would be from drinking water.

Proposed Radium-224 Criteria

Since the average ratio of ^{226}Ra:^{228}Ra:^{224}Ra is assumed to be 1:1:1.6 based on median values of New Jersey occurrence data, the total risk can be calculated at the current federal Maximum Contaminant Levels. (It should be noted that about 5-10% of the samples can vary considerably from this ratio.) At the USEPA radium MCL of 5 pCi/L combined $^{226}Ra + ^{228}Ra$, each

concentration would be 2.5 pCi/L. The corresponding ^{224}Ra concentration would be 4 pCi/L (multiplying 2.5 pCi/L by 1.6). At these concentration levels, the total cancer incidence risk is 2.2×10^{-4} (see Table II-4)

Table II-3: Estimates of total dietary intake (pCi/day) of uranium, ^{226}Ra, ^{228}Ra, ^{210}Pb and contributions from different foodstuff categories (NCRP, 1987)

	Uranium			Radium-226			Radium-228		Lead-210
	New York	Chicago	San Francisco	New York	San Francisco	San Juan	New York	San Francisco	New York
Cereal and grain products	0.22	0.19	0.19	0.57	0.38	0.13	0.43	0.38	0.43
Meat, fish, eggs	0.16	0.27	0.16	0.46	0.081	0.011	0.13	0.081	0.16
Milk and dairy products	0.27	0.054	0.11	0.13	0.054	0.019	0.054	0.11	0.19
Green vegetables, fruits	0.19	0.22	0.19	0.54	0.24	0.54	0.43	0.38	0.32
Root vegetables	0.22	0.19	0.19	0.054	0.027	----	0.11	0.081	0.16
Water[a,b]	0.032	---	---	0.032	0.046	0.019	---	---	0.092
Daily Total	1.1	0.92	0.84	1.8	0.78	0.72	1.2	1.0	1.3

a Assuming 2 liters per day daily intake

b If the median concentration of ^{226}Ra + ^{228}Ra in the Kirkwood-Cohansey aquifer of 3.85 pCi/L is used, the intake of ^{226}Ra and ^{228}Ra in water would be 1.9 pCi/day each

Table II-4: Three Different Ratios of Radium 226, Radium 228, and Radium 224 Representing the Risks Associated with the Current Radium Drinking Water Standard*

Radium 226 (pCi/L)	Radium 228 (pCi/L)	Radium 224 (pCi/L)	Total Lifetime Cancer Incidence Risk	Comments
2.5	2.5	4.0	2.2 x 10-4	Radium 226+228 at the USEPA MCL at assumed ratio
2.4	2.4	3.8	2.1 x 10-4	Radium 226+228 below the USEPA MCL at assumed ratio
0	0	5.0	4.3 x 10-5	All gross alpha particle activity at the USEPA MCL (15 pCi/L) due to Ra-224

* The drinking water standard for radium 226 and radium 228 (combined) is 5 pCi/L.

Since the discovery of the occurrence of ^{224}Ra in New Jersey, the NJDEP's Bureau of Safe Drinking Water has completed one monitoring period with the sampling and analysis of all

community water systems for gross alpha-particle (rapid analysis), gross beta-particle, ^{226}Ra and ^{228}Ra. Table II-5 lists only those wells where the combined ^{226}Ra and ^{228}Ra met the safe drinking water standards, but the gross alpha, because it was analyzed within 48 hours, exceeded the safe drinking water standard. Only the data from one well were listed for municipalities where more than one well exhibited similar data. Examining all the BSDW data, which are not listed here, shows that there are over 75 instances where a sample exceeded the gross alpha MCL of 15 pCi/L, yet passed for ^{226}Ra + ^{228}Ra, and total Uranium. Presumably, these are all instances that would meet the new USEPA MCLs since there is no requirement for a rapid analysis, and would therefore, under current state and federal rules, not require treatment. Since there are 1913 individual wells throughout the State, we can assume the number of cases of MCL exceedences with the rapid analysis requirement will be over 75.

The risks associated with a gross alpha MCL of 15 pCi/L could range from 4.3×10^{-5}, if all the gross alpha were attributed to ^{224}Ra, to 2.1×10^{-4}, if the combined ^{226}Ra+^{228}Ra were just under 5 pCi/L and the ^{224}Ra concentration was determined using the assumed ratio (see Table II-4). Although these risk levels do not meet the 1×10^{-6} goal of A280, they are consistent with the USEPA's acceptable risk range for radionuclides in air, water, and soil, as well as the recently promulgated New Jersey soil remediation standards for radionuclides, and the contribution from natural background radiation. In addition, the further incremental reduction in risk by adhering to a one in one million risk level for drinking water would not be a significant percentage compared to the total exposure from all sources of naturally occurring radiation.

Table II-5: NJDEP Radium Monitoring Data
Municipalities with Water Systems with Gross Alpha Exceedences
and $^{226}Ra/^{228}Ra$ Compliance*

Municipality	County	Short-term Gross Alpha (pCi/L)	Radium-226 (pCi/L)	Radium-228 (pCi/L)	Population (estimated)
Egg Harbor	Atlantic	33	2.3	2.6	100
Hammonton	Atlantic	16	1.8	0.87	5700
Pleasantville C.	Atlantic	17	1.6	1.7	200
Bordentown City	Burlington	20	1.7	1.8	13,500
Burlington Twp	Burlington	17	1.8	2.6	7500
Fieldsboro	Burlington	30	1.6	1.3	600
Florence	Burlington	20	0.41	1.0	10,000
Palmyra	Burlington	17	2.1	2.7	20,300
Willingboro	Burlington	21	0.85	2.9	NWT*
Woodland Twp	Burlington	19	0.84	0.25	2000
Berlin Boro	Camden	17	3.5	0.24	NWT
Camden City	Camden	15	0.98	1.0	10,000
Merchantville	Camden	41	1.3	2.0	10,000
Winslow Twp	Camden	17	3.2	1.4	100
Bridgeton City	Cumberland	27	2.0	2.1	20,000
Fairfield Twp	Cumberland	20	2.3	1.6	200
Vineland City	Cumberland	24	2.1	2.8	12,500
Franklin Twp	Gloucester	21	2.8	1.4	60
Greenwich Twp	Gloucester	36	1.7	2.5	5000
Logan Twp	Gloucester	26	0.92	1.3	1000
Washington Twp	Gloucester	23	1.3	1.7	5500
Hamilton Twp	Mercer	31	1.3	2.4	21,000
Cranbury	Middlesex	19	1.6	1.5	2000
Monroe Twp	Middlesex	18	1.6	3.0	6000
Perth Amboy	Middlesex	27	0.87	1.6	43,000
Sayreville Boro	Middlesex	27	0.3	1.0	39,000
S. Brunswick	Middlesex	26	0.75	3.2	24,000
Howell Twp	Monmouth	16	1.9	2.2	1500
Wall Twp	Monmouth	21	1.9	1.5	40
Dover Twp	Ocean	19	1.9	1.4	36,000
Jackson Twp	Ocean	16	2.2	1.9	1600
Manchester	Ocean	16	2.4	1.8	200
Pennsville Twp	Salem	15	1.4	0.17	NWT
Franklin Boro	Sussex	23	0.26	1.0	600
TOTAL ESTIMATED POPULATION :					**300,000**

A listing on this table does not imply that the well is out of compliance, since the Safe Drinking Water rules use quarterly averaging.
*New Well Test

Estimated Population Risk

What is the average incremental risk savings by requiring the gross alpha-particle test to be analyzed within 48 hours? The following analysis does not include those systems that already exceed the MCL of $^{226}Ra + ^{228}Ra$ since they will have to treat regardless of a decision on ^{224}Ra. Therefore, the data from Table II-5 was used to derive the average population risk if there were no rapid analysis requirement. The average total risk was calculated to be 1.5×10^{-4} using the data in Table II-5 and assuming that the average ^{224}Ra concentration is 1.6 times the average ^{226}Ra concentration. Multiplying this risk by the estimated population affected (approximately 300,000), could produce on the order of 50 additional lifetime cancer cases. [Note: They are not actual cases, just the risk of actual cases occurring.] In other words, by putting the rapid anlaysis standard in place, the avoided risk is 1.7×10^{-4} (50/300,000). This population risk estimate does not include private well users and does not account for expected population increases.

If the water was blended prior to treatment in order to comply with the gross alpha limit, the assumption is that the risk would be cut in half and the result would be a risk of about 25 additional lifetime cancer cases in the affected population. If treatment were used, which is 98% effective in removing radium (Cothern, et al.,1990), then there would be a risk of just 1 additional lifetime cancer case in the affected population. Generally speaking, the risk to the water consumer could be reduced from 2.1×10^{-4} (assuming the gross alpha is above the MCL of 15 pCi/L) to 2×10^{-6} from treatment (assuming a 98% removal efficiency).

The Health Effects Subcommittee understands from the analytical laboratories that the 48-hour analysis requirement does not significantly increase the cost of analysis for gross alpha-particle activity. The rapid analysis recommendation has the advantage of being the same concentration as the USEPA MCLs for both gross alpha particle and ^{226}Ra and ^{228}Ra, without requiring specific analysis for ^{224}Ra.

Unsupported Lead-212 (212Pb)

Parsa et al. (2000a) have determined that elevated gross alpha-particle activity from rapid analysis can sometimes be attributable to the unsupported short-lived isotopes bismuth-212 (^{212}Bi) and polonium-212 (^{212}Po) derived from ^{212}Pb, and bismuth-214 (^{214}Bi), and ^{214}Pb, which in turn decay to alpha-emitting isotopes. The term unsupported means that the longer-lived parent isotopes, such as radium and uranium are not present. The short-lived lead and bismuth isotopes decay from either radon-220 or radon-222 which are present in the water samples when collected (Parsa, et al., 2000b). (See Figure 1 for the decay schemes of uranium and thorium.) Since they are unsupported, the short-lived isotopes will decay without being replaced from the decay of the longer-lived isotopes. The risks associated with these short-lived isotopes are an order of magnitude (in the case of ^{212}Pb), to three orders of magnitude (in the case of ^{214}Bi and ^{214}Pb), less than ^{224}Ra (USEPA, 1999). The significance is that anomalously elevated gross alpha-particle levels due to the unsupported, short-lived radionuclides may mandate costly and needless analysis of uranium and radium, or the installation of treatment which is not really necessary and would prove ineffective in reducing the gross alpha readings (Parsa, et al., 2000). The Health Effects Subcommittee defers to the Testing Subcommittee on the proper sequence of testing times so that the contribution from these unsupported short-lived isotopes can be determined.

Recommendation

The Health Effects Subcommittee recommends that the Drinking Water Quality Institute make the following recommendation to the DEP Commissioner: rulemaking should be initiated that would incorporate the requirement for a rapid gross alpha-particle analysis. The gross alpha limit would remain at 15 pCi/L, excluding uranium and radon, but the analysis must take place within 48 hours of collection. Implementation of this recommendation will have the effect of protecting the public from unacceptably high concentrations of ^{224}Ra in drinking water. This approach is expected to result in an estimated additional risk reduction of 50 lifetime cancer cases statewide when compared to application of the existing gross alpha MCL alone.

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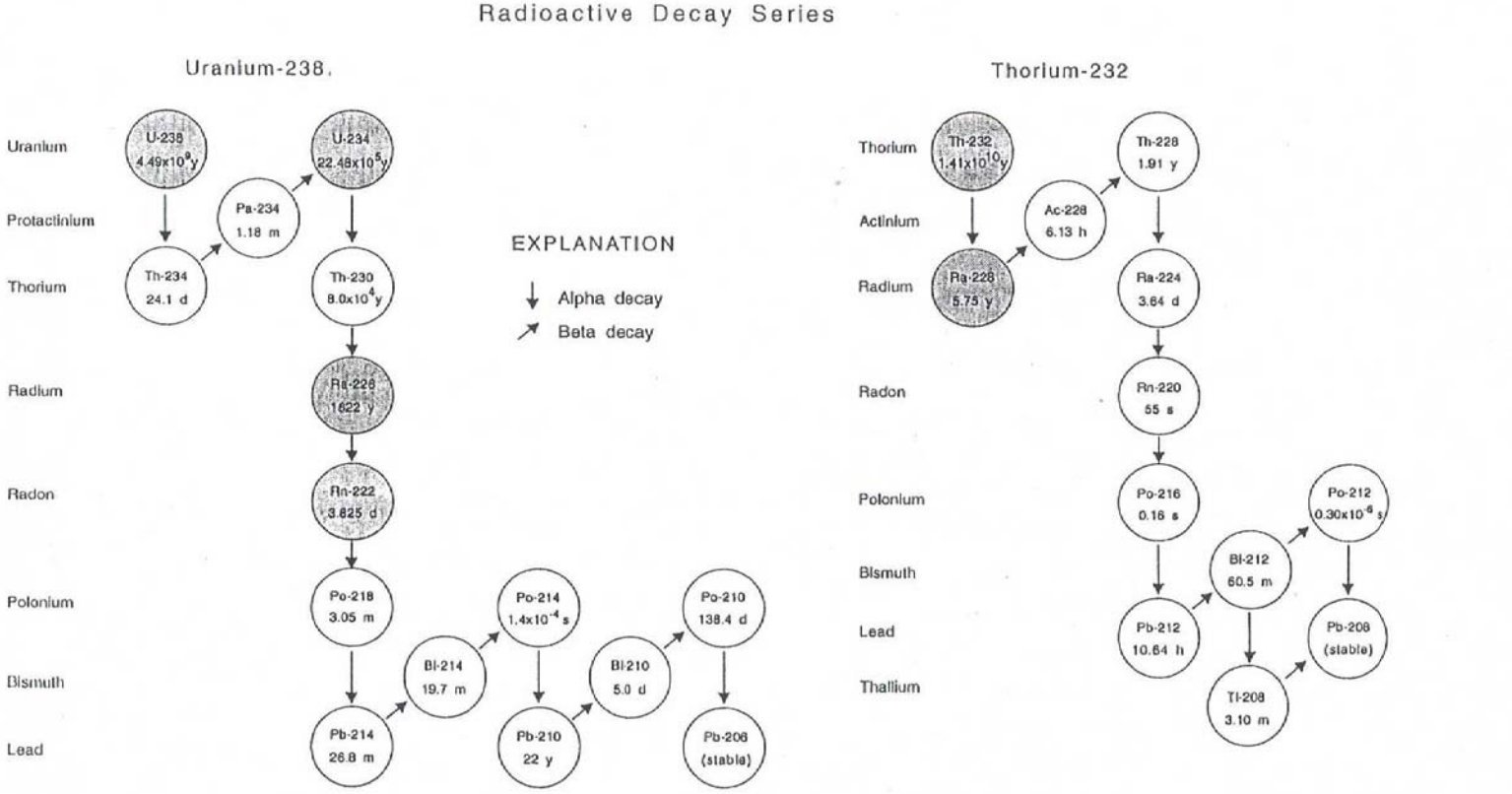
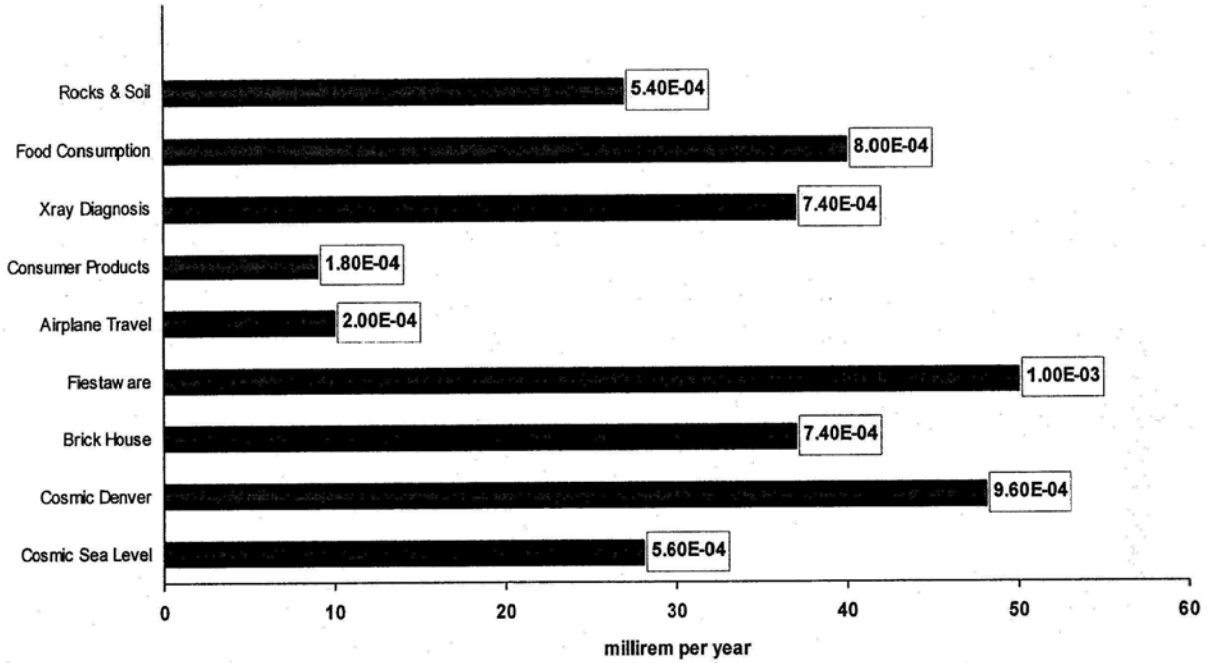


Figure 1. Diagram showing uranium-238 and thorium-232 radioactive decay series. (Radionuclides of interset in this study are shaded). [Times shown are half-lives: y, years; d, days; h, hours; m, minutes; s, seconds;]. (From Hall and others, 1985).

Figure 2: Background Dose



Numbers in scientific notation represent the lifetime cancer incidence risk

Figure 3: Sources of Radium Occurrence Data

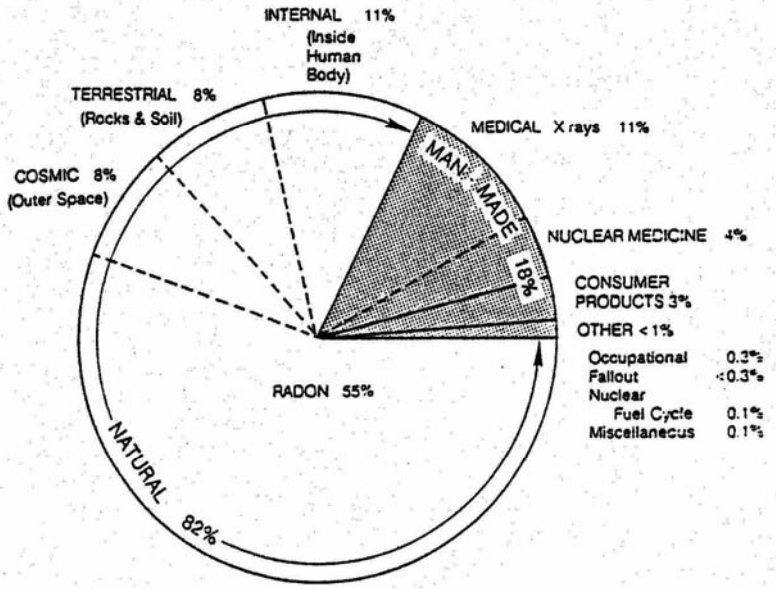


FIGURE 1-1 Sources of radiation exposure to the U.S. population (NCRP87b).

EFFECTS OF EXPOSURE TO LOW LEVELS OF IONIZING RADIATION

TABLE 1-3 Average Annual Effective Dose Equivalent of Ionizing Radiations to a Member of the U.S. Population

	Dose Equivalent[a]		Effective Dose Equivalent	
Source	mSv	mrem	mSv	%
Natural				
Radon[b]	24	2,400	2.0	55
Cosmic	0.27	27	0.27	8.0
Terrestrial	0.28	28	0.28	8.0
Internal	0.39	39	0.39	11
Total natural	—	—	3.0	82
Artificial				
Medical				
x-ray diagnosis	0.39	39	0.39	11
Nuclear medicine	0.14	14	0.14	4.0
Consumer products	0.10	10	0.10	3.0
Other				
Occupational	0.009	0.9	<0.01	<0.3
Nuclear fuel cycle	<0.01	<1.0	<0.01	<0.03
Fallout	<0.01	<1.0	<0.01	<0.03
Miscellaneous[c]	<0.01	<1.0	<0.01	<0.03
Total artificial	—	—	0.63	18
Total natural and artificial	—	—	3.6	100

[a] To soft tissues.
[b] Dose equivalent to bronchi from radon daughter products. The assumed weighting factor for the effective dose equivalent relative to whole-body exposure is 0.08.
[c] Department of Energy facilities, smelters, transportation, etc.

SOURCE: National Council on Radiation Protection and Measurements (NCRP87b).

Appendix II-A: NJ Radium in Water Occurrence Data Provided by USGS and DHSS

Municipality	County	Gross Alpha	^{226}Ra	^{228}Ra	^{224}Ra
JB Farms		NA	1.8 ∀ 0.2	1.6 ∀ 0.3	4.4 ∀ 0.4
Hammonton	Atlantic	15 ∀ 1	2.7 ∀ 0.4	1.6 ∀ 0.4	2.5 ∀ 0.4
Buena Vista	Atlantic	15 ∀ 4	<1	1.1 ∀	<1
Somers Pt City	Atlantic	24 ∀ 6	NA	3.9 ∀	4.6 ∀
Buena Vista	Atlantic	26 ∀ 5	<1	4.7 ∀	8.2 ∀
Hamilton	Atlantic	3.3 ∀ 0.5	0.7 ∀ 0.1	0.5 ∀ 0.1	0.5 ∀ 0.1
Somers Pt City	Atlantic	3.6 ∀ 0.9	0.6 ∀ 0.2	< 0.5	0.5 ∀ 0.2
Buena Vista	Atlantic	31 ∀ 5	3.2 ∀ 0.5	5.4 ∀	8.3 ∀
Egg Harbor	Atlantic	4.9 ∀ 2.9	NA	<1	<1
Buena Vista	Atlantic	7 ∀ 4	NA	1.6 ∀	<1
Buena Vista	Atlantic	76 ∀ 8	17 ∀ 2.2	13 ∀	17 ∀
Buena Vista	Atlantic	9.1 ∀3.2	1.1 ∀ 0.2	1.4 ∀	2.5 ∀
Galloway Twp	Atlantic	<3	NA	<1	<1
Woodland Twp	Burlington	7 ∀ 1	0.8 ∀ 0.2	< 0.8	0.8 ∀ 0.2
Mt. Laurel	Burlington	NA	3.8 ∀ 0.3	1.3 ∀0.2	1.7 ∀ 0.2
Waterford	Camden	18 ∀ 1	2.2 ∀ 0.3	3.9 ∀ 0.6	5.9 ∀ 0.3
Gloucester	Camden	19 ∀ 1	3.5 ∀ 0.2	2.1 ∀ 0.1	2.2 ∀ 0.1
Gloucester Twp	Camden	24 ∀ 1	2.8 ∀ 0.1	2.9 ∀ 0.1	3.6 ∀ 0.2
Winslow	Camden	4.2 ∀ 0.5	0.9 ∀ 0.3	0.5 ∀ 0.1	0.8 ∀ 0.1
Winslow	Camden	77 ∀ 2	5.7 ∀ 0.4	8.8 ∀ 0.6	13 ∀ 1
Vineland	Cumberland	13 ∀ 3	1.8 ∀ 0.3	2.0 ∀	1.6 ∀
Vineland	Cumberland	16 ∀ 4	2.7 ∀ 0.4	3.1 ∀	1.8 ∀
Vineland	Cumberland	23 ∀ 5	NA	7.1 ∀	11 ∀
Vineland City	Cumberland	24 ∀ 1	2.3 ∀ 0.2	3.0 ∀ 0.2	3.9 ∀ 0.2
Bridgeton City	Cumberland	25 ∀ 1	1.9 ∀ 0.1	2.6 ∀ 0.1	4.4 ∀0.3
Fairton Prison	Cumberland	28 ∀ 1	2.8 ∀ 0.3	3.7 ∀ 0.6	7.7 ∀ 0.7
Vineland City	Cumberland	32 ∀ 2	3.8 ∀ 0.2	2.9 ∀ 2.1	3.9 ∀ 0.2
UpperDeerfield	Cumberland	36 ∀ 2	4.3 ∀ 0.2	3.4 ∀ 0.2	4.5 ∀ 0.4
Up. Deerfield	Cumberland	37 ∀ 6	4.8 ∀ 0.7	6.7 ∀	5.7 ∀
Bridgeton City	Cumberland	39 ∀ 2	5.3 ∀ 0.3	4.1 ∀ 0.5	6.0 ∀ 0.3
Up. Deerfield	Cumberland	39 ∀ 6	8.4 ∀ 1.1	2.9 ∀	4.3 ∀
Bridgeton City	Cumberland	42 ∀ 2	3.8 ∀ 0.5	2.5 ∀ 0.5	4.5 ∀ 0.4
Seabrook	Cumberland	42 ∀ 6	5.3 ∀ 0.8	2.2 ∀	3.7 ∀
Vineland City	Cumberland	54 ∀ 3	11 ∀ 1	6.5 ∀ 0.4	7.1 ∀ 0.4
Up. Deerfield	Cumberland	6.6 ∀ 2.6	1.4 ∀ 0.2	1.6 ∀	<1
Vineland	Cumberland	6.9 ∀ 2.5	1.3 ∀ 0.2	1.6 ∀	1.7 ∀
Millville City	Cumberland	< 3	0.3 ∀ 0.1	0.2 ∀ 0.1	0.3 ∀ 0.2

Up. Deerfield	Cumberland	<3	<1	<1	<1
Newfield	Gloucester	11 ∀ 1	1.0 ∀ 0.1	1.3 ∀ 0.1	1.7 ∀ 0.2

Appendix II-A: NJ Radium in Water Occurrence - cont.

Municipality	**County**	**Gross Alpha**	**^{226}Ra**	**^{228}Ra**	**^{224}Ra**
Washingtn Twp	Gloucester	12 ∀ 1	2.7 ∀ 0.4	2.1 ∀ 0.6	5.0 ∀ 0.4
Washingtn Twp	Gloucester	22 ∀ 1	3.8 ∀ 0.5	2.8 ∀ 0.5	7.9 ∀ 0.5
Washgton Twp	Gloucester	23 ∀ 2	1.8 ∀ 0.2	2.0 ∀ 0.1	2.7 ∀ 0.2
Clayton Boro	Gloucester	25 ∀ 4	<1	<1	1.3
Hopewell	Gloucester	42 ∀ 1	4.9 ∀ 0.4	0.9 ∀ 0.4	1.5 ∀ 0.4
Washgton Twp	Gloucester	8.5 ∀ 0.8	1.7 ∀0.2	0.4 ∀ 0.1	1.2 ∀ 0.1
Cranbury	Middlesex	11 ∀ 1	1.1 ∀ 0.2	1.7 ∀ 0.4	2.1 ∀0.5
South Brunswk	Middlesex	17 ∀ 2	1.3 ∀0.3	3.4 ∀ 0.5	6.8 ∀ 0.4
Monroe Twp	Middlesex	18 ∀ 5	NA	3.4 ∀	3.8 ∀
Jamesburg	Middlesex	22 ∀ 1	2.5 ∀ 0.3	4.4 ∀ 0.6	6.2 ∀ 0.3
South Brunswk	Middlesex	26 ∀ 2	0.75 ∀ 0.2	3.2 ∀ 0.5	6.9 ∀ 0.4
Sayreville	Middlesex	40 ∀ 2	2.2 ∀ 0.3	5.2 ∀ 0.5	12.7 ∀ 0.4
Cranbury	Middlesex	5.9 ∀ 0.9	0.50 ∀ 0.2	1.1 ∀ 0.4	2.2 ∀ 0.4
Sayreville	Middlesex	50 ∀ 3	5.1 ∀ 0.4	5.3 ∀ 0.7	15.8 ∀ 0.6
Monroe Twp	Middlesex	7 ∀ 3	0.9 ∀ 0.1	1.1 ∀ 0.1	1.4 ∀ 0.1
Lacey Twp	Ocean	0.6 ∀ 0.1	0.02 ∀ 0.3	0.3 ∀ 0.2	0.05 ∀ 0.2
Manchester	Ocean	1.0 ∀ 0.2	<0.1	<0.5	0.3 ∀ 0.2
Jackson Twp	Ocean	1.9 ∀ 0.3	0.4 ∀ 0.2	<0.5	0.3 ∀ 0.2
Manchester	Ocean	10 ∀ 1	0.9 ∀ 0.1	1.4 ∀ 0.1	1.9 ∀ 0.2
Berkley Twp	Ocean	10 ∀ 1	1.0 ∀ 0.1	1.7 ∀ 0.1	2.9 ∀ 0.7
Lakehurst Boro	Ocean	11 ∀ 1	0.6 ∀ 0.2	1.3 ∀ 0.6	1.5 ∀ 0.2
Dover Twp	Ocean	12 ∀ 2	0.9 ∀ 0.2	1.8 ∀ 0.4	2.7 ∀ 0.2
Dover Twp	Ocean	12 ∀ 3	1.2 ∀ 0.2	1.9 ∀	3.2 ∀
Dover Twp	Ocean	13 ∀ 4	2.9 ∀ 0.5	1.6 ∀	1.2 ∀
Manchester	Ocean	15 ∀ 1	3.4 ∀ 0.5	1.2 ∀ 0.4	1.5 ∀ 0.3
Dover Twp	Ocean	15 ∀ 2	1.4 ∀ 0.3	1.5 ∀ 0.5	2.6 ∀ 0.7
Dover Twp	Ocean	15 ∀ 2	1.8 ∀ 0.1	NA	2.6 ∀ 0.6
Dover Twp	Ocean	15 ∀ 2	2.3 ∀ 0.2	1.8 ∀ 0.1	2.8 ∀ 0.7
Dover Twp	Ocean	15 ∀ 4	1.1 ∀ 0.2	1.7	2.42 ∀
Lakewood Twp	Ocean	15 ∀ 4	NA	1.7 ∀	2.4 ∀
Manchester	Ocean	17 ∀ 4	1.8 ∀ 0.1	1.8 ∀ 0.1	1.9 ∀ 0.1
Lacey Twp	Ocean	18 ∀ 1	3.3 ∀ 0.9	2.0 ∀ 0.4	2.7 ∀ 0.3
Dover Twp	Ocean	20 ∀ 4	3.1 ∀ 0.2	2.4 ∀ 0.1	3.6 ∀ 0.2
Lacey Twp	Ocean	3.1 ∀ 0.2	1.1 ∀ 0.3	0.31 ∀ 0.2	0.6 ∀ 0.2
Lacey Twp	Ocean	39 ∀ 1	8.2 ∀ 0.5	2.9 ∀ 0.5	4.5 ∀ 0.3
Dover Twp	Ocean	4 ∀ 2	1.1 ∀ 0.2	< 1	<1
Lakewood Twp	Ocean	4.6 ∀ 0.6	1.6 ∀ 0.2	0.6 ∀ 0.4	1.2 ∀ 0.3

Lakewood Twp	Ocean	5.1 ∀0.6	0.9 ∀0.2	1.0 ∀ 0.4	1.1 ∀ 0.3
Jackson	Ocean	5.2 ∀ 0.6	0.7 ∀ 0.2	<0.5	0.8 ∀ 0.2

Appendix II-A: NJ Radium in Water Occurrence Data – cont.

Municipality	**County**	**Gross Alpha**	**^{226}Ra**	**^{228}Ra**	**^{224}Ra**
Dover Twp	Ocean	8 ∀ 3	2.1 ∀ 0.3	2.3 ∀	1.7 ∀
Pittsgrove Twp	Salem	50 ∀ 7	6.4 ∀ 0.8	11∀	12 ∀
Pittsgrove Twp	Salem	65 ∀ 8	12 ∀ 2	7.2 ∀	11 ∀
Pittsgrove	Salem	<3	<1	<1	<1

Appendix III: Report of the Testing Subcommittee

New Jersey Drinking Water Quality Institute
New Jersey Department of Environmental Protection

Recommendation to the Institute on Radium-224 (Ra-224) Testing

January 7, 2002

Radium 224
Testing Subcommittee Report
To the Drinking Water Quality Institute

Executive Summary

The Testing Subcommittee has assessed two analytical techniques for the monitoring of Ra-224 in drinking water. It is the understanding of the Testing Subcommittee that the Health Effects Subcommittee is making recommendations that will regulate the presence of Ra-224 as part of the gross alpha standard utilizing the "48-hour Rapid Gross Alpha Test Procedure" currently being employed for drinking water compliance monitoring. The Testing Subcommittee recommends that US EPA approved methods for gross alpha testing, with certain modifications, be defined as the "48-hour Rapid Gross Alpha Test Procedure" and that it be required that these modified test procedures be used when performing the gross alpha scan of drinking water samples for compliance with State and federal rules and regulations.

The gross alpha test procedure, without the recommended modifications, is currently used in the certified laboratory community for drinking water testing. This test procedure does not require the analytical expertise needed of other radiochemical procedures for the direct analysis of Ra-224. Additional analytical tests may be avoided by incorporating the assessment of Ra-224 into the gross alpha procedure. However, the Testing Subcommittee recommends certain method modifications be incorporated into the method in order to address certain analytical concerns pertaining to Radon and Thoron progenies. The Testing Subcommittee also recommends that a specific test procedure utilizing gamma spectroscopy be defined as the Ra-224 in Drinking Water Test Procedure and that this procedure be approved by the NJDEP for the direct determination of Ra-224 in drinking water. The Testing Subcommittee recommends that this test procedure be available to laboratories that wish to further characterize drinking water for the presence of Ra-224, although this may not be a regulatory requirement for ongoing drinking water compliance monitoring.

Charge to the Testing Subcommittee

Over the past two years, the Testing Subcommittee has been charged with assessing two analytical approaches to support the regulation of Ra-224 in drinking water.

On October 18, 1999, the Testing Subcommittee was charged with the task of assessing and recommending the appropriate analytical method(s) for the identification and quantitation of Ra-224 in drinking water. On November 22, 2000, the Testing Subcommittee reported its findings to the Health Effects Subcommittee[1], details of which are discussed below. Later that same year, the Health Effects Subcommittee began assessing a second approach to regulating the presence of Ra-224 in drinking water through the establishment of a gross alpha standard that incorporates Ra-224 risk into the Maximum Contaminant Level (MCL). The Testing Subcommittee was then charged with assessing the applicability of utilizing the 48-hour Gross

[1] Memorandum from Stephen W. Jenniss, Testing Subcommittee Chairman, to Health Effects Subcommittee dated November 22, 2000.

Alpha Test Procedure (currently recommended by the NJDEP and USEPA) in this analytical scheme and identifying any method modifications that needed to be incorporated.

Background

The presence of Ra-224, an alpha emitting isotope with a short half-life of 3.66 days, in groundwater was first discovered in New Jersey as part of the State's investigation of a cancer cluster in Dover Township. Its presence was observed during the priority analysis of certain drinking water samples using a gross alpha scanning procedure. As a result of the priority analysis request, the laboratory had immediately processed the samples upon receipt. This enabled the laboratory to detect the gross alpha emissions from the short-lived isotope, Ra-224.

At the time of the initial discovery, there were no published methods for the direct identification and quantitation of Ra-224 in drinking water. The identification of Ra-224 was made as a result of the State Radiochemistry Laboratory's follow-up research and method development.

The original gross alpha scanning procedure has been developed by the US EPA as an economic scanning procedure for detecting alpha-particle emissions from various radionuclides including radium and uranium isotopes. When these emissions are detected at a level that exceeds a certain standard, federal regulations require that further testing be performed to identify the isotope(s) responsible for the elevated alpha emission. This procedure's federally regulated sample holding time for discrete samples, however, was six (6) months[2] (twelve months for composite samples). Thus, in most cases, short-lived isotopes such as Ra-224 had previously gone undetected because they decayed before the analysis was performed.

In an effort to address the ineffective holding time of the gross alpha scan, the NJDEP Bureau of Safe Drinking Water adopted the policy that all gross alpha scans for drinking water compliance must be conducted within 48 hours from time of sample collection. This "rapid" application of the Gross Alpha Test Procedure was later recommended nationally by the US EPA.[3]

Ra-224 Method Assessment

Since the initial discovery of Ra-224 in the Kirkwood-Cohansey groundwater aquifer, two analytical procedures have been developed for the direct identification and quantitation of Ra-224 (see Table III-1). One procedure, developed by Duke Engineering and Services Laboratory (Boston, MA), is an unpublished analytical technique employing alpha spectroscopy. This procedure involves the collection of 0.5 Liters of water, which then undergoes a complex sample preparation procedure isolating the radium constituents from the sample. The concentration of Ra-224 is then directly measured by counting the prepared sample's alpha particle emission with an alpha spectroscopy system using solid state detectors. This procedure is also capable of concurrently measuring other alpha-emitting radium isotopes. However, this procedure is not a federally approved method for the analysis of Radium in drinking water. This

[2] US EPA, Manual for the Certification of Laboratories Analyzing Drinking Water, Criteria and Procedures, EPA-815-B-97-001, March 1997.
[3] US EPA, National Primary Drinking Water Regulations; Radionuclides, Notice of Data Availability; Proposed Rule. Federal Register, 65 (78), 21587, April 21, 2000.

radiochemistry procedure has a chemical recovery of 40 to 80 percent and a method minimum detectable concentration (MDC) of about 1.0 pCi/Liter. Aside from the unavailability of alpha spectroscopy systems (not common in all the radiation laboratories), this is a difficult technique to use due to the complexity of the sample preparation procedure and the micro-precipitation requirement to prepare a thin source for alpha spectroscopy measurements. Thus, trained skilled staff are required to conduct the procedure and monitor the sample preparation process. Failure to do so directly affects the precision and accuracy of the test method.

A second procedure, developed by Dr. Bahman Parsa of DHSS, has been published in the Journal of Radioactivity and Radiochemistry.[4] This procedure requires the collection and analysis of a larger sample size, 1 - 3 Liters, but employs a simpler sample preparation technique that requires less time and analyst skill to perform. Ra-224 is then indirectly measured through gamma-ray spectroscopy. The procedure is designed so that the gamma radiation from Pb-212, a Ra-224 progeny (decay product), can be assayed, using high-resolution intrinsic Ge detector, and related to the Ra-224 that is present in the sample. This procedure has a chemical recovery of 80 to 100% and a method MDC of 0.4 to 0.8 pCi/L. The US EPA, in the Notice of Data Availability[5], has recommended the use of the gamma spectroscopy method. This procedure has been already approved by the Radium Joint Task Group and Joint Editorial Board of Standard Methods for the Examination of Water and Wastewater. Recently, it received the approval of Standard Methods Committee's general balloting to appear in its next, 21st Edition. Although this procedure is not currently approved for regulatory compliance testing, other Radium isotopes of interest, namely Ra-226 and Ra-228, can be concurrently measured by this method through their respective decay products.

A side by side comparison of these two analytical techniques is shown below in Table III-1.

Gross Alpha Method Assessment/Modifications

The presence of the Ra-224 isotope in drinking water may be indirectly ascertained by performing the rapid gross alpha testing procedure, within 48 to 72 hours from sample collection time. However, application of this "rapid gross alpha testing" protocol has identified certain regions in New Jersey with elevated gross alpha-particle levels commonly unsupported by Radium and Uranium[6]. It has been found that some of the elevated gross alpha-particle emissions are due to the presence of Radon and Thoron progenies, including unsupported Pb-212. In many cases, if the contribution of Radon progenies to gross alpha-particle activity were not included in the final gross alpha result, the drinking water sample would not be in violation of the gross alpha particle standard. This issue had been brought to the attention of the Health Effects Subcommittee. It was the committee's belief that the shorter-lived Radon and Thoron progenies do not pose a health risk such as that of the longer-lived Radium and Uranium

[4] Methed Reference: B. Parsa, “Contribution of Short-lived Radionuclides to Alpha-particle Radioactivity in Drinking Water and Their Impact on the Safe Drinking Water Act Regulations,” Radioactivity and Radiochemistry, 41, Vol. 9 (1998).
[5] US EPA, National Primary Drinking Water Regulations; Radionuclides; Notice of Data Availability; Proposed Rule. Federal Register, 65 (78), 21618, April 21, 2000.
[6] B. Parsa, W.K. Nemeth and R.N. Obed, “The Role of Radon Progenies in Influencing Gross Alpha-Particle Determination in Drinking Water,” Radioactivity and Radiochemistry, 11, Vol. 11 (2000).

isotopes. Therefore, this shortcoming of the 48-hour Rapid Gross Alpha Test needed to be assessed by the Testing Subcommittee.

Table III-1: Comparison of Available Testing Techniques For the Specific Testing of Radium-224

Test Method	Gamma Spectroscopy[4]	Alpha Spectroscopy[7]
MDC (pCi/L)	0.4 - 0.8[8]	1.0
Sample Preparation Time(hr)	2	5
Sample Counting Time(min)	1000	1000
Sample Volume (Liters)	1 - 3	0.5
Chemical Recovery (%)	80 - 100	40 - 80
Analytical Procedure	• Simple, fast technique • Can concurrently measure Ra-226 & Ra-228 with the same prepared sample • Potential interference from unsupported Pb-212, requiring 2nd counting for verification	• Complex sample preparation technique • Direct measurement requiring only one count • Concurrently measures other alpha-emitting radium isotopes • Must determine recovery by Gamma Spectroscopy

The problem associated with utilizing the 48-hour Rapid Gross Alpha Test for regulating Ra-224 was discussed at the Testing Subcommittee meeting that was held on April 18, 2001. At this meeting, a Working Group was formed and charged with the task of developing a strategy to address the issue of Radon and Thoron progenies (including unsupported Pb-212), along with recommending what, if any, method modifications should be made.

In order to identify and differentiate any Radon and Thoron progeny contribution to the gross alpha-particle measurement, the Work Group recommended that:

(1) The gross alpha testing protocol be modified by requiring that the counting of the plancheted sample be initiated between 36 to 48 hours from the time of sample collection. If the calculated value is less than or equal to 5 pCi/L, that value is reported and no further radiochemical analysis of the sample is required; and

(2) If the gross alpha value of the 36 to 48 hour count exceeds 5 pCi/L, then the same plancheted sample must be re-counted between 20 to 28 hours after the initial count and this calculated value reported as the final gross alpha result. This modification will allow complete decay of Radon progenies and eliminate their contribution to gross alpha-

[7] Method Reference: in-house, non-published method developed by Duke Engineering & Services Laboratory, Boston, MA.
[8] Depending on chemical recovery, detector efficiency and time span between sample collection to counting (2-4 days).

particle assay, as well as reducing the impact of unsupported Pb-212 to gross alpha-particle measurements by about 80%.

A flow chart depicting a "typical" analytical compliance-testing scheme using the 48-hour Rapid Gross Alpha Test is included as Figure 1.

The US EPA references several analytical procedures that are approved for conducting the gross alpha test. This test was originally developed as a screening technique, to be followed by other definitive test procedures if needed for further isotopic speciation. These methods, however, allow the usage of different calibration standards.

To minimize the analytical error that may exist through the method's allowance of more than one type of calibration standard, the Testing Subcommittee is recommending that, when performing the 48-hour Rapid Gross Alpha Test, only the Thorium-230 standard shall be used by certified laboratories. This will eliminate the unnecessary error that is attributable to the usage of different calibration standards by laboratories.

Subcommittee Recommendations

The Testing Subcommittee recommends that the analytical technique for the 48-hour Rapid Gross Alpha Scan and the Ra-224 test protocol be available to the certified laboratory community. The Testing Subcommittee recommends specific method modifications be made to the current 48-hour gross alpha scan. These modifications will allow for the measurement of Ra-224 as part of the total alpha scan, while eliminating the counting of other unwanted short-lived isotopes, such as Pb-212 and other Radon progenies. This method, with the recommended modifications, will serve as the test procedure for determining compliance with the Health Effects Subcommittee recommended gross alpha standard.

The Testing Subcommittee also finds benefit in making the direct method for identifying and quantifying Ra-224 (gamma-ray spectrometry) available to the drinking water testing laboratory community. Availability of this direct testing method will enable the State regulators and drinking water facilities to characterize new groundwater wells for Ra-224 and can be used as a tool for long-term groundwater trend assessment.

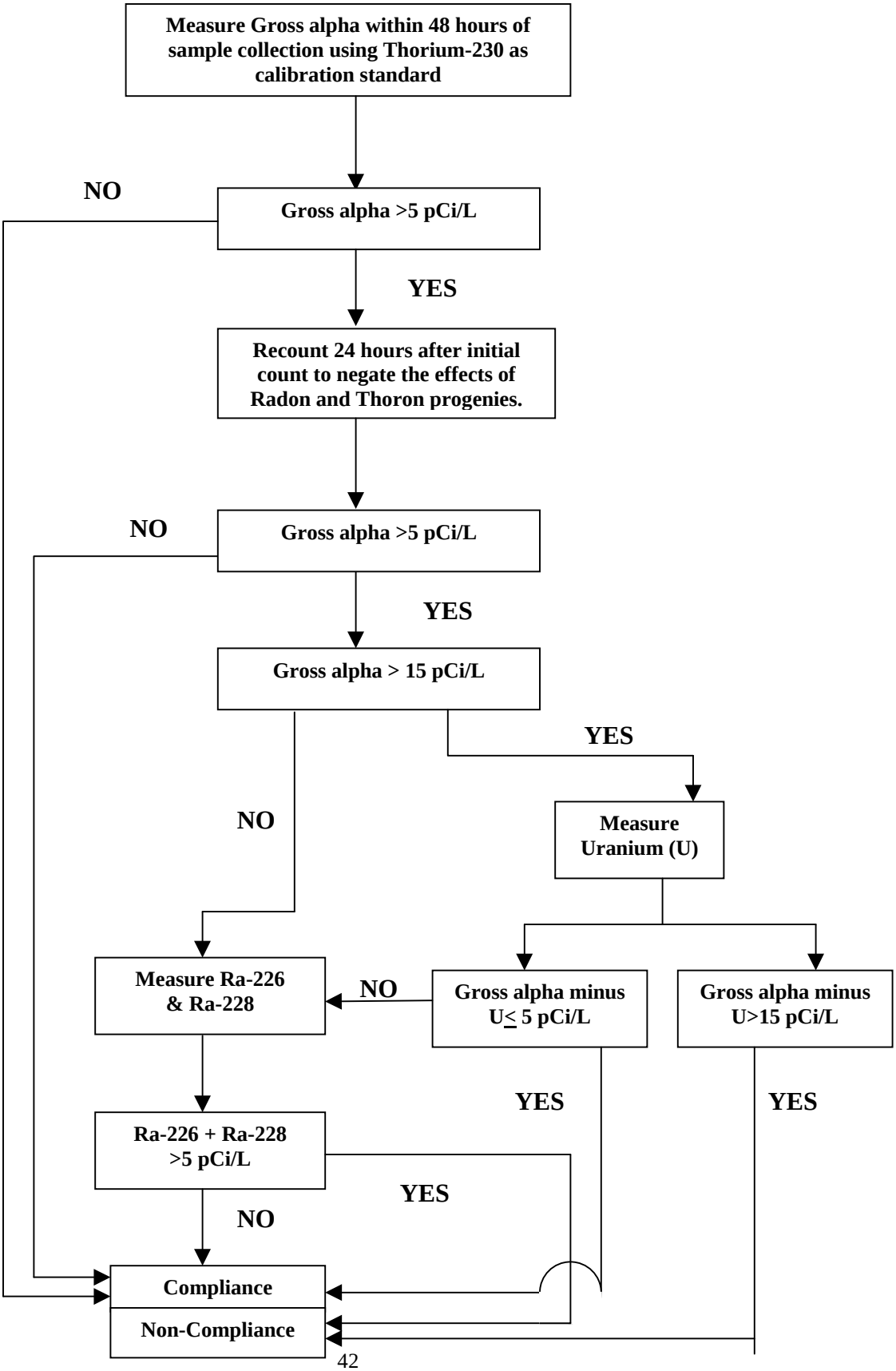
The specific recommendations are as follows:

(1) The NJDEP add to its list of certified drinking water test parameters, "Ra-224". It is also recommended that the NJDEP approved method for the direct determination of Ra-224, be the gamma spectroscopy method developed and published by Dr. Bahman Parsa in Radioactivity and Radiochemistry 41, Vol. 9 (1998).

(2) The NJDEP add to its list of certified test parameters, "48-hour Rapid Gross Alpha Test". The Subcommittee also recommends that the NJDEP approved method for the "48-hour Rapid Gross Alpha Test" be the US EPA approved methods for gross alpha testing with the following modifications:
   a. a Thorium-230 standard shall be used as the test calibration standard;

b. the initial counting of the plancheted sample shall be initiated between 36 to 48 hours from the time of sample collection;
c. if the calculated value from the initial gross alpha count is less than or equal to 5 pCi/L, that value shall be reported and no further radiochemical analysis of the sample is required; and
d. if the gross alpha value from the 36 to 48 hour count exceeds 5 pCi/L, then the same plancheted sample shall be re-counted between 20 to 28 hours after the initial count; and this calculated value shall be reported as the final gross alpha result.

Figure 1: Flow Chart for Typical Drinking Water Compliance Testing Scheme
Using the 48-Hour Rapid Gross Alpha Test



Appendix IV: Report of the Treatment Subcommittee

New Jersey Drinking Water Quality Institute
New Jersey Department of Environmental Protection

Report
on

Radium Removal from Drinking Water
Treatment Options and Costs

Prepared
for

The New Jersey Drinking Water Quality Institute
Treatment / Cost Subcommittee

by

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Section Chief
Permits, Capacity Development, Technical/Infrastructure Evaluation

March 6, 2002

Bureau of Safe Drinking Water
Water Supply Administration

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Introduction

The Treatment/Cost Subcommittee of the New Jersey Drinking Water Quality Institute (NJDWQI) has been tasked under the direction of Subcommittee Chairman A. David Marino to prepare a report on radium removal treatment from public water systems and related costs. This is an abridged report that presents radium removal options that include treatment, alternate sources, aquifer storage and recovery, and waste disposal concerns.

The occurrence of elevated levels of gross alpha activity associated with the Cohansey Aquifer was identified during an extensive sampling of drinking water for chemical and radiological contaminants conducted in 1996 by New Jersey Department of Environmental Protection (NJDEP) and New Jersey Department of Health and Senior Services (NJDHSS) in Dover Township, Ocean County. Samples of well water collected there in March 1996 were shown to have abnormally elevated gross alpha activity levels. Follow up sampling conducted in summer, 1996, with the time between sampling and analysis carefully controlled, enabled the NJDEP radiological laboratory to determine that the elevated levels were due to the presence of radium-224. Radium-224 is in the decay chain of thorium-232 and has a half-life of 3.64 days. The presence of radium-224 in earlier Bureau of Safe Drinking Water (BSDW) regulatory sampling had not been demonstrated primarily because the Interim Primary Drinking Water Regulations allow the compositing of four quarterly samples prior to analysis. Thus, virtually all radium-224 activity in composited samples had decayed away prior to gross alpha activity analysis being performed.

Upon learning of this anomaly, the BSDW instituted a rapid gross alpha testing protocol through the NJDHSS radiological laboratory. In order to assess the rapid test impact on New Jersey's water systems and maintain consistency in the sample collection and analyses, the BSDW assumed responsibility to monitor the public community water systems for radionuclides during the monitoring period of July 1, 1996 through June 30, 2000. In July 1997, the BSDW began monitoring the public community water system's point-of-entry[1] to the distribution system. If the BSDW identified a potential problem, it performed quarterly monitoring for the water system until a compliance determination with the Maximum Contaminant Level (MCL) could be made. All of the more than 600 public community water systems were sampled, including those that bulk-purchase their water from another public community water system.

Radium Occurrence

Radiological contaminants that are being found in New Jersey's drinking water systems for the most part are naturally occurring. The United States Geological Survey conducted studies (See Appendix IV-D) in the 1990s that identified extensive radium occurrence in private wells and to a lesser extent in public water system wells. It is postulated that the elevated levels of radium concentration in the groundwater are caused by surface activity like fertilization of farms and lawns resulting in changes in soil chemistry, which release naturally occurring radium. The majority of these elevated levels are found in certain pockets of the coastal plain's unconfined Cohansey Aquifer. While there are areas with radium 226 present in excess of the MCL, the majority of the elevated levels in gross alpha activity are attributed primarily to radium 224.

[1] Point-of-entry to the distribution system is the point where the water from a source (i.e. well station) enters the distribution system.

Significant gross alpha activity levels were also found in the Middlesex County area in water samples from the Old Bridge and Farrington Aquifers and shallower aquifers (i.e. Englishtown Aquifer).

Through the 1996–2000 monitoring period of sample collection and analysis performed by the BSDW, 23 public community water systems out of over 600 were determined to have exceeded the MCL for gross alpha activity. Five of these systems also exceeded the radium 226 + radium 228 combined MCL of 5 pCi/L. Approximately 100 public community water systems, including those that had exceeded the MCL, were placed on quarterly monitoring due to elevated levels of gross alpha activity[2]. A review of data generated from this monitoring suggests that there is a potential for an additional 20 Public community water systems with one or more sources (points of entry) that will exceed the gross alpha activity once compliance with the MCL is required at the point of entry (after January 1, 2004).

The data show that radium is not generally elevated in surface water sources nor is it elevated in most ground waters. Where found, the gross alpha activity varies from just above the MCL (15 pCi/L) to 200 pCi/L. Likewise, radium 226 + radium 228 varies from 3 to 10 pCi/L. However, one small non-community system's well in Atlantic County had a level of radium 226 + radium 228 of nearly 70 pCi/L. The BSDW recommended that the water system owners immediately provide bottled water or remove the contaminated source from service.

Maximum Contaminant Levels

The interim primary drinking water regulations, which are in effect through December 31, 2003, set the MCL for radionuclides as follows:

Gross Alpha Activity[3]	15	pCi/L
Radium 226 + Radium 228	5	pCi/L
Beta Emitters	4	mrem/yr
Tritium	20,000	pCi/L
Strontium-90	8	pCi/L

The final primary drinking water regulations, which will go in effect January 1, 2004, set the MCLs for (Non-Radon) Radionuclides in Drinking Water, are as follows:

Gross Alpha Activity[3]	15	pCi/L
Radium 226 + Radium 228	5	pCi/L
Beta particle and Photon Radioactivity	4	mrem/yr
Tritium	20,000	pCi/L
Strontium-90	8	pCi/L
Uranium[3]	30	ug/l

[2] If gross alpha activity is greater than 7.5 pCi/L, the public water system is required to perform quarterly monitoring to determine compliance with the MCL.

[3] The gross alpha activity MCL excludes radon and uranium activity. Laboratory results reported by DHSS exclude radon but not uranium, since uranium is an alpha emitter. If gross alpha activity is greater than 15 pCi/L, the sample is tested for uranium where uranium is expected to be present and its level is subtracted from the gross alpha activity to determine gross alpha activity MCL compliance.

Under the interim primary drinking water regulations that remain in effect through December 31, 2003, the MCL is applied to monitoring performed by sampling at sites in the distribution system. The MCL of the final radionuclide rules is applied at the point of entry to the distribution system (point of entry). Hence, we anticipate more systems will exceed the MCL than currently (20 more). Because the mixing and dilution effect that is taking place in the distribution system will no longer be considered. Compliance with the MCL will be determined at the point of entry.

Further, with the MCL for uranium taking effect on January 1, 2004, it is anticipated that there will be a number of small community systems in Sussex County that will be exceeding the uranium MCL. Based on current data, we estimate that seven to 10 public community water systems will exceed the uranium MCL of 27 pCi/L.[4]

Mitigation Options

Public community water systems have several options to mitigate the presence of radium in drinking water. These include, but are not limited to, the following: (1) treatment of the water, (2) use of alternate sources, (3) storage via Aquifer Storage and Recovery (ASR) wells, and (4) use of bottled water as an interim short term option. Each option has its pros and cons. However, for those with the option available, switching sources or connecting to another water system seems to be the most advantageous.

In New Jersey, of the 23 public community water systems with confirmed gross alpha MCL exceedences, several water suppliers (4-5) removed wells with highest radium levels from service and are currently relying on the remaining sources to meet demands. At least 2 small systems were in relatively close proximity to another public water system. Hence, these two systems are no longer considered public water systems and were removed from the BSDW inventory. Two medium to large systems opted for treatment. One system, New Jersey American Water Company (NJAWC), Jamesburg System, has been operating an ion exchange system since February 2000. This is the first full-scale medium sized system in New Jersey to be removing radium from its water supply. The second is the City of Vineland, which constructed a treatment system comprising ion exchange for its Well 13. It was placed in service June 1, 2001. Another system, the City of Bridgeton, is drilling wells in a different aquifer to be blended with existing wells with high radium. At least one system, Monroe Township MUA, Middlesex County, is converting one of its high radium wells to an ASR well. A second well is being converted to an irrigation well to be utilized by a nearby golf course. The remaining systems (17 in all) have yet to decide on an option, the main problem being not having a suitable disposal option for the waste generated by the radium removal treatment plant. For a number of small systems, the NJDEP has requested the water supplier to provide its customers optional sources where the customer can get their drinking water via bottled water if no other alternative is immediately feasible. Lastly, there are at least two water systems that were previously treating their water via ion exchange for radium removal. One system is the Fairton Federal Prison. Fairfield Federal Prison installed an ion exchange treatment in the late eighties and initially

[4] The MCL for uranium is set by 40 CFR 141 at 30 ug/L. The equivalent radioactivity measurement for NJ can be calculated using isotopic analyses data. EPA assumes 30 ug/L is equivalent to 27 pCi/L.

disposed of the radium waste as low level radioactive solid waste at facilities in Utah and New Mexico. The other is Valley View Apartments, a small water system in Vernon Township, Sussex County, which has had an ion exchange system to remove hardness for many years. When it was determined that it exceeded the gross alpha MCL, the unit was regenerated and backwashed more frequently. Subsequent analyses indicate the system now complies with the MCL. This system discharges its waste to an existing septic system that serves the apartment complex. The suitability of the discharge is currently under review by the Division of Water Quality and the Bureau of Environmental Radiation Protection.

Treatment Technologies

The USEPA, through the rule adoption for radionuclides, has identified the following best available treatment technologies (BATs):

1. Ion Exchange
2. Reverse Osmosis
3. Lime softening
4. Coagulation/filtration

It should be noted that lime softening is only effective for removal of radium and uranium. Coagulation/filtration is only effective for removal of uranium. Neither of these two treatment technologies are being seriously considered for treating New Jersey's community water supplies. The elevated levels of gross alpha activity are being found only in ground water sources. Hence, building a lime softening and/or a coagulation/filtration process purposely for the removal of radium and/or uranium is not practical due to the cost of building the facilities without the benefit of any other significant advantages. Also, it's worth noting that there has been an interest by some New Jersey water suppliers and consultants in the use Electro-Dialysis Reversal (EDR) and Hydrous Manganese Oxide (HMO) treatment technologies. Although neither of these technologies was identified by the USEPA as Best Available Technologies (BATs), pilot test studies done in New Jersey by NJAWC for EDR at their Somers Point well station and by Washington Township MUA, Gloucester County for HMO at their Well 10 & 11 prove these technologies to be promising for the removal of radium.

<u>Ion Exchange Treatment Technology</u>

Ion Exchange (IE) Treatment Technology has been in existence and widely used in water treatment for several treatment objectives including hardness, iron, manganese, nitrate removal, and others. In New Jersey, however, the IE treatment process specifically designed for radium removal had not been employed until the late eighties when Fairton Federal Prison designed and built an IE system for radium removal. Because waste generated by the facility could not be disposed of on site via a septic system, the Fairfield Federal Prison employed a second IE unit and operated it as concentrator for treating wastewater generated by the main IE treatment unit. The IE concentrator unit was not regenerated. Instead, it was removed and disposed of as solid radioactive waste at a licensed facility. Fairfield Federal Prison operated in this fashion for a number of years until a public sewer connection became available. Since then, the concentrator is no longer being used and the waste generated by the IE unit is discharged to the public sanitary sewer system, which is ultimately treated by the Cumberland County Utility Authority. **Note:** Since the Fairfield Federal Prison is a federal facility, it is exempt from licensing requirements as per N.J.A.C. 7:28-4.3(a). Further, the appropriateness of the discharge of wastewater generated

by IE unit at the Fairfield Federal Prison to the sanitary sewer system is under review by the Division of Water Quality.

NJAWC, Jamesburg System, was the first New Jersey water system that piloted IE treatment exclusively for removal of radium on a public community water system. The pilot study lasted for several months and was intended to establish IE as a viable treatment alternative for Jamesburg and to establish a waste characterization so that a system could be designed that would meet both treatment and disposal objectives. The pilot study revealed that the IE is effective in removal of radium and gross alpha from drinking water. The pilot also revealed that a State Radioactive Materials license was required. The waste generated presents a significant challenge on meeting the New Jersey discharge limit[5] for disposal in a public sanitary sewer system.

The IE treatment process consists of a tank filled with resin that is regenerated by a strong acid using a brine solution. Raw water is typically introduced to the pressure vessel containing the resin from the top. As water passes through the resin, the radium is chemically removed by exchanging the radium ion with sodium ions. After a pre- determined amount of flow (several thousand bed-volumes) the unit is regenerated. Regeneration allows the resin to release the radium that attaches itself to the resin during the exchange process. The regeneration cycle is followed by a backwash cycle where the excess brine is removed. This is done via reverse flow, typically in an up-flow direction. The backwash cycle is then followed by a rinse cycle. This is accomplished by allowing raw water to pass through the vessel under normal flow and its effluent discharged. Between the regeneration, backwash, and rinse cycles 2-5% of water produced is used to complete the cycle. Depending on the level of radium to be removed and amount of water produced, an IE unit needs to regenerated once every 5-10 days. The regeneration frequency is governed more by the discharge limits to the sanitary sewer system than the system's ability to treat the water to drinking water standards. If an IE concentrator is used to treat the primary source or the backwash waste, then the regeneration frequency or replacement as appropriate could be much longer. However, gamma exposure to workers working in the plant could be a concern. In either case a State Radioactive Materials License is likely to be required.

Reverse Osmosis (RO) Water Treatment Technology

Reverse Osmosis (RO) is a method of separating water from dissolved salts by passing feed-water through a semi-permeable membrane at a pressure greater than the osmotic pressure caused by the dissolved salts to be removed from the water. A literature review reveals that the RO process is typically used for desalting seawater or brackish water. It is therefore also effective for radium removal. There are two types of RO treatment, low and high pressure. The low pressure RO, sometimes referred to as nanofiltration, should be adequate for the removal of radium.

In New Jersey, there currently is only one RO process operating in a public community water system. The City of Cape May operates a high pressure RO treating brackish water from the

[5] The NJ discharge limit into a sanitary sewer system is 1 curie per year and the concentration of radionuclides must not exceed unity (1) calculated as follows: Ra226/400 + Ra228/800 + Ra224/70,000 with concentration units in pCi/L, as per N.J.A.C. 7:28-11.2.

confined Kirkwood-Cohansey Aquifer in an area that has been contaminated by saltwater intrusion. The 2-MGD RO plant has been desalting brackish water and operating continuously since 1998.

Lime Softening Water Treatment Technology

Lime Softening is typically practiced with waters that have natural high alkalinity and high hardness. The water is destabilized by raising the pH of the water to a point above saturation and through the aid of coagulants, mixing, flocculation, and sedimentation the metals and organic contaminants are removed. This causes the radium ions to co-precipitate out with other hardness ions and settle out in a sedimentation basin. Because of its limited application to NJ's waters no further evaluation was made.

Coagulation/Filtration Water Treatment Technology

Coagulation/Filtration Water Treatment Technology can be effective if there are other organic and inorganic constituents to be removed from the water supply. This technology is not very effective if radium is in low concentration and there is a very limited concentration of other organic and inorganic constituents to be removed from the water supply. Because of its limited application to NJ's waters no further evaluation was made.

Electro-Dialysis Reversal (EDR) Water Treatment Technology

The EDR system operates similarly to an RO system except that selective cation and anion membranes are combined with a direct current (DC) electric field to demineralize or deionize water that is being passed though the unit. The polarity of the dc current is reversed periodically to reverse the direction of the ion movement and provide automatic flushing of the scale forming material on the membrane surfaces. NJAWC piloted an EDR system in the summer of 1999 at their Somers Point Well Station. The EDR system was effective in removing the radium from the water. However, due to significant levels of silica and aluminum present in the raw water it experienced frequent fouling due to excessive scale formation. It required pre-treatment for the aluminum and silica removal. Thus, a full-scale treatment removal has not been proposed at this site.

Pre-Formed Hydrous Manganese Oxide Water Treatment Technology

Radium is a divalent cation (Ra^{+2}) and is an alkaline earth metal behaving very much like calcium and magnesium do in water. Hence, softening techniques were identified as BATs by the USEPA. Pre-Formed Hydrous Manganese Oxide Water Treatment Technology is an alternative to softening. Radium has a natural affinity for manganese dioxide by adsorbing itself onto the surface of the Hydrous Manganese Oxide (HMO). HMO addition to the water supply (unless already present) and subsequent removal of the HMO in conjunction with manganese in an iron and manganese removal process using potassium permanganate in a manganese greensand filtration system will effectively remove the radium. Washington Township MUA piloted the Pre-Formed HMO treatment process at their Well 28 and successfully removed the radium to very low levels, generally less than 1 pCi/L.

Alternate Source / Storage via ASR

Another effective means of mitigating radium in drinking water is the use of alternate sources. This option, when available, is effective and practical. It can be implemented either through a direct replacement of one well for another or combined utilization of an alternate source and Aquifer Storage/Recovery (ASR) system. The two options are described in the following paragraphs.

Alternate Source

Mitigation of radium in groundwater may be accomplished by utilizing alternate sources. A water system that has two or more sources may utilize them exclusively or preferentially, depending on the availability of an alternate source(s) with lower amount(s) of radium present. Typically, however, this impacts the water system's firm capacity[6] and may only be effective for a short period. Another option, if available, is to drill a replacement well(s) in a different aquifer that has been previously demonstrated to not be impacted by radionuclides. Where this option is available, NJDEP has been encouraging water suppliers to opt for the alternate supply instead of treatment. It should be noted however, this option can sometimes result in directing a water system to draw from a water supply critical area aquifer (i.e. the Potomac Raritan Magothy (PRM) aquifer system) which may have an adverse impact on the NJDEP's overall water supply goals.

The Piney Point Aquifer, where available, has been a welcome alternative. This aquifer, however, yields much lower volumes than either the Cohansey or the PRM aquifers and it is not available in all areas as an alternative to the Cohansey. Generally, the Piney Point is not available in western Cumberland County (i.e. Vineland). Where it is available (e.g. eastern Cumberland and part of Atlantic County), it is much deeper, thus more expensive to drill a replacement well. For a small system this could mean that the cost of the replacement well will be 3 to 6 times that of the original well. As a secondary concern, by directing many water suppliers to this aquifer, it may soon be over-drafted, adversely impacting existing users. Also, the State of Delaware's public water systems are extensive users of this aquifer to the point of impacting the piezometric[7] level of the aquifer on the New Jersey's side of the Delaware River.

In Middlesex County, one utility has been able to reduce the radium level in its supply by screening replacement wells in the same aquifer (Farrington Aquifer System), eliminating screens in the upper lenses of the aquifer. Evaluating several wells drilled into the same aquifer identified this option. Two older wells drilled in the upper region of the Old Bridge and Farrington Aquifers exhibited gross alpha activity levels above the MCL. Newer wells screened through the entire depth of the formation exhibited lower gross alpha activity. Hence, the utility has converted one of the older wells to an irrigation well for a nearby golf course and a 2nd well 11 is being converted to an ASR well. This utility has also constructed a new well and is proposing a second new well, both of which penetrate the entire water bearing formation of the aquifer.

[6] Firm capacity is defined as pumping equipment and/or treatment capacity (excluding coagulation, flocculation, and sedimentation treatment) when the largest pumping or treatment unit is out of service

[7] The elevation to which water level rises in a well that taps an artesian aquifer

Aquifer Storage and Recovery (ASR) System

ASR systems are gaining acceptance in New Jersey. Currently there are several in use. Wildwood City Water Department has successfully operated ASR wells since the early eighties, but for solving the problem of saltwater intrusion impacts. Since the early nineties and beyond, more utilities have taken interest in ASR systems primarily to meet water diversion cutbacks imposed by the implementation of Water Supply Critical Areas (1 and 2). In both critical areas, water suppliers opted to replace the lost ground water diversion with surface water purchased from regional water supply projects. In order to optimize the use of the surface supply and still maintain reserve capacity for service area growth, a number of water suppliers have constructed ASR systems. These allow the water suppliers long term storage of treated water in a critical area aquifer. Typically, surface or non-critical area ground water is stored during low demand periods (October through April) by recharging the aquifer. Then during high demand period (June through August) it is recovered at pumping rates 3 to 4 times the recharge rates.

One utility in Middlesex County and one in Ocean County see ASR as potential alternative to radium remediation. The Middlesex water utility proposes to recharge an existing well with water produced by other township wells and purchased surface water during the winter to be later recovered during the summer months to meet high system demands and still retain compliance with firm capacity requirements. The Ocean County water utility proposes three ASR wells. These ASR wells have multi functions. They are in part to recharge Cohansey water with high gross alpha particle activity in the Middle PRM and also recharge iron free water (after treatment) in the Lower PRM water during the winter months to be later retrieved during summer high demand periods. The objective is to allow the radium 224 present in the Cohansey water to decay during the long-term storage to below the gross alpha activity MCL when recovered. When the stored water is retrieved during the high demand periods of summer, the gross alpha activity should be below the MCL. Due to iron clogging manifested during the trial periods, it is uncertain whether this proposal will be successful in the ASR system as proposed.

Waste Disposal

Approval for disposal of radium-containing wastes and back wash water has long been a problem in New Jersey. In the eighties neither Cranberry Run nor the Fairton Federal Prison could obtain NJDEP approval. It only became a major issue in 1999 when NJDEP identified 23 public community water systems exceeding the radionuclides MCLs.

Sanitary Sewer System

The Bureau of Environmental Radiation and the Bureau of Pretreatment and Residuals were solicited for their intervention to establish discharge criteria to a public sanitary sewer system. Among other requirements, N.J.A.C. 7:28-11.2 established the following major discharge criteria:

Solubility	-	Waste is soluble or readily dispersible
Yearly Loading	-	Cumulative radiological loading not to exceed 1 Curie
Instantaneous concentration	-	$Ra_{226}/400 + Ra_{228}/800 + Ra_{224}/70{,}000 \leq 1$ (in pCi/L)

Meeting the above discharge limits is quite challenging for any system when using Ion Exchange (IE) treatment technology. Due to the high concentration of brine used to recharge the IE unit, meeting the solubility requirement during the regeneration step by itself may not be possible. This requirement can only be met if the regeneration waste is held in a holding tank and it is thoroughly mixed with the backwash and rinse wastes. The yearly loading of 1 Curie per year should not cause insurmountable problems unless the treatment plant is very large with unusually high radiological contaminants in its raw water. The instantaneous concentration of $Ra_{226}/400 + Ra_{228}/800 + Ra_{224}/70{,}000 \leq 1$ is likely to be the limiting factor. In particular, a water supply containing Ra 226 at or just below the MCL of 5 pCi/L by itself will not meet the unity equation requirement if it operates the treatment in a normal manner. The only way it could be allowed to discharge would be if it operated the IE less efficiently with frequent regeneration cycles and was allowed to mix its waste with other wastes that may be generated at the plant, such as domestic waste and others. As an example, the City of Vineland was able to get approval for Well 13 only because a major sewer trunk line passes through the property. In this instance, NJDEP gave Vineland mixing credits applied within the sewer line, but has imposed limits on when it can discharge (minimum sewer flow and time of day). Vineland has another well (7) that will not meet the instantaneous concentration discharge using an IE unit. It has performed a desktop evaluation for the use of a concentrator and ultimate disposal of the radioactive waste as a solid. Due to the anticipated very high cost of operating the facility if constructed, it has opted to table the project for now. However, very recently, Vineland has proposed radium treatment at Well 10 via IE and it includes a Radium Selective Complexor (RSC) resin bed to remove radium from the waste-stream so that the liquid waste can be disposed via sanitary sewers. The spent resin is disposed as a low-level radioactive waste discussed herein later.

Ground Water Discharge

Ground water discharge is not very practical due to the severe restriction on the concentration of the discharge. However, there may be instances that such a discharge is feasible, especially for small water systems that may not have any other alternative. The Bureau of Environmental Radiation and the Bureau of Non-Point Pollution Control were solicited for their intervention to establish discharge criteria to ground water via dry well or other means. The bureaus, among other requirements, identified and established the following radiological ground water discharge criteria:

Ground Water Discharge Criteria

Radionuclide	Effluent Concentration (μCi/ml)	Effluent Concentration (pCi/L)
Radium 223	1×10^{-7}	100
Radium 224	2×10^{-7}	200
Radium 225	2×10^{-7}	200
Radium 226	6×10^{-8}	60
Radium 227	3×10^{-4}	300,000
Radium 228	6×10^{-8}	60
Uranium – natural	3×10^{-7}	300

Based on the above ground water discharge criteria it is easily recognized that both radium 226 and radium 228 will present significant problems for most systems that may be utilizing Ion Exchange and Preformed Hydrous Manganese Oxide treatment technologies as means of removing radium. Both of these technologies are typically selected for their removal efficiency. But their wastewater volume, as a result of the efficiency, is in the 1-2% range of water produced. This in turn causes the waste stream to be in concentrated form and to typically contain radium levels in the hundreds of pCi/L, thus eliminating groundwater discharge as a viable option. The only logical treatment alternative would be membrane filtration such as RO. Nanofiltration, a low-pressure RO process, operates at an 80 to 90% recovery, thus except for very poor raw water, radium levels in the waste stream can effectively be maintained within the discharge criteria established above.

Surface Water Discharge

In discussion with the Division of Water Quality, Point Source Permitting Region 2, it appears that surface water discharge is not a viable option. They have no specific standards set for radionuclides. Discharge limits for radioactivity set forth in N.J.A.C. 7:9B-1.14(c) are the drinking water standards. This requirement effectively removes surface water discharge as a viable option for consideration.

Low Level Radioactive (or Solid) Waste Disposal

Except for the brief period of Fairton Federal Prison, low level radioactive waste disposal option had not been considered by any public community water system up to now in New Jersey for radium disposal, primarily due to added capital and disposal costs. Low level radioactive waste disposal is certainly a "downside" but worth considering. Radium selective complexors are now available. Dow Chemicals has a barium-impregnated resin that selectively removes radium from water. Dow Chemicals markets the resin under the trade name "DOW EX-RSC. The radium complexor is an ion exchange resin that is specially designed to selectively remove and store very high quantities of radium on its medium. The RSC resin has a loading capacity of 10 to 20 nanocuries per gram (nCi/g). This high storage characteristic of the RSC resin allows it to be utilized to exhaustion with **no** regeneration. This equates to millions of bed volumes being processed before the resin is exhausted. All that it requires is periodic back washing to remove sediments that may be trapped on the RSC resin. The backwash wastewater from the RSC unit is then passed over a bag filter to remove the sediments that may contain radium residue. The RSC resin and bag filter will remove any radium in the waste stream. Thus, the radium free liquid waste may be safely disposed of via sanitary sewers to a sewage treatment plant.

The RSC resin and the bag filter will need to be replaced upon exhaustion. The spent media is then disposed of as low level radioactive waste. There are several radioactive disposal brokers in New Jersey and the surrounding area. These brokers provide variety of services that include sample analysis, assistance with transferring RSC resin and bag filters from the onsite treatment facilities to appropriate storage containers, shipping the waste to any available disposal site, and preparation of associated paperwork for safe disposal of the solid waste in conformance with NRC and State requirements.

With this type of arrangement it is necessary to have at least one wastewater equalizing tank. The tank will hold and serve to mix waste generated from the backwash, regeneration, and rinse

cycles of the IE unit removing radium from the source water. The waste from the equalizing tank is then slowly released and passed through the RSC resin to remove radium. Radium free effluent from the RSC unit is then discharged to a sanitary sewer. Periodically, the RSC unit will require back washing. The RSC back wash waste is directed to the bag filter to capture any sediments that are removed from the RSC resin during the back-wash. The bag filter effluent is directed into the equalizing tank where it is mixed with other waste from the IE unit(s) and discharged in the sanitary sewer system.

Cost

Construction Cost

The construction cost of radium removal from drinking water ranges widely. It is dependent on options available for the unique situation of the water system. The construction costs presented below were derived from data of permit applications for construction projects reviewed by the BSDW and other cost estimating sources. Construction cost estimates have been adjusted to July 2001 Construction Cost Index (CCI).

Connection to another water system

Connection to another proximate water system typically consists of costs for the actual connection and the purchase of the water itself. The cost to construct a water main and any associated facilities (which at a minimum consists of a meter chamber) is easily defined. It ranges from $30.00 to $70.00 per linear foot depending on the pipe diameter and terrain. If the supplying system's pressure is low, a booster pump station with all its ancillary equipment would have to be built. The cost of the booster station can vary significantly from to $0.3 to $7.8 million depending on the size of the station.

Construction of alternate sources

Construction of alternate sources when available can vary significantly. The cost of a new well is governed by the capacity and the depth, and geology of the aquifer. Likewise, the treatment required to meet drinking water standards will also significantly impact the cost. The BSDW construction projects database reveals that wells that pump less than 100 gallons per minute (gpm) cost from $19,000 to $30,000. Wells between 100 gpm and 500 gpm cost from $124,000 to $480,000. Wells over 700-gpm cost from $200,000 to $1.6 million. If wells require treatment consisting of more than disinfection and corrosion control, a multiplier of 1.5 to 3 should be used to estimate cost.

Construction of an Ion Exchange treatment plant[8]

Assuming the water system is able to provide treatment, the IE cost for a plant less than 100 gpm is from $21,000 to $93,000. The cost for an IE of a plant between 100 gpm and 700 gpm is from $380,000 to $1.1 million. The cost of an IE plant over 700 gpm is from $1 to $1.3 million.

[8] The costs provided were derived from BSDW data. With the exception of the Jamesburg Plant and Vineland's Well 13 Plant, the IE units utilized were for iron and hardness removal.

Construction of a Reverse Osmosis treatment plant

Data on cost to construct reverse osmosis plants is minimal. Thus the figures presented should be viewed as very rough. The cost of an RO plant for less than 100 gpm is from $50,000 to $150,000. The cost of an RO plant between 100 gpm and 700 gpm is from $150,000 to $700,000. The cost of an RO plant over 700 gpm is from $600,000 to $1.1 million. These RO estimates are for the RO modules and associated pumping equipment. They **do not** include the building to house the RO units nor any other ancillary treatment and/or equipment that may be necessary and associated with the provision of an RO treatment system. Furthermore, a good rule of thumb to use to estimate the cost of a typical RO system (not including buildings etc.) is based on the following table in terms of the initial capital cost per gallons of water required per day, assuming 24 hours per day production.

Required Treatment Capacity (gallons/day)	**Initial Capital Cost for RO Unit(s) ($/gallon treat. capacity/day)**
72,000	$1.00 - $1.20
144,000	$0.80 - $1.00
500,000	$0.65 - $0.75
1,000,000	$0.55 - $0.60

A rough estimate of an RO treatment plant including building and ancillary treatment and/or equipment is summarized below:

Nominal Treatment Capacity (gallons/day)	**RO Membrane & Pumping Equipment Cost**	**Building and Ancillary Equipment Etc.**	**Total Plant Capital Cost**
100,000	$ 100,000	$ 175,000	$ 275,000
500,000	$ 350,000	$ 400,000	$ 750,000
1,000,000	$ 600,000	$ 660,000	$ 1,260,000

The Cape May project is a 2-MGD plant and had an actual (1997) cost of $4.2 million which included a new brackish water well, auxiliary power, and a significant wastewater discharge pipeline. The estimated cost of the RO and ancillary equipment is approximately $3.2 million. With advancement of the membrane technology and manufacturing, it should be noted that the cost has decreased during the past five years.

Other Treatment Technologies

There is no cost data readily available on other treatment technologies for the removal of radium. However, it is acknowledged that preformed Hydrous Manganese Oxide (HMO) process could be considered for radium removal. The treatment process involves primarily a continuous feed of HMO and potassium permanganate followed by greensand filtration or similar filtration process. Therefore, the cost of an HMO plant is likely to be very similar to an iron and/or manganese removal plant. A review of the BSDW database reveals the typical cost for iron and manganese removal plant proposed in the past 3 years to be between $ 0.40 to $ 1.00 per gallon of treatment capacity. The larger plants are likely to have the lower unit cost.

Other Costs

There are other costs associated with retrofitting an existing plant that are very difficult to estimate and very site specific. It is evident, that if an IE treatment technology is used, there will most likely be associated with the project a mixing and holding tank if it is to discharge to a sanitary sewer system. Likewise, the site will most likely require significant improvements to accommodate the additional treatment. And at times, the raw water needs to be transported via a raw water pipeline to an alternate site that is practical for the construction of a treatment plant. We have seen this scenario frequently enough to warrant mentioning.

There are other factors that impact the capital cost of a treatment project. No specific cost range is provided because they can vary significantly and are very site specific. These cost variables include land acquisition (when necessary), engineering, legal, and permitting.

Operating Cost

The operating cost of radium removal from drinking water can have a wide range depending on the size of the water system, remedial option implemented, treatment technology used, and disposal method of wastewater or residuals. Also worth mentioning is the cost of monitoring for radionuclides once treatment is provided. For example, NJAWC has spent in excess of $80,000 for radiological monitoring of the their pilot plant and treatment plant during a period of 18 months for their Jamesburg system.

Connection to another system

Operation and maintenance cost for a typical connection to another system is minimal, thus not included in the operation estimates. The big factor for the cost here is the purchase price of the water. The purchase price of water can vary from $1,200 to $3,700 per million gallons (MG) for a bulk purchase contract and $ 2,200 to $3,700 per MG for retail prices.

Operating cost for a typical IE

Operation and maintenance cost for a typical IE can be summarized as follows:

Plant Flow Rate (gpd)	Energy (kwh/yr)			Maintenance Material ($/yr)	Sodium Chloride (lbs)	Labor (hr/yr)	Total Annual O & M Cost[9]
	Building	Process	Total				
100,000	10,500	200	10,700	1,600	250	1,000	$ 52,700
500,000	26,000	900	26,900	4,900	1,000	1,100	$ 62,700
1,000,000	35,000	1,180	37,180	8,000	2,000	1,200	$ 71,900

[9] Electricity – $0.1/kwh; Labor - $50.00/hr; Sodium Chloride - $0.07/lb

Operating cost for a typical RO

Operation and maintenance cost for a typical RO can be summarized as follows:

Plant Flow Rate (gpd)	Energy (kwh/yr)			Maintenance Material ($/yr)		Labor (hr/yr)	Total Annual O & M Cost[10]
	Building	Process	Total	General	RO Repl.		
100,000	10,500	61,500	72,000	1,600	8,300	1,000	$ 67,100
500,000	26,000	164,300	190,300	4,900	29,000	1,100	$ 107,900
1,000,000	35,000	301,800	336,800	8,000	46,000	1,200	$ 147,700

Laboratory Services Cost

While the frequency of monitoring for the Jamesburg system is expected to decrease in the near future, it is anticipated that a water plant that is treating for radionuclides can expect to spend upwards of $14,000 to 22,000 per year.[11]

Waste Disposal Cost

Operation and maintenance cost for a typical waste disposal system depends on option implemented.

Disposal to a sanitary sewer system through a regional sewer authority has minimal operating and maintenance costs thus these are not included in the operation estimates. The big factor for the cost here is the discharge fees charged by the sewer authority. These discharge fees can vary from $2,500 to $4,300 per million gallons (MG) discharged. In order to calculate the flows it is estimated from 1 to 5 percent of the water produced depending on the concentration of the contaminants removed and treatment option selected will be the resultant wastewater volume.

Disposal of the waste via groundwater should have minimal to no operating cost. It's only cost should be monitoring. Thus, no further evaluation was made.

Disposal of radium as a low-level radioactive waste, if a radium complexor is necessary prior to discharge in the sanitary sewer, will greatly increase disposal-operating cost. Disposal of the waste is very much dependent on the availability of sites to take the waste and the demand for such services. The classification of radioactive waste generated by a drinking water plant is expected to be "A Unstable." The current disposal rate for "A Unstable" radium waste ranges from $82 to $319 per cubic foot which does not include any permitting, shipping preparation and transportation services. The $82 to $319 are January 2002 quotes from American Ecology in Washington State and Barnwell in South Carolina. American Ecology also imposes a $2,500 minimum charge and a volume discount of 4% for disposal in excess of 50 cubic feet.

[10] Electricity – $0.1/kwh; Labor - $50.00/hr; RO membrane replacement once every 6 years at 50% of original capital cost

[11] Cost is based on: (1) gross alpha monitoring of the treated water biweekly, raw water quarterly, and monthly monitoring of the waste stream if discharged to a sanitary sewer system, (2) Radium 226 and Radium 226 monitoring of the raw water quarterly and monthly monitoring of the waste stream, and (3) Uranium monitoring when appropriate (typically required in the Sussex Co region). Cost for analyses charged by the DHSS Laboratory are as follows: Gross Alpha - $140.00, Ra 224 - $325.00, Ra 226 – $215.00, Ra 228 - $325.00, and Uranium - $500.00.

The City of Vineland is proposing to treat their Well 10, a 1,200 gpm source, using a radium selective complexor (RSC) resin and bag filters to remove radium from the waste it sends to the regional sanitary sewer system. Vineland's consultant estimates the cost to be from $60,000 to $100,000 per year to dispose of RSC resin and bag filters. Vineland estimates the RSC resin needs a complete change 3 times per year based on a 50% operating time of their Well 10. Vineland's estimates are based on the Spring 2001 quotes received from licensed radioactive waste brokers which include permitting, shipping preparation and transportation services. Vineland anticipates generating 160 to 200 cubic feet per year of "A Unstable" radium waste. Vineland's unit cost including permitting, shipping preparation and transportation is in the range of $375 to $500 per cubic foot.

Annual operation cost for waste disposal[12] can be summarized as follows:

Plant Flow (gpd)	Sewer & Solid Waste (RSC Resin or Similar)			Sewer Only
	Sewer	Solid Waste[13]	Total	
100,000	$ 2,300	$12,000	$ 14,300	$ 2,300
500,000	$11,500	$40,000	$ 51,500	$11,500
1,000,000	$23,000	$80,000	$103,000	$23,000

Cost Summary

The capital and operating cost[14] can be summarized as follows:

1. A 100,000-gallon per day plant is capable of serving a population of 500, or 125 customers. The annualized cost including debt service, capital recovery, maintenance, and operation of a typical radium removal plant ranges from $75,000 to $113,000. Therefore, the annual cost per household served by a **very small** community water system is expected to be between $600 and $900.

2. A 500,000-gallon per day plant is capable of serving a population of 2,500, or 625 customers. The annualized cost including debt service, capital recovery, maintenance, and operation of a typical radium removal plant ranges from $126,000 to $189,000. Therefore, the annual cost per household served by a **small** community water system is expected to be between $200 and $300.

3. A 1,000,000-gallon per day plant is capable of serving a population of 5,000, or 1,250 customers. The annualized cost including debt service, capital recovery, maintenance, and operation of a typical radium removal plant ranges from $202,000 to $304,000. Therefore, the annual cost per household served by a medium size community water system is expected to be between $160 and $240.

[12] Assumes plant is operated 50% of the time, generates 5% waste flow, sewer discharged at $2.50 / 1,000 gallon, and RSC resin disposal cost to be similar to those projected at Vineland's Well 10.
[13] The estimates given are the middle of Vineland's range of $60,000 to $100,000 and include a 50% premium for the 100,000-gpd plant due to anticipated higher per unit cost of smaller plant.
[14] It assumes the radium may be disposed of as a soluble waste via sanitary sewers or septic system not requiring a radium selective complexor.

4. The increase in annual cost per household served by a **large** to **very large** community water system due to economy of scale is expected to be significantly lower than a household served by a small and medium size water system. For example, assume a large water system serving 10,000 customers that is required to treat one of their well stations, say a 1 MGD plant will incur annualized costs similarly as those present in item 3 above. Under this circumstance, the increase annual cost to the household is expected to be between $20 and $30.

Conclusions

1. Currently available treatment technologies such as ion exchange, reverse osmosis, and preformed hydrous manganese oxide can effectively remove radium isotopes including Ra_{224} from drinking water to levels well below current and proposed MCLs with rapid gross alpha testing methodology. The treatment selection will most likely be driven by disposal options;

2. Small community and non-community water systems may not have practical cost effective alternatives. The cost of disposal of the waste, if not allowed to be discharged into the ground and if there are no public sewers available, may be prohibitively high;

3. Site restrictions may limit options available to the water purveyor and are likely to drive the cost up for the solution, possibly requiring raw water transmission to an alternate site suitable for the construction of a water treatment plant;

4. Private wells that draw water from the Cohansey Aquifer and others are also affected by radium in a very significant way. While treatment options are available mainly via a water softener, the impact of the discharge waste into the septic system and possible secondary radiological exposure of the homeowner by being in close proximity to the water softener vessel and/or septic tank requires further evaluation by NJDEP. It may be necessary that the current NJDEP issued Homeowner's Guide to Radionuclides in Drinking Water issued in 1998 may need to be revisited;

5. The increase of annual household cost for radium removal is expected to be less than $20 for customers served by very large community water systems and as much as $900 for customers served by very small community water systems; and

6. The annual amortized and operating cost for a household with its own well requiring radium removal treatment, such as a water softener, is expected to be between $250 and $500. This estimate assumes that the waste is discharged on site through a conventional septic system or dry well.

7. The overall cost impact to New Jersey for removing radium from public drinking water can be summarized as follows:
   - Community water systems would require an initial capital investment approximately $33 million;
   - Non-Community water systems would require an initial capital investment approximately $1.3 million.

- The **additional** impact it would have to treat **private wells** is unpredictable. The costs depend on the occurrence dictated by the number of wells tested. As a rough estimate[15], there is a potential total cost of approximately $25 million.

[15] Based on occurrence data for approximately 900 non-transient water systems extrapolated for an estimated 300,000 private wells.

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13. American Ecology, WA, an informal quote for "A Unstable" radium disposal from Laura Lee Barry, January 18, 2002.

14. Barnwell, SC, an informal quote for "A Unstable" radium disposal through their website at www.chemnuclear.com by Jenny Goodman, NJDEP, January 14, 2002.

Appendix IV-A: Radiological Results (1996-2000 Compliance)
Bureau of Safe Drinking Water

System ID#	*System Name*	*Sample Location*	*Sample Type*	*Date Sampled*	*Gross Alpha*	*Radium 226*	*Radium 228*	*Uranium*
0102001	ATLANTIC CITY MUA	138 N. INDIANA AVE	CP	3/16/2000				
0102001	ATLANTIC CITY MUA	ACMUA INDIANA FIREHO	D	12/20/2000	2.1			
0102001	ATLANTIC CITY MUA	POINT OF ENTRY	P	8/20/1997	3.1			
0102001	ATLANTIC CITY MUA	WELL #12	R	8/20/1997	1.6			
0102001	ATLANTIC CITY MUA	WELL #16	R	8/20/1997	7.2	0.82	1.4	
0102001	ATLANTIC CITY MUA	WELL #17	R	8/20/1997	5.9	0.84	1.4	
0102001	ATLANTIC CITY MUA	WELL #18	R	8/20/1997	3.2			
0102001	ATLANTIC CITY MUA	WELL #19	R	8/20/1997	5			
0102001	ATLANTIC CITY MUA	WELL #20	R	8/20/1997	4.1			
0102001	ATLANTIC CITY MUA	WELL #21	R	8/20/1997	2.6			
0102001	ATLANTIC CITY MUA	WELL #23	R	8/20/1997	2			
0102001	ATLANTIC CITY MUA	WELL #24	R	8/20/1997	2.1			
0102001	ATLANTIC CITY MUA	WELL #15A	R	9/17/1997	-0.04			
0103001	BRIGANTINE WATER	BRIGANTINE MUNI BLDG	D	8/27/1997	0.41			
0103001	BRIGANTINE WATER	1417 BRIGANTINE AV W	CP	5/24/1999				
0104001	CRANBERRY RUN MOBILE	WELLS #1 & #2	P	9/17/1997	78	8.3	7.7	0.25
0104001	CRANBERRY RUN MOBILE	CLUBHOUSE	Q1	12/10/1997	66	6.9	7.5	
0104001	CRANBERRY RUN MOBILE	CLUBHOUSE	Q2	2/10/1998	51	6.5	5.6	
0104001	CRANBERRY RUN MOBILE	COMMUNITY CENTER	Q3F	6/8/1998	72	4.7	5.9	
0104003	BUENA BOROUGH MUA	WELLS #1 & #2 - POE	P	9/17/1997	0.8			
0105001	BUENA FAMILY MANOR	WELL #1 - POE	P	12/10/1997	2.7			
0105002	ALPINE VILLAGE MOBILE HOME	421 MAIN AVE	D	11/16/2000	1.9			
0105002	ALPINE VILLAGE	WELLS #1 & #3 - POE	P	9/17/1997	1.7			
0107001	EGG HARBOR CITY WATER	LIVERPOOLWELLS 5,6,7	P	9/17/1997	-0.07			
0108002	ENGLISH CREEK MANOR	WELLS #1 & #2	P	9/8/1997	8	0.5		
0108002	ENGLISH CREEK MANOR	LAUNDRY ROOM	Q1	12/10/1997	5.5	0.67		
0108002	ENGLISH CREEK MANOR	LAUNDRY ROOM	Q2	2/10/1998	6.5	0.75		
0108002	ENGLISH CREEK MANOR	OFFICE	Q3F	6/8/1998	2.9			
0108002	ENGLISH CREEK MANOR	UNIT #34 ENGLISH/CED	CP	9/9/1998				
0108003	TILTON TERRACE	WELL #3 - POE	P	9/8/1997	1.5			
0108003	TILTON TERRACE	WELL #4 - POE	P	9/8/1997	3.8			
0108003	TILTON TERRACE	WELL #5 - POE	P	9/8/1997	2.8			
0108004	NORMS DALE MOBILE HOME	UNIT#64 OCEAN HTS.AV	CP	5/23/2000				

0108004	NORMSDALE MOBILE HOME	WELL #1 - POE	P	9/8/1997	1.7			
0108004	NORMSDALE MOBILE HOME	WELL #2 - POE	P	9/8/1997	1.5			
0108005	SEAVIEW WATER COMPANY	WELL #1 - POE	P	9/10/1997	-0.11			
0108006	TOWER MOBILE HOMES -	WELL #1 - POE	P	9/8/1997	1.3			
0108006	TOWER MOBILE HOMES -	115 VICTORY DRIVE	CP	11/3/1999				
0108007	STEEPLE CHASE VILLAGE	208 CLAUDETTE PLACE	D	7/19/1901				
0108007	STEEPLE CHASE VILLAGE	WELL #1	P	9/8/1997	6.6	0.34		
0108007	STEEPLE CHASE VILLAGE	WELL #2	P	9/8/1997	6	0.75		
0108008	OCEAN HEIGHTS TRAILER	WELL #3 - POE	P	9/10/1997	4.3			
0108009	STONY FIELD ESTATES	1106 SHERRY ANNE PL.	CP	5/23/2000				
0108009	STONY FIELDS ESTATES	WELLS #1 & #2 - POE	P	9/10/1997	0.95			
0108011	KARL LE MANOR	WELL #1	P	9/10/1997	1.1			
0108011	KARL LE MANOR	WELL #2	P	9/10/1997	1.6			
0108011	KARL LE MANOR	WELL #3	P	9/10/1997	1.6			
0108012	STEEPLECHASE VILLAGE	UNIT #801 SHARKEY PL	CP	6/19/2000				
0108012	STEEPLECHASE VILLAGE -	WELL #4 - POE	P	9/10/1997	7.1	0.8		
0108012	STEEPLECHASE VILLAGE -	WELL #3 - POE	P	9/10/1997	4.6			
0108013	TOWER 1999 MOBILE HOME	UNIT #31 RT 322/40	CP	6/19/2000				
0108013	TOWER 1999 MOBILE HOME	WELL #2 - POE	P	8/27/1997	27	2.9	2.5	
0108013	TOWER 1999 MOBILE HOME	WELL #3 - POE	P	8/27/1997	28	2.7	2.5	
0108013	TOWER 1999 MOBILE HOME	TRAILER #23	Q1	12/10/1997	33	2.3	2.6	
0108013	TOWER 1999 MOBILE HOME	#23	Q2	2/10/1998	28	2.3	2.2	
0108013	TOWER 1999 MOBILE HOME	#29	Q3F	6/8/1998	27	2.1	2.9	
0108013	TOWER 1999 MOBILE HOME	WELL #2 - RAW	SS	12/6/1999	8.3	1.6	1.9	
0108013	TOWER 1999 MOBILE HOME	WELL #3 - RAW	SS	12/6/1999	19	3.2	3.3	0.09
0108014	TOWER EAST MOBILE HOME	WELL #1 - POE	P	8/27/1997	3.5			
0108014	TOWER EAST MOBILE HOME	WELL #2 - POE	P	8/27/1997	4.1			
0108014	TOWER EAST MOBILE HOME	84 PENNSYLVANIA DR	CP	11/3/1999				
0108015	KARL LE MANOR - SYSTEM #2	WELL A	P	9/10/1997	1.4			
0108015	KARL LE MANOR - SYSTEM #2	WELL B	P	9/10/1997	0.79			
0108015	KARL LE MANOR - SYSTEM #2	WELL C	P	9/10/1997	1.3			
0108016	TOWER MOBILE HOMES -	WELL #2 - POE	P	8/27/1997	6.2	1.2		
0108016	TOWER MOBILE HOMES -	25 OXFORD DRIVE	CP	10/14/1999				
0108017	TOWER MOBILE HOMES -	WELL #3 - POE	P	8/27/1997	7.4	0.55		
0108017	TOWER MOBILE HOMES -	157 ATLANTIC AVE	CP	10/14/1999				
0108018	ELMWOOD ESTATES	WELL 31 - POE	P	9/15/1997	1.9			
0108019	OAK FOREST MOBILE HOME	WELLS #1 & #2 - POE	P	9/15/1997	2.3			

0108021	ANDCOVE INCORPORATED	WELL #2 - POE	P	9/15/1997	13	0.93		
0108021	ANDCOVE INCORPORATED	WELL #1 - POE	P	9/15/1997	10	1	0.93	
0108021	ANDCOVE INCORPORATED	OFFICE	Q1	12/10/1997	10	0.94	1	
0108021	ANDCOVE INCORPORATED	OFFICE	Q2	2/10/1998	9.7	0.77	1	
0108021	ANDCOVE INCORPORTAED	OFFICE	Q3F	6/8/1998	11	0.87	1.2	
0108021	ANDCOVE INCORPORATED	125 MARGATE BLVD	CP	12/15/1999				
0108023	EGG HARBOR RIVER BEACH	135 THOMPSON LANE	CP	9/9/1998				
0111004	POMONA MOBILE HOME PARK	523 TURNER AVE	CP	4/5/2000				
0111004	POMONA MOBILE HOME PARK	WELLS #1,#2,#3-POE	P	9/15/1997	17	0.89	2	
0111004	POMONA MOBILE HOME PARK	TRAILER #257	Q1	12/10/1997	15	0.84	2.2	
0111004	POMONA MOBILE HOME PARK	257 PARK AVE	Q2	2/9/1998	19	0.72	2	
0111004	POMONA MOBILE HOME PARK	#257	Q3	6/8/1998	14	0.61	2.1	
0111004	POMONA MOBILE HOME PARK	#257	Q4F	9/14/1998	10	0.82	2.2	
0111006	SHADY PINES MOBILE HOME	WELLS #1 & #2 - POE	P	9/15/1997	3.5			
0111006	SHADY PINES MOBILE HOME	WELLS #3 & #4	P	9/15/1997	4.5			
0111006	SHADY PINES MOBILE HOME	124 SHADY LANE	CP	4/22/1998				
0112001	HAMILTON TOWNSHIP MUA	WELL #5 - POE	P	9/17/1997	1.1			
0112001	HAMILTON TOWNSHIP MUA	WELL #6 - POE	P	9/17/1997	2			
0112001	HAMILTON TOWNSHIP MUA	WELL #8 - POE	P	9/17/1997	3.2			
0112001	HAMILTON TOWNSHIP MUA	WELL #8	USGS	9/22/1997	3.3	0.47		
0112001	HAMILTON TOWNSHIP MUA	WELL #9	NWT	11/12/1997	0.25			
0112002	BLACK HORSE MANOR	234 FILMORE AVENUE	CP	3/16/2000				
0112002	BLACK HORSE MANOR	WELL #1 - POE	P	9/15/1997	7	0.54	0.93	
0112003	INLAND ESTATES	WELL #1 - POE	P	9/15/1997	5.1			
0113001	HAMMONTON WATER	MUNICIPAL BUILDING	Q8	1/5/2000	20	4.2	2.3	0.32
0113001	HAMMONTON WATER	MUNICIPAL BUILDING	Q9F	6/14/2000	14	2.8	1.8	
0113001	HAMMONTON WATER	MUNICIPAL BUILDING	Q1	9/15/1997	15	1.2		
0113001	HAMMONTON WATER	100 CENTRAL AVE	CP	9/25/1997	17			
0113001	HAMMONTON WATER	WELL #5	USGS	10/21/1997	13	2.7	1.6	
0113001	HAMMONTON WATER	MUNICIPAL BUILDING	Q2	12/10/1997	18.9	2	0.96	
0113001	HAMMONTON WATER	MUNICIPAL BUILDING	Q3	2/9/1998	14.2	1.5	0.98	
0113001	HAMMONTON WATER	MUNICIPAL BUILDING	Q4	6/8/1998	14	1.9	1.5	
0113001	HAMMONTON WATER	WELL #1	R	12/10/1998	8	1.1	1.8	
0113001	HAMMONTON WATER	WELL #3	R	12/10/1998	8	0.93	1.4	
0113001	HAMMONTON WATER	WELL #5 - POE	P	12/10/1998	14	2.1	1.4	
0113001	HAMMONTON WATER	WELL #4 - POE	P	12/10/1998	7	2.5	1.8	
0113001	HAMMONTON WATER	MUNICIPAL BUILDING	Q5	3/10/1999	9.6	1.4		

0113001	HAMMONTON WATER	MUNICIPAL BUILDING	Q6	9/28/1999	16	1.8	0.87	0.23
0113001	HAMMONTON WATER	MUNICIPAL BUILDING	Q7	11/1/1999	17	2.3	1.3	0.08
0115001	LONGPORT WATER	MUNICIPAL BUILDING	D	8/27/1997	0.33			
0116001	MARGATE CITY WATER DEPT	BENSON&WINCHESTER	D	12/14/2000	0.1			
0116001	MARGATE WATER	MUNICIPAL BUILDING	D	8/27/1997	0.79			
0116001	MARGATE WATER	NO. DECATUR AVE	CP	5/24/1999				
0117001	MULLICA WOODS	WELLS #1 & #4 - POE	P	9/17/1997	-0.06			
0119001	DELILAH TERRACE	6515 DELILAH RD	D	11/15/2000	2.1			
0119001	DELILAH TERRACE MHP	WELL #3 - POE	P	9/3/1997	4.6			
0119001	DELILAH TERRACE MHP	WELL #2	P	9/3/1997	17	1.6	1.7	
0119001	DELILAH TERRACE MHP	WELL #2 - POE	P	9/3/1997	17			
0119001	DELILAH TERRACE MHP	TRAILER #2074	Q1	12/10/1997	6.2	0.6	0.64	
0119001	DELILAH TERRACE MHP	#2089	Q2	2/10/1998	14	1.7	1.3	
0119001	DELILAH TERRACE MHP	#2062	Q3	6/8/1998	14	1.7	1.8	
0119001	DELILAH TERRACE MHP	2017 1ST STREET	CP	7/30/1998				
0119001	DELILAH TERRACE MHP	#2082	Q4F	9/14/1998	5			
0119002	NJAWC - ATLANTIC	WELL #3 - POE	P	8/25/1997	5.8	0.82		
0119002	NJAWC - ATLANTIC	WELL #9 - POE	P	8/25/1997	27	2.4	3.3	
0119002	NJAWC - ATLANTIC	WELL #6 - POE	P	8/25/1997	12	0.98	1.3	
0119002	NJAWC - ATLANTIC	WELL #8 - POE	P	8/25/1997	9.4	1.2		
0119002	NJAWC - ATLANTIC	WELLS #1A & 1B - POE	P	8/25/1997	1			
0119002	NJAWC - ATLANTIC	WELL #4 - POE	P	8/25/1997	6.3	0.65		
0119002	NJAWC - ATLANTIC	WELL #7 - POE	P	8/25/1997	3.1			
0119002	NJAWC - ATLANTIC	WELLS 2A & 2B - POE	P	8/25/1997	1.5			
0119002	NJAWC - ATLANTIC	WELL #5 - POE	P	8/25/1997	4.1			
0119002	NJAWC - ATLANTIC	WELL #10 - POE	P	8/25/1997	2.5			
0119002	NJAWC - ATLANTIC	CHRIS GAUPP - WELL20	P	9/3/1997	0.01			
0119002	NJAWC - ATLANTIC	TILTON RD - WELL #19	P	9/3/1997	0.27			
0119002	NJAWC - ATLANTIC	MARTINAV WELL 13 POE	P	9/3/1997	1.2			
0119002	NJAWC - ATLANTIC	SPRUCE RD WELLS14&18	P	9/3/1997	4.6			
0119002	NJAWC - ATLANTIC	WELL #12 - POE	P	9/3/1997	7.1	0.29		
0119002	NJAWC - ATLANTIC	WELL #16	P	9/3/1997	9.8	0.71	1.1	
0119002	NJAWC - ATLANTIC	WELL #15 - POE	P	9/3/1997	10	0.62		
0119002	NJAWC - ATLANTIC	WELL #11 - POE	P	9/3/1997	20	0.3		
0119002	NJAWC - ATLANTIC	SOMERS PT MUNI BLDG	Q1	12/10/1997	6.8	0.68		
0119002	NJAWC - ATLANTIC	SOMERS PT MUNI BLDG	Q2	2/10/1998	6.7	0.34		
0119002	NJAWC - ATLANTIC	SOMERS PT MUNI BLDG	Q3	6/8/1998	12	0.38		

0119002	NJAWC - ATLANTIC	WELL #5	USGS	6/30/1998	3.6	0.6		
0119002	NJAWC - ATLANTIC	SOMERS PT MUNI BLDG	Q4F	9/14/1998	10	0.48		
0119002	NJAWC - ATLANTIC	1 No. 1ST	CP	12/2/1999				
0122001	VENTNOR WATER & SEWER	WELLINGTON&LITTLE RK	D	12/6/2000	0.01			
0122001	VENTNOR CITY WATER &	MUNICIPAL BUILDING	D	8/27/1997	0.6			
0122001	VENTNOR CITY WATER &	WELLINGTON & L. ROCK	CP	11/9/1999				
0123001	WEYMOUTH TOWNSHIP MUA	DISTRIBUTION	D	9/17/1997	6.1	0.59	0.83	
0123001	WEYMOUTH TOWNSHIP MUA	1201 N.MADDEN AVENUE	CP	11/3/1999				
0123002	THE OAKS OF WEYMOUTH	WELLS #1 & #2 - POE	P	9/17/1997	0.02			
0201001	ALLENDALE WATER	WELL #11 - POE	P	10/8/1997	3.7			
0201001	ALLENDALE WATER	1 ERIE PLAZA	CP	4/14/1998				
0211001	ELMWOOD PARK WATER	MUNICIPAL BUILDING	D	10/15/1997	0.96			
0211001	ELMWOOD PARK WATER	375 RIVER DRIVE	CP	8/24/1999				
0217001	FAIRLAWN WATER	WELLS 2,7,8,9,15,ETC	POE	10/15/1997	4.4			
0217001	FAIRLAWN WATER	8-01 FAIRLAWN AVE	CP	7/6/1999				
0220001	UNITED WATER - FRANKLIN	WELL #18 - POE	P	10/8/1997	-1			
0220001	UNITED WATER - FRANKLIN	FRANKLIN LAKES RD	CP	6/28/1999				
0221001	GARFIELD WATER	111 OUTWATER LN	D	12/27/2000	0.25			
0221001	GARFIELD WATER	WELLS 1,2,4,5,10,ETC	POE	10/15/1997	3.6			
0221001	GARFIELD WATER	OUTWATER LANE	CP	9/15/1998				
0228001	HO-HO-KUS WATER	HO-HO-KUS BOROUGH	P	10/8/1997	-0.1			
0228001	HO-HO-KUS WATER	340 N.FRANKLIN TWP	CP	4/14/1998				
0231001	LODI WATER DEPARTMENT	MUNICIPAL BUILDING	D	10/15/1997	0.4			
0231001	LODI WATER DEPARTMENT	MAIN STREET& GRAHAM	CP	8/24/1999				
0232001	LYNDHURST WATER DEPT	265 CHASE AVE	D	12/21/2000	0.08			
0232001	LYNDHURST WATER	MUNICIPAL BUILDING	D	10/15/1997	0.3			0
0232001	LYNDHURST WATER	400 WEARL AVE	CP	8/10/1999				0
0233001	MAHWAH WATER	60 ISLAND RD	D	11/30/2000	1.5			
0233001	MAHWAH WATER	WELLS #2 & #4 - POE	P	10/8/1997	0.6			0
0233005	BOGERTS RANCH ESTATES	WELL #1 - POE	P	10/8/1997	3.2			0
0238001	UNITED WATER NJ	HAWORTH PLANT - POE	P	10/15/1997	0.79			0
0239001	PASSAIC VALLEY	214 RIDGE RD	D	12/4/2000	0.25			
0239001	NORTH ARLINGTON WATER	MUNICIPAL BLDG	D	10/15/1997	0.58			
0239001	NORTH ARLINGTON WATER	3 LEGION PLACE	CP	8/10/1999				
0242001	OAKLAND WATER	WELL #10 - POE	P	10/8/1997	-0.7			
0247001	PARK RIDGE WATER	MILL ROAD TP	P	10/15/1997	6.7	0.26		
0247001	PARK RIDGE WATER	53-55 PARK AVENUE	CP	6/23/1999				

0248001	RAMSEY WATER DEPARTMENT	WELLS #1 & #2 - POE	P	10/8/1997	2.2			
0251001	RIDGEWOOD WATER	IRVING WELL - POE	P	10/8/1997	1.8			
0251001	RIDGEWOOD WATER	131 N. MAPLE AVENUE	CP	3/16/1999				
0257001	SADDLE BROOK WATER	MUNICIPAL BUILDING	D	10/15/1997	0.4			
0257001	SADDLE BROOK WATER	252 WEST STREET	CP	8/24/1999				
0264001	WALDWICK WATER	WELL #6 - POE	P	10/8/1997	2			
0264001	WALDWICK WATER	15 E. PROSPECT ST	CP	8/2/1999				
0265001	WALLINGTON WATER	MUNICIPAL BUILDING	D	10/15/1997	1.2			
0265001	WALLINGTON WATER	94 HATHAWAY STREET	CP	8/10/1999				
0303001	BORDENTOWN WATER	MUNICIPAL BUILDING	Q3	1/3/2000	18	1.3	0.7	0.28
0303001	BORDENTOWN WATER	MUNICIPAL BUILDING	Q4F	6/12/2000	16	1.7	2.1	0.39
0303001	BORDENTOWN WATER	324 FARNSWORTH AVE	P	12/4/2000	18	1.2	1.8	0.46
0303001	BORDENTOWN WATER	WELLS #1,2 & 4	P	4/12/1999	6.8	1.7	1.6	
0303001	BORDENTOWN WATER	MUNICIPAL BUILDING	Q1	7/19/1999	20	1.7	1.8	1
0303001	BORDENTOWN WATER	MUNICIPAL BUILDING	Q2	10/5/1999	14	1.8	2	
0305001	BURLINGTON CITY WATER	HIGH & PEARL STREETS	CP	10/1/1997	0.37			
0305001	BURLINGTON CITY WATER	PLANT TREATMENT TAP	P	4/12/1999	0.18			
0306001	BURLINGTON TOWNSHIP	MUNICIPAL BUILDING	Q3	1/3/2000	2.6			
0306001	BURLINGTON TOWNSHIP	MUNICIPAL BUILDING	Q4F	6/12/2000	1.1			
0306001	BURLINGTON TWP WATER	1106 OXMEAD RD	D	4/11/1901	0.53			
0306001	BURLINGTON TOWNSHIP	WELLS #1,2,3,&4-POE	P	4/12/1999	1.4			
0306001	BURLINGTON TOWNSHIP	WELLS #5 & #6 - POE	P	4/12/1999	16	0.97	1.4	0.38
0306001	BURLINGTON TOWNSHIP	WELL #7 - RAW	R	5/3/1999	17	1.8	2.6	0.2
0306001	BURLINGTON TOWNSHIP	MUNICIPAL BUILDING	Q1	7/19/1999	1.6			
0306001	BURLINGTON TOWNSHIP	MUNICIPAL BUILDING	Q2	10/5/1999	0.34			
0307002	ALBERT WAGNER YOUTH	WARD AVENUE	CP	10/9/1997	0.98			
0307002	ALBERT WAGNER YOUTH	WELL #5 - POE	P	4/13/1999	0.96			
0311001	FENIMORE TRAILER PARK	4 KOA CT	CP	1/27/2000				
0311001	FENIMORE TRAILER PARK	WELL #3 - POE	P	4/14/1999	0.45			
0313001	EVESHAM MUA	WELL #13 - POE	P	3/31/1999	0.37			
0314001	FIELDSBORO WATER	MUNICIPAL BUILDING	Q3	1/3/2000	30	1.6	1.3	0.35
0314001	FIELDSBORO WATER	MUNICIPAL BUILDING	Q4F	6/12/2000	12	1.6	1.6	
0314001	FIELDSBORO WATER	MUNICIPAL BUILDING	D	4/12/1999	8.6	1.1	1.4	
0314001	FIELDSBORO WATER	MUNICIPAL BUILDING	Q1	7/19/1999	21	1.4	2.1	0.42
0314001	FIELDSBORO WATER	MUNICIPAL BUILDING	Q2	10/5/1999	10.6	1.3	1.6	
0314001	FIELDSBORO WATER	18 WASHINGTON STREET	CP	12/21/1999				
0315001	FLORENCE TOWNSHIP WATER	MUNICIPAL BUILDING	Q3	1/3/2000	20	0.41	1	0.7

0315001	FLORENCE TOWNSHIP WATER	MUNICIPAL BUILDING	Q4F	6/12/2000	13	0.57	1.1		
0315001	FLORENCE TWP MUNICIPAL	MUNICIPAL BLDG	D	11/29/2000	9.8	0.65	1.1		
0315001	FLORENCE TOWNSHIP WATER	PLANT POE	P	4/12/1999	12	0.61	1.5		
0315001	FLORENCE TOWNSHIP WATER	MUNICIPAL BUILDING	Q1	7/19/1999	19	0.82	0.67	0.26	
0315001	FLORENCE TOWNSHIP WATER	MUNICIPAL BUILDING	Q2	10/5/1999	13	0.35	0.45		
0318001	COLUMBUS WATER COMPANY	190C ATLANTIC AVENUE	CP	7/20/1998					
0318001	COLUMBUS WATER COMPANY	WELL #1 - POE	P	4/14/1999	0.54				
0318002	HOMESTEAD WATER UTILITY	120 HOMESTEAD DRIVE	CP	8/24/2000					
0318002	HOMESTEAD WATER UTILITY	WELL ,#2 - POE	P	4/14/1999	6.4	0.29			
0319001	MAPLE SHADE UTILITIES	PARK AVE WWTP	D	3/14/1901	0.43				
0319001	MAPLE SHADE WATER	WELLS #8 & #11 - POE	P	4/13/1999	0.11				
0320001	MEDFORD TOWNSHIP DEPT OF	26 CORSHAM DRIVE	CP	7/13/1998					
0320001	MEDFORD TOWNSHIP DEPT OF	WELL #10 - POE	P	3/31/1999	0.49				
0320001	MEDFORD TOWNSHIP DEPT OF	WELL #9 - POE	P	3/31/1999	0.85				
0320001	MEDFORD TOWNSHIP DEPT OF	WELL #17 - RAW	NWT	4/13/1999	0.27				
0320002	MEDFORD LEAS	WELL #2 - POE	P	3/31/1999	3.7				
0322001	MOORESTOWN WATER	111 W. SECOND AVE	CP	3/23/2000					
0322001	MOORESTOWN WATER DEPT	601 E. THIRD ST	D	12/11/2000	3.2				
0322001	MOORESTOWN WATER	PLANT TREATMENT-POE	P	4/12/1999	6.7	0.35			
0323001	MOUNT HOLLY WATER	17 PINE STREET	CP	7/25/2000					
0323001	MOUNT HOLLY WATER	GREEN ST TP WELL 3R	P	4/13/1999	3.5				
0324001	MOUNT LAUREL MUA	WELL #6 - POE	P	4/19/1999	1.8				0
0325001	US ARMY - FORT DIX	691 JULIUSTOWN ROAD	CP	3/17/1998	1.5				
0325001	US ARMY - FORT DIX	WELL #5 - POE	P	4/19/1999	1.1				
0325001	US ARMY - FORT DIX	SURFACE WATER PLANT	P	4/19/1999	1.8				
0326001	CALIFORNIA VILLA MHP	#B40	CP	1/12/1999					
0326001	CALIFORNIA VILLA MHP	WELL #1 - POE	P	4/5/1999	1.5				
0326001	CALIFORNIA VILLA MHP	#B40	CP	4/12/1999					
0326002	DEEP WELL TERRACE	#63	CP	3/30/1999					
0326002	DEEP WELL TERRACE	WELL #1A	P	5/3/1999	0.12				
0326002	DEEP WELL TERRACE	WELL #3 - POE	P	5/3/1999	0.3				
0326003	HANOVER EAST APARTMENTS	WELLS #1 & #2 - POE	P	4/5/1999	0.77				
0326003	HANOVER EAST APARTMENTS	221 NEW EGYPT COOKST	CP	11/22/1999					
0326004	HANOVER MOBILE VILLAGE	WELL #2 - POE	P	4/6/1999	0.11				
0326004	HANOVER MOBILE VILLAGE	WELL #1 - POE	P	4/6/1999	1.8				
0326005	CEDAR GROVE APARTMENTS	WELLS #1 & #2 - POE	P	4/5/1999	0.98				
0326006	McGUIRE AIR FORCE BASE	WELL #8 - POE	P	4/6/1999	3				

0326006	MCGUIRE AIR FORCE BASE	VANDENBERG AVENUE	CP	12/14/1999				
0326007	SOUTH'S MOBILE HOME COURT	D2OFF COKKSTWN\NE RD	CP	4/27/1998				
0326007	SOUTH'S MOBILE HOME COURT	WELL #1 - POE	P	4/5/1999	0.75			
0326007	SOUTH'S MOBILE HOME COURT	WELL #2 - POE	P	4/5/1999	0.85			
0326008	SPARTAN VILLAGE MHP	#101	CP	6/11/1998				
0326008	SPARTAN VILLAGE MHP	WELL #2 - POE	P	4/6/1999	0.46			
0326008	SPARTAN VILLAGE MHP	WELL #1 - POE	P	4/6/1999	1.8			
0326009	WAGON WHEEL ESTATES	#208 OFF JONES MILL	CP	5/26/1998				
0326009	WAGON WHEEL ESTATES		P	4/6/1999	0.24			
0326010	CALIFORNIA VILLA MHP #2	WELL #2 - POE	P	4/5/1999	0.69			
0326010	CALIFORNIA VILLA MHP #2	C23	CP	5/3/1999				
0326011	CALIFORNIA VILLA MHP #2	WELL #3 - POE	P	4/5/1999	0.72			
0326012	MILLSTREAM NORTH	WELL #1 - POE	P	4/6/1999	0.54			
0326013	MILLSTREAM SOUTH	JONES MILL ROAD	CP	10/9/1997	0.51			
0326013	MILLSTREAM SOUTH	WELL #1 - POE	P	4/6/1999	0.6			
0326014	LEE MOBILE HOMES	LOT #1 N.E/COOKSTOWN	CP	3/15/2000				
0326014	LEE MOBILE HOMES	WELL #1 - POE	P	4/6/1999	0.32			
0327001	NJAWC - WESTERN DIVISION	SHARPS SCHOOL	Q3	1/18/2000	3.3			
0327001	NJ AMERICAN WATER CO -	SHARPS SCHOOL	Q4F	6/25/2000	2.8			
0327001	NJAWC - WESTERN DIVISION	N27&HAYES - CAMDEN	CP	2/25/1999				
0327001	NJAWC - WESTERN DIVISION	TREATMENT PLANT	P	4/28/1999	0.22			
0327001	NJAWC - WESTERN DIVISION	BEVERLY STATION	P	4/28/1999	1.3			
0327001	NJAWC - WESTERN DIVISION	WELL #14 - POE	P	4/28/1999	16	1.5	2.8	0.15
0327001	NJAWC - WESTERN DIVISION	WELL #32	R	4/28/1999	6	0.56		
0327001	NJAWC - WESTERN DIVISION	POMONA ROAD	R	4/28/1999	12.3	0.73		
0327001	NJAWC - WESTERN DIVISION	LAUREL SPRINGS	R	6/9/1999	0.71			
0327001	NJAWC - WESTERN DIVISION	WELL #27	R	6/9/1999	17	2.1	2.7	0.28
0327001	NJAWC - WESTERN DIVISION	SHARPS SCHOOL	Q1	8/30/1999	3.6			
0327001	NJAWC - WESTERN DIVISION	SHARPS SCHOOL	Q2	11/16/1999	3.6			
0328001	PEMBERTON BOROUGH WATER	WELL #5 - POE	P	3/29/1999	0.32			
0329001	BURLINGTON COUNTY	WELL #8 - POE	P	3/29/1999	1.8			
0329001	BURLINGTON COUNTY	624 PEM/BROWNS MILLS	CP	11/16/1999				
0329002	HILLTOP MOBILE VILLAGE	WELL #1 - POE	P	3/29/1999	0.39			
0329003	LAKE VALLEY WATER	16 SCRAPETOWN RD	CP	7/25/2000				
0329003	LAKE VALLEY WATER	WELL #1 - LAFAYETTE	P	5/3/1999	0.52			
0329003	LAKE VALLEY WATER	WELL #2 - POE	P	5/3/1999	3.5			
0329004	PEMBERTON TOWNSHIP W.D. -	WELL #6 - POE	P	3/29/1999	0.29			

0329004	PEMBERTON TOWNSHIP W.D. -	15 TRENTON RD	CP	4/13/1999				
0329005	PINEVIEW TERRACE	WELL #1 - POE	P	3/29/1999	0.41			
0329006	NJ AMERICAN WATER	226 NORCROSS LANE	CP	7/31/2000				
0329006	NJAWC - SUNBURY	WELL #1 - POE	P	3/29/1999	0.34			
0329007	DEBORAH HEART AND LUNG	11 PINE MILL ROAD	CP	6/11/1998				
0329007	DEBORAH HEART AND LUNG	WELL #2 - POE	P	3/29/1999	0.54			
0329008	PINEFIELD APARTMENTS	900 CONIFER DRIVE	CP	3/15/2000				
0329008	PINEFIELD APARTMENTS	WELL #2	R	5/3/1999	-0.29			
0332001	FAWN LAKE VILLAGE	#97 ARROWHEAD ROAD	CP	4/13/1998				
0332001	FAWN LAKE VILLAGE	#76	D	3/31/1999	3.5			
0332002	OAKVIEW LEISURE VILLAGE	WELL #1 - POE	P	3/31/1999	6.2	1	0.6	
0333001	PINELANDS WATER COMPANY	236 HUNTINGTON DRIVE	CP	5/21/1998				
0333001	PINELANDS WATER COMPANY	WELL #4 - POE	P	5/3/1999	0.12			
0333002	MOBILE ESTATES OF	WELL #1 - POE	P	4/13/1999	0.94			
0333003	RICHARDS MOBILE HOME PARK	766 IRENE LANE	CP	3/15/2000				
0333003	RICHARDS MOBILE HOME PARK	WELL #1 -POE	P	4/13/1999	0.76			
0333004	VINCENTOWN WATER	WELL #1 - POE	P	4/14/1999	0.42			
0335001	ALLENWOOD MOBILE ESTATES	TRAILER #32	CP	4/13/1998				
0335001	ALLENWOOD MOBILE ESTATES		D	3/31/1999	0.51			
0338001	WILLINGBORO MUA	MUNICIPAL BUILDING	Q3	1/18/2000	8.3	0.86	0.97	
0338001	WILLINGBORO MUA	MUNICIPAL BUILDING	Q4F	6/12/2000	1.4			
0338001	WILLINGBORO MUA	TP, MERRIBROOK CIR	P	11/29/2000	3.6			
0338001	WILLINGBORO MUA	398 CHARLESTON ROAD	CP	9/10/1997	6	0.27		
0338001	WILLINGBORO MUA	WELL #5A	NWT	5/26/1998	21	0.85	2.9	0.35
0338001	WILLINGBORO MUA	WELL #1 - POE	P	4/20/1999	12	0.88	1.6	
0338001	WILLINGBORO MUA	MUNICIPAL BUILDING	Q1	7/26/1999	8	0.68	0.58	
0338001	WILLINGBORO MUA	MUNICIPAL BUILDING	Q2	10/5/1999	5.7	0.4	0.37	
0339001	NEW LISBON STATE SCHOOL	ADMIN BUILDING	Q3	2/16/2000	11	0.63	0.26	
0339001	NEW LISBON STATE SCHOOL -	ADMIN BUILDING	Q4F	6/14/2000	14			
0339001	NEW LISBON STATE SCHOOL	WELL #9	R	4/15/1998	6.9	0.8		
0339001	NEW LISBON STATE SCHOOL	WAGNER WELL - POE	P	4/20/1999	7.3	1.3	1.2	
0339001	NEW LISBON STATE SCHOOL	WELL #1 - POE	P	4/20/1999	8.5	0.77		
0339001	NEW LISBON STATE SCHOOL	ADMIN BUILDING	Q1	9/1/1999	12	0.71	0.11	
0339001	NEW LISBON STATE SCHOOL	ADMIN BUILDING	Q2	11/1/1999	19	0.84	0.25	0.26
0339001	NEW LISBON STATE SCHOOL	WALLIN AV & KELLY DR	CP	11/16/1999				
0340001	WRIGHTSTOWN MUA	WELL #3 - POE	P	4/19/1999	0.45			
0340002	MAPLEWOOD APARTMENTS	WELLS #1 & #2 - POE	P	4/6/1999	0.27			

0340002	MAPLEWOOD APARTMENTS	MEANY RD @ 528	CP	12/6/1999				
0404001	BELLMAWR WATER	WELLS #3 & #6 - POE	P	3/3/1999	0.85			
0405001	BERLIN WATER DEPARTMENT	MUNI BLDG	Q3	2/14/2000	2.7			
0405001	BERLIN WATER DEPARTMENT	59 S. WHITE HORSE PK	CP	6/5/2000				
0405001	BERLIN WATER DEPARTMENT	MUNICIPAL BUILDING	Q4F	6/19/2000	6.8	1	0.23	
0405001	BERLIN WATER DEPARTMENT	WELL #12	NWT	10/15/1996	17	3.5		0.24
0405001	BERLIN WATER DEPARTMENT	WELLS #8 & #9 - POE	P	2/17/1999	1.9			
0405001	BERLIN WATER DEPARTMENT	MUNI BLDG	Q1	9/22/1999	2.9			
0405001	BERLIN WATER DEPARTMENT	MUNI BLDG	Q2	10/27/1999	3.2			
0407001	BROOKLAWN WATER	WELL #1,3,&4	P	3/3/1999	1.7			
0408001	CAMDEN CITY WATER	ADMINISTRATION BLDG	Q3	2/14/2000	0.91			
0408001	CAMDEN CITY WATER	ADMIN BUILDING	Q4F	6/19/2000	11	0.09	0.07	
0408001	CAMDEN CITY WATER	DELAWARE AV & ELM ST	CP	1/11/1999				
0408001	CAMDEN CITY WATER	MORRIS DELAIR PLANT	P	3/3/1999	0.58			
0408001	CAMDEN CITY WATER	PARKSIDE PLANT	P	3/3/1999	15	0.98	1	
0408001	CAMDEN CITY WATER	MUNICIPAL BUILDING	Q1	8/30/1999	1.6			
0408001	CAMDEN CITY WATER	MUNICIPAL BUILDING	Q2	11/16/1999	1.8			
0410001	TOWN & COUNTRY MOBILE	#62 OFF CENTER AVE	CP	6/18/1998				
0410001	TOWN & COUNTRY MOBILE	WELL #1 - POE	P	2/17/1999	4.4			
0410001	TOWN & COUNTRY MOBILE	WELL #2 - POE	P	2/17/1999	6.4	1.3	1.1	
0411001	CLEMENTON WATER	WELL #11 - POE	P	3/10/1999	2			
0412001	COLLINGSWOOD WATER	ATLANTIC AVENUE	CP	3/9/1998	3.7			
0412001	COLLINGSWOOD WATER	WELLS #3,#4&#5-POE	P	2/23/1999	4.6			
0414001	GLOUCESTER CITY WATER	WELLS#40&#43 - POE	P	2/23/1999	2.6			
0415002	CONSUMERS NJ WC -	ADMIN BUILDING	Q3	2/2/2000	5.8	1.2	0.46	
0415002	CONSUMERS NJ WC -	ADMIN OFFICE	Q4F	4/11/2000	4.5			
0415002	CONSUMERS NJ WC -	WELL #11R	R	12/3/1997	6.5	2.7		
0415002	CONSUMERS NJ WC -	1946 WILLIAMSTOWN RD	CP	8/17/1998				
0415002	CONSUMERS NJ WC -	WELLS #10 & #11 -POE	P	3/10/1999	3.3			
0415002	CONSUMERS NJ WC -	WELLS #8 & #12	P	3/10/1999	7.7	2.3	0.93	
0415002	CONSUMERS NJ WC -	WELLS 14,15,16 & 17	P	3/10/1999	11	1.6	1.5	
0415002	CONSUMERS NJ WC -	DIVISION OFFICE	Q1	9/22/1999	2.8			
0415002	CONSUMERS NJ WC -	ADMIN OFFICE	Q2	12/1/1999	3.5			
0416001	HADDON TOWNSHIP WATER	135 HADDON AVENUE	CP	2/14/2000				
0416001	HADDON TOWNSHIP WATER	WELLS #2,#3,#4 - POE	P	3/3/1999	2.5			
0417001	HADDONFIELD WATER DEPT	555 CENTER ST	D	11/29/2000	2.1			
0417001	HADDONFIELD WATER	15 N. HADDON AVE.	CP	6/23/1998				

0417001	HADDONFIELD WATER	WELLS #1A,5,7 - POE	P	3/3/1999	1.8			
0424001	MERCHANTVILLE-PENNSAUKE	ADMIN BUILDING	Q4F	2/14/2000	13	0.63	0.56	
0424001	MERCHANTVILLE-PENNSAUKE	BROWNING RD WELL #1	P	3/3/1999	41	1.3	2	
0424001	MERCHANTVILLE-PENNSAUKE	MERCHANTVILLE BORO	Q1	6/22/1999	16	1.4	1.6	0.13
0424001	MERCHANTVILLE-PENNSAUKE	W. COMM BLDG	Q2	7/26/1999	15	1	1.9	
0424001	MERCHANTVILLE-PENNSAUKE	ADMIN BUILDING	Q3	11/16/1999	15	0.87	1.5	0.11
0425001	MOUNT EPHRAIM WATER	MUNICIPAL BUILDING	Q4F	2/2/2000	5.7	0.02	0.2	
0425001	MOUNT EPHRAIM WATER	BORO HALL	D	2/23/1999	10	0.24		
0425001	MOUNT EPHRAIM WATER	MUNICIPAL BUILDING	Q1	6/8/1999	8.5	0.26		
0425001	MOUNT EPHRAIM WATER	MUNICIPAL BUILDING	Q2	7/26/1999	6.4	0.14	0.23	
0425001	MOUNT EPHRAIM WATER	MUNICIPAL BUILDING	Q3	10/27/1999	3.3			
0428002	PINE HILL MUA	MUNI BLDG	Q3	2/2/2000	2.5			
0428002	PINE HILL BOROUGH MUA	48 WEST 6TH AVE.	CP	6/5/2000				
0428002	PINE HILL BOROUGH MUA	PINE HILL BOROUGH	Q4F	6/19/2000	4			
0428002	PINE HILL MUA	40 MAC KNIGHT DR	D	2/21/1901	0.86			
0428002	PINE HILL MUA	WELL #7 - TURNERSVIL	R	1/7/1998	0.69			
0428002	PINE HILL MUA	WELLS #6 & #7	P	3/10/1999	8.7	3.7		
0428002	PINE HILL MUA	MUNI BLDG	Q1	9/22/1999	3.5			
0428002	PINE HILL MUA	MUNI BLDG	Q2	10/27/1999	8.8	0.36	0.2	
0435001	WINSLOW TOWNSHIP MUA -	WELL #6 - POE	P	2/17/1999	0.15			
0435003	WATERFORD TOWNSHIP MUA -	2123 ATCO AVENUE	CP	2/7/2000				
0435003	WATERFORD TOWNSHIP MUA -	108 FENWAY	D	2/17/1999	3.8			
0435003	WATERFORD TOWNSHIP MUA -	#290 FRONT STREET	D	7/14/1999	7.4	1	0.25	
0435375	WATERFORD TWP SCHOOLS	WATERFORD	P	6/1/1999	15	0.22		0.16
0435xxx	WATERBRIDGE COOP	2392 TRICIA COURT	PVT	8/31/1999				
0435xxx	WATERBRIDGE COOP	2362 TRICIA COURT	PVT	8/31/1999				
0436001	ANCORA PSYCHIATRIC	ADMIN BLDG	Q4F	1/12/2000	9.8	2.1	0.3	
0436001	ANCORA PSYCHIATRIC	WOODLAND DRIVE	CP	1/21/1998	10	1.4	0.97	
0436001	ANCORA PSYCHIATRIC	WELL #8 - POE	P	2/17/1999	3.7			
0436001	ANCORA PSYCHIATRIC	MAIN ADMIN BLDG	Q1	6/9/1999	7.4	1.6		
0436001	ANCORA PSYCHIATRIC	MAIN BLDG	Q2	7/14/1999	11	0.64	0.11	
0436001	ANCORA PSYCHIATRIC	ADMINISTRATION BLDG	Q3	10/26/1999	9	0.61	0.15	
0436002	ELMTOWNE VILLAGE	POE	P	2/9/1999	0.64			
0436006	STRAWBERRY VILLAGE	#1	Q4F	1/12/2000	57	6.1	8.6	0.7
0436006	STRAWBERRY VILLAGE	DISTRIBUTION	D	9/11/1996	17	3.2	1.4	
0436006	STRAWBERRY VILLAGE	#25 OFF RT 561	CP	6/18/1998				
0436006	STRAWBERRY VILLAGE	WELLS #1 & #2 - POE	P	2/17/1999	56	6.9	11	

0436006	STRAWBERRY VILLAGE	#1	Q1	6/9/1999	103	9.2	8.4	0.74
0436006	STRAWBERRY VILLAGE	#1 - MAINTENANCE	Q2	7/14/1999	90	5.9	8.3	0.13
0436006	STRAWBERRY VILLAGE	#1	Q3F	10/26/1999	47	6.3	6.9	0.11
0436007	WINSLOW TOWNSHIP MUA -	MUNI BLDG	Q4F	1/12/2000	11	2.7	2	
0436007	WINSLOW TWP MUNICIPAL	131 SICKLERVILLE RD	CP	7/6/2000				
0436007	WINSLOW TOWNSHIP MUA -	WELL #2 - POE	P	2/9/1999	3.8			
0436007	WINSLOW TOWNSHIP MUA -	WELLS #7 & #9 - POE	P	2/9/1999	6.4	2.4	1.2	
0436007	WINSLOW TOWNSHIP MUA -	WELL #3 - POE	P	2/9/1999	8.8	2		
0436007	WINSLOW TOWNSHIP MUA -	WELL #8 - POE	P	2/9/1999	13	1.9	1.4	
0436007	WINSLOW TOWNSHIP MUA -	WELL #4 - POE	P	2/9/1999	30	2.3	2.8	
0436007	WINSLOW TOWNSHIP MUA -	WELL #4 - POE	P	2/17/1999	4.1			
0436007	WINSLOW TOWNSHIP MUA -	MUNI BLDG	Q1	6/9/1999	7.2	1.9	1.8	
0436007	WINSLOW TOWNSHIP MUA -	MUNI BLDG	Q2	7/14/1999	9.8	1.7	1.5	
0436007	WINSLOW TOWNSHIP MUA -	MUNI BLDG	Q3	10/26/1999	5			
0436008	WINSLOW TOWNSHIP MUA - E.	WELL #10 - POE	P	2/9/1999	2.7			
0436009	ELMTOWNE VILLAGE	POE	P	2/9/1999	0.62			
0436010	WINSLOW COURT MHP	412 WILLIAMSTOWN RD	D	7/19/1901				
0501001	AVALON WATER & SEWER	DISTRIBUTION	D	7/14/1997	-0.78			
0501001	AVALON WATER & SEWER	DUNE DRIVE & 30TH	CP	6/16/1999				
0502001	CAPE MAY WATER & SEWER	WELLS #3,#4,#5	R	7/9/1997	1.3			
0502001	CAPE MAY WATER & SEWER	WELL #6 - NWT	NWT	4/28/1998	0.83			
0502001	CAPE MAY WATER & SEWER	WELL #7 - R	NWT	3/1/1999	1.3			
0502001	CAPE MAY WATER & SEWER	643 WASHINGTON ST	CP	6/24/1999				
0503001	BORO OF CAPE MAY POINT	1 DISTRIBUTIONSAMPLE	D	7/9/1997	2			
0504302	NEW JERSEY HIGHWAY	OCEANVIEW-SEAVILLE	NWT	11/9/1999	0.92			
0505001	DEL CAMINO TRAILER PARK	1 POE SAMPLE	P	7/9/1997	0.41			
0505001	DEL CAMINO TRAILER PARK	#8 OFF ROUTE 9	CP	6/22/1999				
0505002	LOWER TOWNSHIP MUA	WELL #3 POE	P	7/9/1997	0.04			
0505002	LOWER TOWNSHIP MUA	WELL #1 - POE	P	7/9/1997	0.92			
0505002	LOWER TOWNSHIP MUA	WELL #2 - POE	P	7/9/1997	1.4			
0505002	LOWER TOWNSHIP MUA	AIRPORT WELL #1 -POE	P	7/9/1997	1.7			
0505002	LOWER TOWNSHIP MUA	WELL #AP2	NWT	11/19/1998	0.9			
0505003	CAPE MAY MOBILE ESTATES	WELL #1 AND #2 POE	P	7/21/1997	-0.55			
0505003	CAPE MAY MOBILE ESTATES	F13 GARRET AVENUE	CP	8/5/1998				
0505005	GREENWOOD CONDO COMPLEX	WELL #2	NWT	11/19/1998	0.57			
0506001	DELSEA WOODS MHP	WELL #1 POE	P	7/21/1997	-1.1			
0506001	DELSEA WOODS MHP	56 MAPLE	CP	8/5/1998				

0506004	EDGEWOOD VILLAGE MHP	POE	P	7/21/1997	-0.64
0506007	GRANDE WOODS MHP	POE	P	7/21/1997	0.14
0506007	GRANDE WOODS MHP	361 GRANDE BLVD	CP	3/18/1998	0.47
0506008	MIDDLE TOWNSHIP WATER	DISTRIBUTION	D	7/21/1997	-1.5
0506008	MIDDLE TOWNSHIP WATER	482 OLD AVALON BLVD	CP	6/2/1999	
0506009	MIDDLE TOWNSHIP WATER	DISTIBUTION	D	7/21/1997	-0.1
0506009	MIDDLE TOWNSHIP WATER	751 STONE HARBOR BVD	CP	6/2/1999	
0506010	NJAWC - NEPTUNE SYSTEM	DISTRIBUTION	D	7/21/1997	0.16
0506010	NJAWC - NEPTUNE SYSTEM	10 S. BOYD ST	CP	6/2/1999	
0506012	PRESIDENTIAL COURTS	DISTRIBUTION	D	7/21/1997	0.11
0506012	PRESIDENTIAL COURTS	MIDDLE TOWNSHIP	CP	3/1/1999	
0506013	A&J MOBILE HOME PARK	WELL #2	R	7/9/1997	0.46
0506013	A&J MOBILE HOME PARK	WELL #1	R	7/9/1997	0.72
0506015	DOMIKE MOBILE HOME PARK	POE	P	7/21/1997	-0.26
0506015	DOMIKE MOBILE HOME PARK	140 MAURICE AVENUE	CP	3/18/1998	1.7
0508001	NJAWC - OCEAN CITY SYSTEM	DISTRIBUTION	D	7/21/1997	-1.5
0508001	NJAWC - OCEAN CITY SYSTEM	WELL #15 - R	NWT	10/13/1998	-0.13
0508001	NJAWC - OCEAN CITY SYSTEM	2901 WEST AVENUE	CP	2/8/1999	
0509001	SEA ISLE CITY WATER	DISTRIBUTION	D	7/14/1997	-0.74
0509001	SEA ISLE CITY WATER	WELL #7	NWT	2/8/1999	0.4
0509001	SEA ISLE CITY WATER	233 JFK BOULEVARD	CP	6/8/1999	
0510001	STONE HARBOR WATER	DISTRIBUTION	D	7/14/1997	-1.6
0510001	STONE HARBOR WATER	11617 2ND AVENUE	CP	10/5/1998	
0511001	NJAWC - STRATHMERE	DISTRIBUTION	D	7/14/1997	-0.38
0511001	NJAWC - STRATHMERE	5 SOUTH	CP	6/8/1999	
0511002	PINE HILL MHP - SYSTEM #1	WELL #1 POE	P	7/23/1997	0.65
0511002	PINE HILL MHP - SYSTEM #1	WELL #1A	NWT	11/10/1998	0.93
0511003	SHORE ACRES MHP	WELLS #1 & #2 POE	P	7/23/1997	1.1
0511003	SHORE ACRES MHP	59 SOUTH DRIVE	CP	6/16/1999	
0511005	PINE HILL MHP - SYSTEM #2	POE	P	7/23/1997	0.63
0511005	PINE HILL MHP - SYSTEM #2	76 BARRINGTON ROAD	CP	6/8/1999	
0511006	PINE HILL MHP - SYSTEM #3	POE	P	7/23/1997	3.2
0511006	PINE HILL MHP - SYSTEM #3	#5 OLMSTEAD ROAD	CP	9/28/1998	
0512001	WEST CAPE MAY WATER	1 DISTRIBUTIONSYSTEM	D	7/9/1997	1.9
0512001	WEST CAPE MAY WATER	732 BROADWAY	CP	6/24/1999	
0513001	WEST WILDWOOD WATER	DISTRIBUTION	D	7/14/1997	-1.5
0513001	WEST WILDWOOD WATER	701 W. GLENWOOD	CP	6/22/1999	

0514001	WILDWOOD WATER	RTE47PUMPSTATION POE	P	7/14/1997	-0.51		
0514001	WILDWOOD WATER	WELL #39 POE	P	7/14/1997	-0.44		
0514001	WILDWOOD WATER	WELL #3 POE	P	7/14/1997	-0.91		
0514001	WILDWOOD WATER	WELL #44 POE	P	7/14/1997	-1.4		
0514001	WILDWOOD WATER	WELL #34 POE	P	7/14/1997	-0.64		
0516001	WOODBINE MUA	809 FRANKLIN AVE	D	5/2/1901			
0516001	WOODBINE MUA	WELLS #6 AND #7 POE	P	7/13/1997	4.5		
0601001	BRIDGETON WATER	PINEY POINT	R	5/8/2000	0.2	0.37	0.02
0601001	BRIDGETON WATER	2 PINEYPT & 1 WELL21	R	5/8/2000	8.9	0.92	1.4
0601001	BRIDGETON WATER	2:PINEY PT 1:WELL#18	R	5/8/2000	5.1	0.88	0.33
0601001	BRIDGETON WATER	2 PINEYPT & 1 WELL14	R	5/9/2000	6.3	1.4	0.7
0601001	BRIDGETON WATER	PINEY POINT	R	5/9/2000	0.25	0.24	-0.1
0601001	BRIDGETON WATER	2:PINEY PT 1:WELL#13	R	5/9/2000	5.2	1.2	1
0601001	BRIDGETON WATER	1:PINEY PT 1:WELL#13	R	5/10/2000	7.8	2	0.69
0601001	BRIDGETON WATER	PINEY POINT	R	5/10/2000	0.43	0.34	-0.12
0601001	BRIDGETON WATER	2:PINEY PT 1:WELL#?	R	5/10/2000	3	0.66	1.3
0601001	BRIDGETON WATER	WELL #11	USGS	6/24/1997	39	4.6	3.9
0601001	BRIDGETON WATER	WELL #14	USGS	6/30/1997	36	3.5	4.9
0601001	BRIDGETON WATER	WELL #2	USGS	7/8/1997	36	3.8	2.5
0601001	BRIDGETON WATER	WELL #17	USGS	7/14/1997	50	1.8	2.5
0601001	BRIDGETON WATER	MUNICIPAL BUILDING	D	7/30/1997	27	3.7	2.8
0601001	BRIDGETON WATER	WELLS #8 & #18 - RAW	R	7/30/1997	29	2.1	3.2
0601001	BRIDGETON WATER	WELL #11 - POE	P	7/30/1997	46	4.2	4.1
0601001	BRIDGETON WATER	WELL #2 - POE	P	7/30/1997	39	3.5	2.8
0601001	BRIDGETON WATER	WELL #14 - POE	P	7/30/1997	36	4.5	3.8
0601001	BRIDGETON WATER	WELL #1A - POE	P	7/30/1997	31	2.1	2.6
0601001	BRIDGETON WATER	WELL #17 - POE	P	7/30/1997	27	2	2.1
0601001	BRIDGETON WATER	WELL #13 - POE	P	7/30/1997	19	2.3	1.9
0601001	BRIDGETON WATER	WELL #17	USGS	10/14/1997	25.5	1.8	2.3
0601001	BRIDGETON WATER	MUNICIPAL BUILDING	Q1	12/8/1997	20	2.3	2.2
0601001	BRIDGETON WATER	MUNICIPAL BLDG	Q2	2/18/1998	19	3.1	2.1
0601001	BRIDGETON WATER	WELL #20	NWT	3/25/1998	21	2.6	2.6
0601001	BRIDGETON WATER	WELL #19	NWT	3/25/1998	55	4	5.7
0601001	BRIDGETON WATER	WELL #21	NWT	5/28/1998	32	3.1	3.5
0601001	BRIDGETON WATER	MUNICIPAL BLDG	Q3F	6/15/1998	24	2.9	2.9
0604001	FORTESCUE REALTY	US POST OFFICE	D	8/4/1997	3.1		
0604001	FORTESCUE REALTY	335 NEW JERSEY AVE	CP	8/18/1997	0.01	0.06	

0605001	FAIRTON OAKS	74 BROOKSTONE DRIVE	CP	3/28/2000				
0605001	FAIRTON TRAILER PARK	WELLS #2 AND #3A-POE	P	8/18/1997	7.4	1.3	1.4	
0605001	FAIRTON TRAILER PARK	WELL #1 - POE	P	8/18/1997	7.7	1.4	1.1	
0605001	FAIRTON TRAILER PARK	LAUNDRY ROOM	Q1	12/17/1997	6.5	0.97		
0605001	FAIRTON TRAILER PARK	LAUNDRY ROOM	Q2	3/4/1998	4.2			
0605001	FAIRTON TRAILER PARK	LAUNDRY	Q3F	6/17/1998	6.4	1.1	0.86	
0605002	TIPS TRAILER PARK	WELL #3 - POE	P	8/13/1997	18	1.9	2	
0605002	TIPS TRAILER PARK	HOUSE NEXT TO WELL#2	D	8/13/1997	5.7	1.5		
0605002	TIPS TRAILER PARK	WELL #1 - POE	P	8/13/1997	17	2	1.6	
0605002	TIPS TRAILER PARK	WELL #3 - POE	EPA	9/29/1997	23			
0605002	TIPS TRAILER PARK	TRAILER #21	Q1	12/8/1997	8.5	1.8		
0605002	TIPS TRAILER PARK	#65	Q2	3/4/1998	20	2.3	1.6	
0605002	TIPS TRAILER PARK	#166	Q3F	6/17/1998	4.8			
0605002	TIPS TRAILER PARK	#197 OFF RTE 49	CP	10/14/1998				
0605004	FAIRTON FEDERAL		R	1/5/2000	28	2.8	3.7	
0605004	FAIRTON FEDERAL	TREATED	SS	1/5/2000	22	2.7	3	
0605004	FAIRTON FEDERAL	DISTRIBUTION	Q1	7/30/1997	15	1.1	0.97	
0605004	FAIRTON FEDERAL	WELLS #1 & #2 - POE	P	7/30/1997	18	0.62	2	
0605004	FAIRTON FEDERAL	POWER HOUSE SINK	Q2	12/8/1997	18	0.79	1.7	
0605004	FAIRTON FEDERAL	POWERHOUSE SINK	Q3	3/4/1998	12	1.1	1.2	
0605004	FAIRTON FEDERAL	POWERHOUSE	Q4F	6/17/1998	14	0.77	1.3	
0605004	FAIRTON FEDERAL		CP	4/19/1999				
0607001	HOPEWELL PLACE	WELL#1 OLD STGCCH RD	R	3/28/2000	43	5.8	5.1	0.28
0609001	NJ STATE PRISON - BAYSIDE	MENS ROOM	D	8/4/1997	-0.12			
0609001	NJ STATE PRISON - BAYSIDE	4293 RTE 47	CP	2/24/1999				
0610001	MILLVILLE WATER	500 COLUMBIA AVENUE	CP	1/4/2000				
0610001	MILLVILLE WATER	RIECH AVENUE	D	4/28/1997	2.2			
0610001	MILLVILLE WATER	MUNICIPAL BUILDING	D	8/18/1997	7.4	1.2		
0610001	MILLVILLE WATER	WELL #4 - POE	P	8/18/1997	8.8	0.84	0.93	
0610001	MILLVILLE WATER	WELL #17 - POE	P	8/18/1997	1.7			
0610001	MILLVILLE WATER	WELL#13,14,15,16-POE	P	8/18/1997	1.9			
0610001	MILLVILLE WATER	BRIDGETONPK WELL POE	P	8/18/1997	11	1.8		
0610001	MILLVILLE WATER	MUNICIPAL BUILDING	Q1	12/17/1997	4.4			
0610001	MILLVILLE WATER	MUNICIPAL BLDG	Q2	3/4/1998	6.5	0.69	0.79	
0610001	MILLVILLE WATER	MUNICIPAL BLDG	Q3F	6/17/1998	7.9	0.81	0.85	
0610002	COUNTRY MEADOWS TRAILER	WELLS #1 & #2 - POE	P	8/18/1997	1.3			
0612001	J & J COMMUNITY PARK	LOT #16 TP LANE	CP	3/21/2000				

0612001	J & J COMMUNITY PARK	WELLS #1 & #2 - POE	P	8/4/1997	121	10.5	10.1
0612001	J & J COMMUNITY PARK	DISTRIBUTION	Q1	8/4/1997	111	10.7	11.2
0612001	J & J COMMUNITY PARK	WELLS #1 & #2 - POE	P	10/1/1997	123		
0612001	J & J COMMUNITY PARK	#16 TRAILER	Q2	12/8/1997	110	9.2	10.2
0612001	J & J COMMUNITY PARK	#16	Q3	3/4/1998	124	11	8.2
0612001	J & J COMMUNITY PARK	#16	Q4F	6/17/1998	98	11	9.1
0613001	SEABROOK WATER COMPANY	WELL #13 - POE	P	8/4/1997	37	5.6	2.6
0613001	SEABROOK WATER COMPANY	DISTRIBUTION	Q1	8/4/1997	31	5.3	2.6
0613001	SEABROOK WATER COMPANY	WELL #12 - POE	P	8/4/1997	34	6.5	3
0613001	SEABROOK WATER COMPANY	RTE 77 -WATER OFFICE	Q2	12/8/1997	24	5	2.5
0613001	SEABROOK WATER COMPANY	OFFICE BLDG	Q3	3/4/1998	29	5.6	2.1
0613001	SEABROOK WATER COMPANY	1116 1ST AVENUE	CP	5/28/1998			
0613001	SEABROOK WATER COMPANY	OFFICE	Q4F	6/15/1998	28	4.5	1.9
0613004	UPPER DEERFIELD VOL FIRE	69 CORNWELL DR	D	2/6/1901	7.2	2.7	2.5
0613004	UPPER DEERFIELD - CARLL'S	COUNTY ADM BLDG RT56	Q1	8/4/1997	9.5	2.8	1.7
0613004	UPPER DEERFOELD - CARLL'S	WELLS #3 & #4 - POE	P	8/4/1997	11	2.4	1.9
0613004	UPPER DEERFIELD - CARLL'S	COUNTY ADMIN BLDG	Q2	12/8/1997	7.5	2.2	2.1
0613004	UPPER DEERFIELD - CARLL'S	COUNTY ADM BLDG	Q3	3/4/1998	9.7	3.4	1.9
0613004	UPPER DEERFIELD - CARLL'S	COUNTY ADMIN BLDG	Q4F	6/15/1998	11	3.4	2
0614002	BERRYMAN'S BRANCH MOBILE	144 BLUEBERRY LANE	CP	1/4/2000			
0614002	BERRYMAN'S BRANCH MOBILE	WELLS #1 & #2 - POE	P	8/13/1997	9.5	1.6	
0614002	BERRYMAN'S BRANCH MOBILE	#7 WINDING WAY-DIST	Q1	12/8/1997	1		
0614002	BERRYMAN'S BRANCH MOBILE	#207 SHIRLEY	Q2	3/31/1998	10	1.6	1.1
0614002	BERRYMAN'S BRANCH MOBILE	OFFICE	Q3F	6/17/1998	11	1.6	1.2
0614002	BERRYMAN'S BRANCH MOBILE	WELL #4	NWT	7/27/1998	6.8	1.1	
0614002	BERRYMAN'S BRANCH MOBILE	WELL #3	NWT	7/27/1998	6.9	1.4	
0614003	CITY OF VINELND WATER	3539 N MILL RD	D	11/15/2000	10	1.9	1.7
0614003	VINELAND WATER & SEWER	3539 N MILL RD	D	11/15/2000	10	1.9	1.7
0614003	VINELAND CITY WATER &	402-04 LANDIS AVENUE	D	4/28/1997	6	1.6	1.9
0614003	VINELAND CITY WATER &	WELL #10	USGS	5/12/1997	24	2.1	2.8
0614003	VINELAND CITY WATER &	WELL #3	USGS	5/19/1997	32	3.4	2.7
0614003	VINELAND CITY WATER &	WELL #9 - POE	P	8/6/1997	22	2.6	2
0614003	VINELAND CITY WATER &	WELL #2 - RAW	R	8/6/1997	17	1.9	1.9
0614003	VINELAND CITY WATER &	WELL #4 - POE	P	8/6/1997	8.6	2.1	1.4
0614003	VINELAND CITY WATER &	WELL #6 - POE	P	8/6/1997	27	2.2	3
0614003	VINELAND CITY WATER &	WELL #5 - POE	P	8/6/1997	27	2.8	2.2
0614003	VINELAND CITY WATER &	WELL #3 - RAW	R	8/6/1997	20	3	1.6

0614003	VINELAND CITY WATER &	WELL #8 - POE	P	8/6/1997	12	1.8	1.3	
0614003	VINELAND CITY WATER &	WELL #7 - POE	P	8/6/1997	8.6	1.3	1.6	
0614003	VINELAND CITY WATER &	WELL #10 - POE	P	8/6/1997	18	2.2	2.9	
0614003	VINELAND CITY WATER &	WELL #11 - POE	P	8/6/1997	9.5	1	1.4	
0614003	VINELAND CITY WATER &	MUNICIPAL BUILDING	D	8/13/1997	14	1.7	2	
0614003	VINELAND CITY WATER &	WELL #14 - POE	P	8/13/1997	13	2	1.8	
0614003	VINELAND CITY WATER &	WELL #12 - POE	P	8/13/1997	38	5.8	3.8	
0614003	VINELAND CITY WATER &	WELL #13 - POE	P	8/13/1997	49	9.3	5.6	
0614003	VINELAND CITY WATER &	WELL #13 - POE	EPA	9/30/1997	51			
0614003	VINELAND CITY WATER &	MUNICIPAL BUILDING	Q1	12/8/1997	14	1.7	1.8	
0614003	VINELAND CITY WATER &	MUNICIPAL BUILDING	Q2	3/31/1998	15	1.6	1.9	
0614003	VINELAND CITY WATER &	MUNICIPAL BLDG	Q3F	6/15/1998	22	2	1.7	
0614003	VINELAND CITY WATER &	1594 WILLIS PLACE	D	10/14/1998	11	1.6	1.1	
0614004	CHAPMANS MOBILE HOME	WELL #4 - POE	P	8/13/1997	9.5	1.2		
0614004	CHAPMANS MOBILE HOME	SALES OFFICE - DIST	Q1	12/8/1997	5.1			
0614004	CHAPMANS MOBILE HOME	SALES OFFICE	Q2	3/30/1998	9.3	1.4	1.3	
0614004	CHAPMANS MOBILE HOME	OFFICE	Q3F	6/15/1998	8.5	1.1	0.94	
0614005	FAIRVIEW MANOR MHP	WELLS #1 & #2 - POE	P	8/13/1997	4.1			
0614009	LAKE ACRES MOBILE HOME	WELLS #1 & #2 - POE	P	8/18/1997	13	1.8	1.5	
0614009	LAKE ACRES MOBILE HOME	#17 GENTILE	Q1	12/17/1997	7.2	1.5	1.1	
0614009	LAKE ACRES MOBILE HOME	#17 GENTILE	Q2	3/31/1998	7.7	1.3	1.5	
0614009	LAKE ACRES MOBILE HOME	#17	Q3F	6/15/1998	9.1	1.4	1.3	
0614009	LAKE ACRES MOBILE HOME	4191 LAKE AVE	CP	11/4/1998				
0701001	NEWARK WATER SUPPLY	429 STEPHENS ST	D	11/27/2000	0.02			
0701001	BELLEVILLE WATER	MUNICIPAL BLDG	D	10/14/1998	0.11			
0701001	BELLEVILLE WATER	407 JORALEMON	CP	12/7/1999				
0702001	BLOOMFIELD WATER	1455 BROAD STREET	CP	8/19/1997	0.51	0.06		
0702001	BLOOMFIELD WATER	1 MUNICIPAL PLAZA	CP	4/20/1998				
0702001	BLOOMFIELD WATER	MUNI BLDG	D	10/7/1998	0.65			
0703001	CALDWELL WATER	MUNI BLDG	D	10/7/1998	0.81			
0703001	CALDWELL WATER	1 PROVOST SQUARE	CP	12/22/1999				
0704001	CEDAR GROVE WATER	525 POMPTON AVE	CP	1/3/2000				
0704001	CEDAR GROVE WATER	MUNI BLDG	D	10/7/1998	0.12			
0704002	ESSEX COUNTY UTILITIES	ADMIN BLDG	Q3*	2/23/2000	48	-0.1	0.12	2.6
0704002	ESSEX COUNTY UTILITIES	125 FAIRVIEW AVENUE	CP	3/14/2000				
0704002	ESSEX COUNTY UTILITIES	ADMIN BLDG	Q4	4/12/2000	3.3			
0704002	ESSEX COUNTY UTILITIES	ADMIN BUILDING	Q5F	6/21/2000	13	1.2	0.19	

0704002	ESSEX COUNTY UTILITIES	WELL #9 - POE	P	10/19/1998	7.5	0.34	
0704002	ESSEX COUNTY UTILITIES	ADMIN BLDG	Q1	9/29/1999	5.6	0.16	-0.01
0704002	ESSEX COUNTY UTILITIES	ADMIN BLDG	Q2	11/17/1999	3.8		
0705001	EAST ORANGE WATER	99 S GROVE ST	D	11/27/2000	8.5	0.27	0.09
0705001	EAST ORANGE WATER	PUMP STATION	P	2/4/1998	3.2		
0705001	EAST ORANGE WATER	ELMWOOD AV&CLINTON S	CP	5/11/1998			
0706001	ESSEX FELLS WATER	MUNICIPAL BLDG	D	10/14/1998	2.1		
0706001	ESSEX FELLS WATER	WELL #17 - POE	P	12/8/1998	4.7		
0707001	FAIRFIELD WATER	MUNI BLDG	D	10/7/1998	0.11		
0708001	GLEN RIDGE WATER	MUNI BLDG	D	10/7/1998	0.89		
0708001	GLEN RIDGE WATER	3 HERMAN STREET	CP	1/4/1999			
0710001	LIVINGSTON TOWNSHIP	WELL #5 - POE	POE	10/19/1998	1.5		
0712001	NJAWC - SHORT HILLS	325 WHITE OAK RIDGE	CP	1/3/2000			
0712001	NJAWC - SHORT HILLS	CANOE BROOK TP - POE	P	3/8/1999	2.4		
0712001	NJAWC - SHORT HILLS	BALTRUSOL12,15,17POE	P	3/8/1999	1.5		
0713001	MONTCLAIR WATER BUREAU	WELL #3 - POE	POE	10/19/1998	4.2		
0714001	PEQUANNOCK WATER SUPPLY	BETH ISRAEL HOSPITAL	D	12/7/2000	0.02		
0714001	NEWARK WATER	PEQUANNOCK TP	POE	7/8/1998	-0.2		
0715001	NORTH CALDWELL WATER	MUNI BLDG	D	10/7/1998	3.3		
0715001	NORTH CALDWELL WATER	136 GOULD AVENUE	CP	12/22/1999			
0716001	NUTLEY WATER DEPARTMENT	228 CHESTNUT STREET	CP	1/3/2000			
0716001	NUTLEY WATER DEPARTMENT	MUNICIPAL BLDG	D	10/14/1998	0.19		
0717001	ORANGE WATER DEPT	300 PARSONAGE HILL R	D	11/27/2000	2.3		
0717001	ORANGE WATER DEPARTMENT	FILTER PLANT	P	2/4/1998	0.42		
0717001	ORANGE WATER DEPARTMENT	419 CENTRAL AVENUE	CP	4/20/1998			
0718001	ROSELAND WATER	MUNICIPAL BLDG	D	10/14/1998	2.9		
0718001	ROSELAND WATER	300 EAGLE ROCK ROAD	CP	4/15/1999			
0719001	SOUTH ORANGE WATER	3RD ST & SLOAN ST	CP	3/29/2000			
0719001	SOUTH ORANGE WATER	MUNI BLDG	D	3/8/1999	3.9		
0720001	VERONA WATER DEPARTMENT	10 COMMERCE CT	D	12/21/2000	0.05		
0720001	VERONA MUA	MUNICIPAL BLDG	D	10/14/1998	0.26		
0720001	VERONA MUA	7 GOULD STREET	CP	4/15/1999			
0721001	WEST CALDWELL W DEPT	30 CLINTON RD	D	12/20/2000	0.07		
0721001	WEST CALDWELL WATER	MUNICIPAL BLDG	D	10/14/1998	0.16		
0721001	WEST CALDWELL WATER	30 CLINTON AVENUE	CP	12/22/1999			
0801001	CLAYTON WATER	MUNI BLDG	Q3	2/7/2000	2.2		
0801001	CLAYTON WATER	MUNI BLDG	Q4F	4/11/2000	2.3		

0801001	CLAYTON WATER	E.HIGH ST @DELSEA DR	CP	5/24/2000				
0801001	CLAYTON WATER	WELL #6	NWT	12/22/1998	18	1.8	3.5	0.5
0801001	CLAYTON WATER	WELL #5 - POE	P	1/27/1999	0.37			
0801001	CLAYTON WATER	WELL #6	NWT	4/12/1999	28	1.6	3.6	0.36
0801001	CLAYTON WATER	MUNI BLDG	Q1	7/28/1999	3.1			
0801001	CLAYTON WATER	MUNI BLDG	Q2	12/1/1999	6.4	0.62	1.2	
0802001	DEPTFORD TOWNSHIP MUA	MUNIC BLDG	Q4	2/22/2000	0.4			
0802001	DEPTFORD TOWNSHIP MUA	MUNICIPAL BUILDING	Q5F	6/13/2000	1.8			
0802001	DEPTFORD TOWNSHIP MUA	1011 COOPER STREET	CP	1/7/1998	24	7.1	2.3	
0802001	DEPTFORD TOWNSHIP MUA	WELL #8 - POE	P	2/3/1999	2.8			
0802001	DEPTFORD TOWNSHIP MUA	WELL #2 - POE	P	2/3/1999	11	0.78	0.77	
0802001	DEPTFORD TOWNSHIP MUA	MUNI BLDG	Q1	6/7/1999	3.1			
0802001	DEPTFORD TOWNSHIP MUA	MUNI BLDG	Q2	7/28/1999	2.6			
0802001	DEPTFORD TOWNSHIP MUA	MUNI BLDG	Q3	11/23/1999	3.1			
0803001	EAST GREENWICH TOWNSHIP	MUNI BLDG	Q4F	2/1/2000	5.6	0.37	0.24	
0803001	EAST GREENWICH TOWNSHIP	21 COHAWKIN RD	CP	4/27/2000				
0803001	EAST GREENWICH TOWNSHIP	WELL #2 - POE	P	1/26/1999	2.7			
0803001	EAST GREENWICH TOWNSHIP	WELL #3 - POE	P	1/26/1999	7.2	0.64	0.7	
0803001	EAST GREENWICH TOWNSHIP	MUNICIPAL BLDG	Q1	6/8/1999	5			
0803001	EAST GREENWICH TOWNSHIP	MUNI BLDG	Q2	7/28/1999	5.7	0.51	0.28	
0803001	EAST GREENWICH TOWNSHIP	MUNI BLDG	Q3	11/23/1999	7.7	2.8	0.13	
0804001	LAUX LAKEVIEW PARK	WELL #3 - POE	P	2/2/1999	0.52			
0804001	LAUX LAKEVIEW PARK	C19 OFF RTE 77	CP	10/6/1999				
0804002	SILVER GATE WATER	WELL #2 - RAW	NWT	1/5/1999	4.9			
0804002	SILVER GATE WATER	WELL #1	NWT	1/5/1999	10	2.7	1.9	
0805001	IONA TRAILER PARK	40 HALE AVENUE	CP	9/21/1998				
0805001	IONA TRAILER PARK	WELL #3 - POE	P	2/2/1999	0.58			
0805002	MALAGA MOBILE HOME PARK	N43 OFF DELSEA DRIVE	CP	4/16/1998				
0805002	MALAGA MOBILE HOME PARK	APARTMENT #31	D	2/2/1999	2.1			
0805003	MALAGA VILLA APARTMENTS	LAUNDRY ROOM	Q4	2/7/2000	11	1.6	1.2	
0805003	MALAGA VILLA APARTMENTS	WELL #2 RT 47	D	5/9/2000	1.9			
0805003	MALAGA VILLA APARTMENTS	MUNICIPAL BUILDING	Q5F	6/13/2000	2			
0805003	MALAGA VILLA APARTMENTS	975 DELSEA DRIVE	CP	4/16/1998				
0805003	MALAGA VILLA APARTMENTS	WELL #1 - POE	P	2/2/1999	14	2.5	1.9	
0805003	MALAGA VILLA APARTMENTS	LAUNDRY OUTSIDE TAP	Q1	6/22/1999	20	3.4	2.6	0.12
0805003	MALAGA VILLA APARTMENTS	LAUNDRY ROOM	Q2	8/23/1999	21	2.8	1.4	0.26
0805003	MALAGA VILLA APARTMENTS	LAUNDRY ROOM	Q3	12/27/1999	2.5			

0806001	GLASSBORO WATER	WELL #8 - MALLARD ST	NWT	1/11/2000	6.6	2	0.41	
0806001	GLASSBORO WATER	WELL #9 MALLARD ST	NWT	1/11/2000	8	1.7	0.91	
0806001	GLASSBORO WATER	WELL #7 - DELSEA DR	NWT	1/11/2000	5.6	1.3	0.97	
0806001	GLASSBORO WATER	27 E. HIGH ST.	CP	5/24/2000				
0806001	GLASSBORO WATER	WELL #6 - POE	P	1/27/1999	0.22			
0807001	GREENWICH TOWNSHIP	MUNI BLDG	Q4F	2/1/2000	24	0.85	1.9	
0807001	GREENWICH TOWNSHIP	WALNUT ST	CP	4/27/2000				
0807001	GREENWICH TOWNSHIP	WELL #6 - POE	P	1/26/1999	12	0.65	1.2	
0807001	GREENWICH TOWNSHIP	WELL #5 - POE	P	1/26/1999	19	0.86	1.7	
0807001	GREENWICH TOWNSHIP	WELL #4 - POE	P	1/26/1999	19	0.27		
0807001	GREENWICH TOWNSHIP	MUNI BLDG	Q1	6/8/1999	29	0.87	1.9	0.26
0807001	GREENWICH TOWNSHIP	MUNI BLDG	Q2	7/28/1999	17	1.1	1.7	0.28
0807001	GREENWICH TOWNSHIP	MUNI BLDG	Q3	11/23/1999	36	1.7	2.5	0.15
0808001	SOUTH JERSEY WATER	120 NORTH MAIN ST	CP	7/17/2000				
0808001	SOUTH JERSEY WATER	WELL #3 - POE	P	2/8/1999	4.9			
0808001	SOUTH JERSEY WATER	WELL #5-WOODLAND AVE	NWT	8/11/1999	5.9	0.48	0.17	
0809001	PENNS GROVE WATER	MUNI BLDG	Q3	2/1/2000	13	0.78	1.1	
0809001	PENNS GROVE WATER	MUNICIPAL BUILDING	Q4F	6/29/2000	27	2.5	3.7	0.62
0809001	PENNS GROVE WATER	WELL #2 - POE	P	1/26/1999	10	1.2	1.9	
0809001	PENNS GROVE WATER	MUNI BLDG	Q1	6/8/1999	26	0.92	1.3	0.26
0809001	PENNS GROVE WATER	LOGAN TWP MUNI BLDG	Q2	12/1/1999	13	0.23	1.4	
0809002	NJAWC - LOGAN SYSTEM	101 BECKETT RD	CP	1/19/2000				
0809002	NJAWC - LOGAN SYSTEM	WELL #3 - POE	P	1/26/1999	0.89			
0809002	NJAWC - LOGAN SYSTEM	WELL #1A - POE	P	1/27/1999	4.2			
0810004	MANTUA TOWNSHIP MUA	397 MAIN ST	D	11/29/2000	0.23			
0810004	MANTUA TOWNSHIP MUA	WELLS #6,#7&#8 - POE	P	2/8/1999	2.9			
0810005	MANOR WATER ASSOCIATIONS	40 LINCOLN AVE	CP	4/11/2000				
0810005	MANOR WATER ASSOCIATIONS	#44	D	2/8/1999	1.8			
0811002	MONROE TOWNSHIP MUA	MUNI BLDG	Q4F	1/11/2000	8	1.4	0.69	
0811002	MONROE TOWNSHIP MUA	WELL #11 - RAW	NWT	2/14/2000	5.3			
0811002	MONROE MUA	1641 RED OAK	D	11/16/2000	3.7			
0811002	MONROE MUA	1641 RED OAK	D	1/24/1901	3.6			
0811002	MONROE TOWNSHIP MUA	WELL #8 - POE	P	2/1/1999	0.83			
0811002	MONROE TOWNSHIP MUA	WELLS #9 & #10	P	2/1/1999	2			
0811002	MONROE TOWNSHIP MUA	WELL #7 - POE	P	2/1/1999	4.9			
0811002	MONROE TOWNSHIP MUA	WELL #5 - POE	P	2/1/1999	7.7	1.4	1.3	
0811002	MONROE TOWNSHIP MUA	WELL #6 - POE	P	2/3/1999	2			

0811002	MONROE TOWNSHIP MUA	MUNI BLDG	Q1	6/7/1999	7.5	0.87	1	
0811002	MONROE TOWNSHIP MUA	MUNI BLDG	Q2	8/16/1999	6.6	1.4	0.9	
0811002	MONROE TOWNSHIP MUA	MUNI BLDG	Q3	10/25/1999	8	1.5	0.74	
0811003	NATIONWIDE MOBILE HOME	SALES OFFICE	Q4F	1/11/2000	14	2.4	1.2	
0811003	NATIONWIDE MOBILE HOME	313 OKLAHOMA AVE	CP	6/15/2000				
0811003	NATIONWIDE MOBILE HOME	WELL #2	P	2/1/1999	17	2.3	1.8	0.21
0811003	NATIONWIDE MOBILE HOME	SALES OFFICE	Q1	6/7/1999	15	2.4	1.2	
0811003	NATIONWIDE MOBILE HOME	OFFICE	Q2	8/16/1999	11.4	1.6	1.5	
0811003	NATIONWIDE MOBILE HOME	SALES OFFICE	Q3	10/25/1999	16	2.5	0.66	0.13
0812001	NATIONAL PARK WATER	WELL #6 - POE	P	2/3/1999	3.8			
0813001	NEWFIELD WATER	18 CATAWBA AVE	CP	6/15/2000				
0813001	NEWFIELD WATER	WELL #3	USGS	9/16/1997	11	1.1	1.3	
0813001	NEWFIELD WATER	WELL #3 RAW	R	1/12/1998	8	0.74	1.1	
0813001	NEWFIELD WATER	MUNICIPAL BLDG	Q1	6/15/1998	12	0.53	1.3	
0813001	NEWFIELD WATER	MUNICIPAL BLDG	Q2	9/14/1998	9.7	1.1	1.4	
0813001	NEWFIELD WATER	MUNICIPAL BUILDING	Q3	12/21/1998	11	1.1	1.6	
0813001	NEWFIELD WATER	MUNI BLDG	Q4F	3/10/1999	6.5	0.44	1.1	
0814001	PAULSBORO WATER	WELL #7 - POE	P	2/8/1999	0.88			
0815001	PITMAN WATER DEPARTMENT	WELL #3 - POE	P	1/27/1999	1.8			
0816001	HARRISONVILLE MOBILE HOME	18 MAPLE AVE	CP	4/11/2000				
0816001	HARRISONVILLE MOBILE HOME	WELL #1 - POE	P	2/2/1999	0.4			
0817001	SWEDESBORO WATER	517 KINGS HIGHWAY	CP	2/3/1998	2.3			
0817001	SWEDESBORO WATER	WELL #4 - POE	P	2/8/1999	3.2			
0818004	WASHINGTON TOWNSHIP MUA	MUA BLDG	Q4F	1/11/2000	4.3			
0818004	WASHINGTON TOWNSHIP MUA	WELL #11	USGS	6/2/1997	23	1.3	1.7	
0818004	WASHINGTON TOWNSHIP MUA	WELL #16 - POE	P	2/2/1999	4.9			
0818004	WASHINGTON TOWNSHIP MUA	WELLS #10 & #11 -POE	P	2/2/1999	12	1.9		
0818004	WASHINGTON TOWNSHIP MUA	WELL #11 - POE	P	2/2/1999	14	2.2	1.7	
0818004	WASHINGTON TOWNSHIP MUA	WELL #10	R	2/2/1999	15	3.8	2.1	
0818004	WASHINGTON TOWNSHIP MUA	MUNI BLDG	Q1	6/7/1999	7	0.94	0.8	
0818004	WASHINGTON TOWNSHIP MUA	MUA BLDG	Q2	8/16/1999	6.8	1.3	0.79	
0818004	WASHINGTON TOWNSHIP MUA	MUA OFFICE	Q3	10/25/1999	7.2	1.3	0.44	
0819001	WENONAH WATER	MUNI BLDG	Q3	2/7/2000	3.6			
0819001	WENONAH WATER	WELL #2 - POE	P	2/8/1999	5			
0819001	WENONAH WATER	WELL #1 - POE	P	3/22/1999	4.6			
0819001	WENONAH WATER	WELL #2 - POE	P	3/22/1999	5.1			
0819001	WENONAH WATER	MUNI BLDG	Q1	6/22/1999	5.4			

0820001	WEST DEPTFORD TOWNSHIP	WELL #6 - POE	P	2/3/1999	1.6	
0821001	WESTVILLE WATER	WELL #5 - POE	P	2/9/1999	2.4	
0822001	WOODBURY CITY WATER	29 DELAWARE ST.	CP	5/16/2000		
0822001	WOODBURY CITY WATER	13 DELAWARE ST	D	12/27/2000	3.8	
0822001	WOODBURY CITY WATER	WELL #6A	NWT	9/10/1997	4.1	0.6
0822001	WOODBURY CITY WATER	WELL #7 - POE	P	1/27/1999	3.7	
0823001	WOODBURY HEIGHTS WATER	WELL #1 - POE	P	1/27/1999	3	
0823001	WOODBURY HEIGHTS WATER	534 ELM AVENUE	CP	9/30/1999		
0824001	CONSUMERS OF NJ	129 ASHBURN WAY	CP	7/17/2000		
0824001	WOOLWICH WATER COMPANY	WELL #1	NWT	12/8/1998	3.4	
0824001	CONSUMERS NJ WC -	WELL #2 - RAW	NWT	1/19/1999	2.9	
0901001	BAYONNE WATER	MUNICIPAL BLDG	D	10/27/1997	-0.03	
0902001	EAST NEWARK WATER	MUNICIPAL BLDG	D	10/27/1997	-0.02	
0902001	EAST NEWARK WATER	34 SHERMAN AVE	CP	6/3/1999		
0904001	HARRISON WATER DEPT	300 PARSONAGE HL RD	D	11/27/2000	0.09	
0904001	HARRISON WATER	MUNICIPAL BLDG	D	10/27/1997	0.13	
0904001	HARRISON WATER	318 HARRISON AVE	CP	6/3/1999		
0905001	HOBOKEN WATER SERVICES	MUNICIPAL BLDG	D	10/27/1997	0.41	
0906001	JERSEY CITY WATER	DPW BLDG	D	10/27/1997	0.11	
0906001	JERSEY CITY WATER	715 SUMMIT DRIVE	CP	2/25/1998	0.45	
0907001	KEARNY WATER SERVICES	570 ELM ST	D	11/27/2000	0.46	
0907001	KEARNY WATER DEPARTMENT	MUNICIPAL BUILDING	D	10/27/1997	0.21	
0907001	KEARNY WATER DEPARTMENT	402 KEARNY AVE	CP	1/13/1999		
1003001	BLOOMSBURY WATER	WELL #2 - POE	P	11/5/1997	0.99	
1004001	CONSUMERS NJ WC - CALIFON	MAIN STREET	CP	03/20/2000		
1004001	CONSUMERS NJ WC - CALIFON	WELLS 3,4& 5 - POE	P	11/5/1997	0.66	
1005001	CLINTON WATER	LILAC DRIVE-WELL#6	P	11/17/1997	8.1	0.01
1005001	CLINTON WATER	WELL #2 - POE	P	11/17/1997	1.2	
1005001	CLINTON WATER	WELL #3 - POE	P	11/17/1997	3.4	
1005001	CLINTON WATER	WELL #1 - POE	P	11/17/1997	3.8	
1005001	CLINTON WATER	MUNICIPAL BLDG	Q1	2/25/1998	7.1	0.32
1005001	CLINTON WATER	NEW STREET	CP	4/2/1998	9.3	0.5
1005001	CLINTON WATER	MUNICIPAL BUILDING	Q2	6/1/1998	7.8	0.57
1005001	CLINTON WATER	MUNICIPAL BLDG	Q3F	8/31/1998	6.3	0.47
1007001	DELAWARE TOWNSHIP MUA	759 CO RT. 523	CP	6/1/2000		
1007001	DELAWARE TOWNSHIP MUA	WELL #1 - POE	P	11/12/1997	1.6	
1007002	ROSEMONT WATER COMPANY	WELLS #1 & #2 - POE	P	11/12/1997	8.9	0.06

1007002	ROSEMONT WATER COMPANY	US POST OFFICE	Q1	2/25/1998	5.2		
1007002	ROSEMONT WATER COMPANY	US POST OFFICE	Q2	6/1/1998	3.3		
1007002	ROSEMONT WATER COMPANY	820 ROSEMONT-RINGOES	CP	6/2/1998			
1007002	ROSEMONT WATER COMPANY	U.S. POST OFFICE	Q3F	8/31/1998	1.4		
1009001	FLEMINGTON WATER	WELL #7 - POE	P	11/17/1997	0.08		
1009001	FLEMINGTON WATER	WELL #1	P	11/17/1997	4.9		
1009001	FLEMINGTON WATER	COURT WELL #5	P	11/17/1997	7.2	0.03	
1009001	FLEMINGTON WATER	REAVILLE WELL #4	P	11/17/1997	10	0.09	
1009001	FLEMINGTON WATER	MUNICIPAL BLDG	Q1	2/25/1998	7.4	0.21	
1009001	FLEMINGTON WATER	MUNICIPAL BUILDING	Q2	6/1/1998	11	0.14	
1009001	FLEMINGTON WATER	MUNICIPAL BLDG	Q3F	8/31/1998	5.7	0.12	
1011001	NJAWC - FRENCHTOWN	TRENTON WELL	P	11/12/1997	12	0.07	
1011001	NJAWC - FRENCHTOWN	RACE STREET WELL	POE	11/12/1997	18	2.2	6.4
1011001	NJAWC - FRENCHTOWN	MUNICIPAL BLDG	Q1	2/25/1998	12	0.44	
1011001	NJAWC - FRENCHTOWN	MUNICIPAL BUILDING	Q2	6/1/1998	11	0.76	
1011001	NJAWC - FRENCHTOWN	MUNI BLDG	Q3	8/31/1998	9.3	0.64	
1011001	NJAWC - FRENCHTOWN	MUNICIPAL BUILDING	Q4F	12/29/1998	11	0.93	
1012001	GLEN GARDNER WATER	MAIN STREET	D	9/4/1997	1.2		
1012001	GLEN GARDNER WATER	WELL #3 - POE	P	11/5/1997	0.52		
1012001	GLEN GARDNER WATER	WELLS #2 & #4 - POE	P	11/5/1997	0.56		
1013001	HAMPTON BOROUGH WATER	WELL #1 - RAW	R	11/5/1997	0.97		
1014001	HIGH BRIDGE WATER	WELL #8 - POE	P	11/5/1997	2.2		
1014001	HIGH BRIDGE WATER	WELL #2	POE	11/5/1997	0.82		
1015002	CONSUMERS NJ WC -	WELL #1 - POE	P	11/17/1997	4.8		
1015003	CONSUMERS NJ WC - RIEGEL	WELL #2 - POE	P	11/12/1997	4.4		
1015003	CONSUMERS NJ WC - RIEGEL	WELL #1	POE	11/12/1997	0.72		
1015003	CONSUMERS NJ WC - RIEGEL	RTE 519&ANDERSON RD	CP	4/2/1998	2		
1015004	CONSUMERS NJ WC - FOX HILL	101 REYNARD DRIVE	CP	2/1/2000			
1015004	CONSUMERS NJ WC - FOX HILL	WELLS #1 & #2	P	11/12/1997	6.8	0.03	
1017001	UWR - LAMBERTVILLE	TREATMENT PLANT	P	11/17/1997	11	0.07	
1017001	UWR - LAMBERTVILLE	MUNICIPAL BLDG	Q1	2/25/1998	0.18		
1017001	UWR - LAMBERTVILLE	74 SOUTH UNION ST	CP	3/2/1998	0.46		
1017001	UWR - LAMBERTVILLE	MUNICIPAL BLDG	Q2	6/1/1998	0.27		
1017001	UWR - LAMBERTVILLE	MUNICIPAL BUILDING	Q3F	8/31/1998	-0.28		
1019001	BUNNVALE WATER COMPANY	43 SUN MOUNTAIN RD	D	11/17/1997	0.35		
1019001	BUNNVALE WATER COMPANY	421 NORTH ROAD	CP	3/2/1998	0.34		
1019002	HAGEDORN CENTER FOR	WELL #1 - RAW	R	11/5/1997	0.63		

1019003	SPRUCE RUN TRAILER PARK	WELL #1 - POE	P	11/5/1997	4.3			
1019003	SPRUCE RUN TRAILER PARK	34B CREGAR ROAD	CP	10/26/1998				
1020001	MILFORD WATER DEPARTMENT	40 FRENCHTOWN RD	CP	6/1/2000				
1020001	MILFORD WATER DEPARTMENT	WELL #2 - POE	P	11/12/1997	4.7			
1020001	MILFORD WATER DEPARTMENT	YORK ROAD - WELL #1	P	11/12/1997	10	0.34		
1020001	MILFORD WATER DEPARTMENT	MUNICIPAL BUILDING	Q1	2/25/1998	5.2			
1020001	MILFORD WATER DEPARTMENT	MUNICIPAL BUILDING	Q2	6/1/1998	10	0.32		
1020001	MILFORD WATER DEPARTMENT	MUNI BLDG	Q3F	8/31/1998	7.8	0.28		
1023001	STOCKTON WATER	12 BRIDGE ST.	CP	6/1/2000				
1023001	STOCKTON WATER	WELL #1	R	11/12/1997	1.2			
1025001	EDNA MAHAN CORRECTIONAL	RTE 513 & I78	CP	2/1/2000				
1025001	EDNA MAHAN CORRECTIONAL	WELL #1 - POE	P	11/5/1997	3.5			
1101002	EAST WINDSOR MUA	MUNI BLDG	Q4F	1/4/2000	0.84			
1101002	EAST WINDSOR MUNICIPAL	7 WILTSHIRE DR	D	9/6/2000		0.99	1.7	
1101002	EAST WINDSOR MUNICIPAL	HICKORY CORNER RD	D	7/19/2001				
1101002	EAST WINDSOR MUA	CRANBURY RD - WELL#7	POE	4/22/1998	6.3	0.55		
1101002	EAST WINDSOR MUNICIPAL	WELL#8	NWT	8/13/1998	1.5			
1101002	EAST WINDSOR MUA	WELL #2 - POE	P	2/3/1999	12	0.86	1.8	
1101002	EAST WINDSOR MUA	MUNI BLDG	Q1	5/25/1999	8.6	0.67	0.97	
1101002	EAST WINDSOR MUA	MUNI BLDG	Q2	7/13/1999	6.6	0.83	1.1	
1101002	EAST WINDSOR MUA	MUNI BLDG	Q3	10/6/1999	5			
1103001	CONSUMERS NJ WC -	WELL#11 PARK AVE RAW	USGS	4/5/2000	15	2.1	2.6	
1103001	CONSUMERS NJ WC -	EXXON STN. RTE.33 D	USGS	4/5/2000	20	1.3	2.4	
1103001	CONSUMERS NJ WATER CO -	ROBERT FROST #10	D	6/28/2000	2			
1103001	CONSUMERS NJ WATER CO -	DAYSON AVE. WELL #13	SS	6/28/2000	7.7	1	0.38	
1103001	CONSUMERS NJ - HAMILTON	PARK AVE WELL #11	SS	6/28/2000	13	1.7	2.3	
1103001	CONSUMERS NJ WC -	PARK AVE WELL	POE	4/22/1998	14	1.3	2	
1103001	CONSUMERS NJ WC -	RTE 33/WHORSE EXXON	Q1	9/2/1998	30	1.3	2.1	
1103001	CONSUMERS NJ WC -	EXXON STATION RTE 33	Q2	12/9/1998	15	0.81	1.7	
1103001	CONSUMERS NJ WC -	WHITEHORSE-MERCER RD	Q3	3/1/1999	18	1.5	1.5	
1103001	CONSUMERS NJ WC -	WELL #11 - PARK AVE	P	3/24/1999	14	1.2	2.5	
1103001	CONSUMERS NJ WC -	WELL #10 - POE	P	3/24/1999	4.7			
1103001	CONSUMERS NJ WC -	WELL #12 - PAXSON AV	P	3/24/1999	9.9	1.2	1.6	
1103001	CONSUMERS NJ WC -	PAXSON AVENUE #9	R	3/24/1999	31	1.3	2.4	0.28
1103001	CONSUMERS NJ WC -	22 MILL BEND ROAD	Q3-2	3/30/1999	13	0.58	1.3	
1103001	CONSUMERS NJ WC -		Q4	5/24/1999	13	0.75	1.4	0
1103001	CONSUMERS NJ WC -	RTE #33 - EXXON	Q5	7/13/1999	15	1.1	1.9	0

1103001	CONSUMERS NJ WC -	RTE 33 - EXXON	Q5-2	9/17/1999	15	1.1	1.9	0
1103001	CONSUMERS NJ WC -	MUNI BLDG	Q6F	10/6/1999	16	0.41	0.28	0.5
1104001	HIGHTSTOWN WATER	TREATMENT PLANT- POE	POE	4/22/1998	2.7			
1105001	HOPEWELL BORO WATER	WELL #4	R	4/27/1998	2.5			
1105001	HOPEWELL BORO WATER	WELL #5 - POE	P	4/27/1998	50	2.5		36.2
1105001	HOPEWELL BORO WATER	WELL #2 - POE	P	4/27/1998	77	6	0.82	39.5
1105001	HOPEWELL BORO WATER	WELL #6	R	4/27/1998	6.3	0.25		
1105001	HOPEWELL BORO WATER	MUNI BLDG	Q1	9/2/1998	37	2.3		28.7
1105001	HOPEWELL BORO WATER	MUNICIPAL BUILDING	Q2	12/7/1998	19	2.3	0.95	8.2
1105001	HOPEWELL BORO WATER	MUNI BLDG	Q3	3/1/1999	37	2.3	0.72	13.7
1105001	HOPEWELL BORO WATER	MUNI BLDG	SS	7/20/1999	35	2	0.18	7.2
1105001	HOPEWELL BORO WATER	WELLS #2 & #5 - POE	SS	7/20/1999	41	4.9	0.94	36.2
1105001	HOPEWELL BORO WATER	MUNICIPAL BLDG	Q4F	9/20/1999	27	2.5	0.3	10.2
1106001	HOPEWELL TOWNSHIP WATER	WELLS #2 & #3 - POE	POE	4/22/1998	7.2	0.11		
1106002	MERCER COUNTY	RT 29	CP	4/25/2000				
1106002	MERCER COUNTY	WELLS #3 & #4	POE	4/27/1998	1.3			
1107001	LAWRENCEVILLE SCHOOL	WELL #1	POE	4/22/1998	3.2			
1107002	LAWRENCEVILLE WATER	66 PHILLIPS AVENUE	CP	1/6/2000				
1107002	LAWRENCEVILLE WATER	WELL #6 - POE	POE	4/22/1998	2.2			
1108001	PENNINGTON WATER	MUNICIPAL BLDG	Q1	9/2/1998	6.9	0.07		
1108001	PENNINGTON WATER	MUNICIPAL BUILDING	Q2	12/7/1998	8.1	0.14		
1108001	PENNINGTON WATER	MUNI BLDG	Q3	3/1/1999	7.3	0.22		
1108001	PENNINGTON WATER	MUNI BLDG	Q4F	5/24/1999	8.2	-0.03		
1108001	PENNINGTON WATER	MUNI BLDG	SS	7/20/1999	8.4	0.13	0.02	
1108001	PENNINGTON WATER	WELL #7 - POE	SS	7/20/1999	8.6	0.24	0.02	
1111001	TRENTON WATER	BEAR TAVERN RD & I95	CP	12/1/1997	0.19			
1111001	TRENTON WATER	POE	POE	4/22/1998	0.48			
1204001	EAST BRUNSWICK WATER	485 CRANBURY RD	CP	1/5/2000				
1204001	EAST BRUNSWICK WATER	MUNICIPAL BLDG	D	1/12/1999	0.26			
1205001	EDISON WATER COMPANY	7 LANGSTAFF AVENUE	CP	1/20/2000				
1205001	EDISON WATER COMPANY	MUNICIPAL BLDG	D	1/13/1999	0.49			
1206001	HELMETTA WATER	MUNICIPAL BUILDING	D	1/20/1999	0.53			
1207001	HIGHLAND PARK WATER	220 FIFTH AVE	CP	1/5/2000				
1207001	HIGHLAND PARK WATER	MUNICIPAL BLDG	D	1/13/1999	0.18			
1208001	NJ AMERICAN WATER CO -	FINISHED TAP	SS	5/23/2000	1.3	-0.06	0.16	
1208001	NJ AMERICAN WATER CO -	WASTEWATER	SS*	5/23/2000	360	149	340	
1208001	NJ AMERICAN WATER CO -	MUNICIPAL BUILDING	Q	6/27/2000	4.4			

1208001	NJAWC - JAMESBURG	W. RAILROAD/HILLSIDE	CP	12/22/1997	27	1.3	3.3	
1208001	NJAWC - JAMESBURG	MUNI BLDG	Q1	12/14/1998	33	2.1	4.1	
1208001	NJAWC - JAMESBURG	WELL #6	R	1/20/1999	20	2.4	4.6	
1208001	NJAWC - JAMESBURG	WELL #7 - POE	P	1/20/1999	34	2.2	5.1	
1208001	NJAWC - JAMESBURG	MUNI BLDG	Q2	3/1/1999	24	2.3	4.9	
1208001	NJAWC - JAMESBURG	MUNI BLDG	Q3	5/25/1999	57	1.8	4.4	
1208001	NJAWC - JAMESBURG	MUNI BLDG	Q4	7/13/1999	36	2.4	5.7	0.18
1208001	NJAWC - JAMESBURG	MUNI BLDG	Q5F	10/6/1999	35	2.8	5	0.24
1209002	OLD BRIDGE MUA	THROCKMORTON LANE	CP	9/29/1998				
1209002	OLD BRIDGE MUA	BROWNTOWN PLANT	P	1/20/1999	0.66			
1209002	OLD BRIDGE MUA	WELLS #10 & #12	P	1/20/1999	0.68			
1212001	MILLTOWN WATER	SOUTH MAIN STREET	CP	3/26/1998	1.1			
1212001	MILLTOWN WATER	MUNICIPAL BUILDING	D	1/12/1999	0.26			
1213002	MONROE TOWNSHIP MUA	WELL #20 - RAW	NWT	1/13/2000	4.4			
1213002	MONROE TOWNSHIP MUA	MUNICIPAL BUILDING	D	8/23/2000	3.6			
1213002	MONROE TOWNSHIP MUA	PERRINE../SCHOOL..RD	D	12/22/1997	20	2	3	
1213002	MONROE TOWNSHIP MUA	WELL #16A	POE	2/2/1998	14	2	3.5	
1213002	MONROE TOWNSHIP MUA	MUNICIPAL BLDG	Q1	6/22/1998	15	1.2	2.7	
1213002	MONROE TOWNSHIP MUA	MUNI BLDG	Q2	9/2/1998	18	1.6	3	
1213002	MONROE TOWNSHIP MUA	MUNI BLDG	Q3	12/14/1998	17	2.3	3.1	
1213002	MONROE TOWNSHIP MUA	MUNI BLDG	Q4F	1/11/1999	15	2.1	3.8	
1213002	MONROE TOWNSHIP MUA	WELL #5 - POE	P	1/11/1999	34	3.4	5.7	
1213002	MONROE TOWNSHIP MUA	WELL #19	P	1/11/1999	17	2.3	2.6	
1213002	MONROE TOWNSHIP MUA	WELL #8A	P	1/11/1999	16	2.1	4.3	1.2
1213002	MONROE TOWNSHIP MUA	WELL #17 - POE	P	1/11/1999	13	1.9	2.4	
1213002	MONROE TOWNSHIP MUA	WELL #11 - POE	P	1/11/1999	44	2.9	5.4	
1213002	MONROE TOWNSHIP MUA	WELL #18A	P	1/12/1999	2.4			
1214001	NEW BRUNSWICK WATER	180 SOMERSET ST	D	12/28/2000	0.28			
1214001	NEW BRUNSWICK WATER	PLANT TREATMENT TAP	P	1/12/1999	0.46			
1215001	NORTH BRUNSWICK TWP	1150 NEWTON ST	D	12/5/2000	0.07			
1215001	NORTH BRUNSWICK WATER	710 HERMAN ROAD	CP	3/19/1998	0.24			
1215001	NORTH BRUNSWICK WATER	PLANT TREATMENT TAP	P	1/12/1999	0.1			
1216001	PERTH AMBOY DEPT OF MUNIC	MUNI BLDG	Q4F	1/4/2000	3.6			
1216001	PERTH AMBOY DEPT OF MUNIC	WELLS # 6 & #9	P	1/13/1999	27	0.87	1.6	
1216001	PERTH AMBOY DEPT OF MUNIC	MUNI BLDG	Q1	6/14/1999	9.2	0.68		
1216001	PERTH AMBOY DEPT OF MUNIC	MUNI BLDG	Q2	7/21/1999	10	0.49	1.3	
1216001	PERTH AMBOY DEPT OF MUNIC	MUNI BLDG	Q3	10/12/1999	1.3			

1216001	PERTH AMBOY DEPT OF MUNIC	MUNI BLDG	Q3-2	11/9/1999	16	1	2.2	0.14
1219001	SAYREVILLE WATER	WELLS I & L	R	2/2/1998	27	0.3	1	
1219001	SAYREVILLE WATER	MUNICIPAL BLDG	Q1	6/22/1998	25	0.59		0.31
1219001	SAYREVILLE WATER	MUNICIPAL BUILDING	Q2	9/22/1998	14	0.46	0.56	
1219001	SAYREVILLE WATER	WELL I & L	R	9/22/1998	40	2.2	4.9	
1219001	SAYREVILLE WATER	167 MAIN STREET	CP	9/29/1998				
1219001	SAYREVILLE WATER	MUNI BLDG	D	10/13/1998	32	0.1		
1219001	SAYREVILLE WATER	WELL I - POE SS	R S	10/13/1998	50	5.1	5.3	
1219001	SAYREVILLE WATER	MUNICIPAL BLDG	Q3	12/16/1998	3.8			
1219001	SAYREVILLE WATER	MORGAN PLANT	P	1/13/1999	52	2.9	7.5	
1219001	SAYREVILLE WATER	MUNICIPAL BUILDING	Q4F	1/13/1999	23	0.47		
1219001	SAYREVILLE WATER	MUNI BLDG	SS	9/13/1999	22	0.78	0.26	0.16
1219001	SAYREVILLE WATER	DUHERNAL POE	SS	9/13/1999	20	0.58	0.29	0.34
1220001	SOUTH AMBOY WATER	140 N. BROADWAY	CP	1/20/2000				
1220001	SOUTH AMBOY WATER	MUNI BLDG	Q1	1/13/1999	13	-0.11		
1220001	SOUTH AMBOY WATER	MUNI BLDG	Q2	6/14/1999	11	0.41		
1220001	SOUTH AMBOY WATER	MUNI BLDG	Q3	7/21/1999	11	-0.03	0.18	
1220001	SOUTH AMBOY WATER	MUNI BLDG	Q4F	11/9/1999	11	0.46	0.08	
1221004	SOUTH BRUNSWICK TWP	MUNI BLDG	Q6	2/22/2000	2.6			
1221004	SOUTH BRUNSWICK TWP	KINGSTON LN&RIDGE RD	CP	3/27/2000				
1221004	SOUTH BRUNSWICK TWP	MUNIC BLDG	Q7F	4/12/2000	2.1			
1221004	SOUTH BRUNSWICK TWP	WELL #11 POE	USGS	4/24/2000	19	1.5	4	
1221004	SOUTH BRUNSWICK TWP	WELL #11 RAW	USGS	4/24/2000	23	1.7	4.1	
1221004	SOUTH BRUNSWICK TWP	#11 DISTRIBUTION	USGS	4/24/2000	2.7	0.08	0.1	
1221004	SOUTH BRUNSWICK TWP	WELL #13	USGS	4/25/2000	21			
1221004	SOUTH BRUNSWICK TWP	WELL #13 RAW	USGS	4/25/2000	24	2.9	4.2	
1221004	SOUTH BRUNSWICK	MUNICIPAL BUILDING	Q8F	6/20/2000	1.4			
1221004	SOUTH BRUNSWICK TWP	WELL #11	R	2/2/1998	29	1.2	4.3	
1221004	SOUTH BRUNSWICK TWP	MUNI BLDG	Q1	6/22/1998	7.4	0.99	2	
1221004	SOUTH BRUNSWICK TWP	MUNICIPAL BLDG	Q2	9/2/1998	7.6	1.1	1.6	
1221004	SOUTH BRUNSWICK TWP	MUNI BLDG	Q2-2	9/22/1998	5.3			
1221004	SOUTH BRUNSWICK TWP	WELL #11	P	9/22/1998	17	1.3	3.4	
1221004	SOUTH BRUNSWICK TWP	WELL #11	R	10/13/1998	26	0.75	3.2	
1221004	SOUTH BRUNSWICK TWP	MUNI BLDG	SS	10/13/1998	8.4	0.56	1.4	
1221004	SOUTH BRUNSWICK TWP	WELL #11 - POE	P	10/13/1998	18	0.61	3.1	
1221004	SOUTH BRUNSWICK TWP	MUNICIPAL BUILDING	Q3	12/14/1998	7.1	0.92	1.5	
1221004	SOUTH BRUNSWICK TWP	MUNI BLDG	Q4	1/12/1999	18	2.4	3	

1221004	SOUTH BRUNSWICK TWP	WELL 13 - POE	P	1/12/1999	21	2.9	4	0.69
1221004	SOUTH BRUNSWICK TWP	WELL #15	P	1/12/1999	0.52			
1221004	SOUTH BRUNSWICK TWP	MUNI BLDG	Q5	11/9/1999	8.2	0.61	1.2	
1221004	SOUTH BRUNSWICK TWP	MUNI BLDG	Q5-2	12/27/1999	5.8	0.01	0.37	
1223001	SOUTH RIVER WATER	61 MAIN STREET	CP	1/5/2000				
1223001	SOUTH RIVER WATER	WELLS 2,5,6,CISTERN	P	1/20/1999	0.59			
1224001	SPOTSWOOD WATER	WELL #3	P	1/20/1999	0.46			
1224001	SPOTSWOOD WATER	WELLS #4 & #5 - POE	P	1/20/1999	23	2.3	5.4	
1224001	SPOTSWOOD WATER	MUNI BLDG	Q1	5/25/1999	10	0.3	1.2	
1224001	SPOTSWOOD WATER	MUNI BLDG	Q2	7/13/1999	6.6	0.62	0.31	
1224001	SPOTSWOOD WATER	MUNI BLDG	Q3F	9/17/1999	6.6	0.62	0.31	
1225001	MIDDLESEX WATER COMPANY	WOODBRIDGE MUNI BLDG	Q4F	1/4/2000	5			
1225001	WOODBRIDGE MUNICIPAL BLDG	MAIN ST	D	10/17/2000	4.7			
1225001	MIDDLESEX WATER COMPANY	1 MAIN ST	D	10/17/2000	5.7			
1225001	MIDDLESEX WATER CO	1 MAIN ST	D	12/27/2000	1			
1225001	MIDDLESEX WATER CO	1 MAIN ST	D	12/27/2000	3.5			
1225001	MIDDLESEX WATER COMPANY	CARL OLSEN TP - POE	P	1/13/1999	0.43			
1225001	MIDDLESEX WATER COMPANY	MAPLE AVE TP	P	1/13/1999	3.1			
1225001	MIDDLESEX WATER COMPANY	PARK AVE PLANT - POE	P	1/13/1999	3.6			
1225001	MIDDLESEX WATER COMPANY	SPRING LAKE TP	P	1/13/1999	5.6	0.25		
1225001	MIDDLESEX WATER COMPANY	S. TINGLEY PLANT	P	1/13/1999	7.9	0.1		
1225001	MIDDLESEX WATER COMPANY	NO. TINGLEY PLANT	P	1/13/1999	11	0.02		
1225001	MIDDLESEX WATER COMPANY	MUNI BLDG	Q1	6/14/1999	0.12			
1225001	MIDDLESEX WATER COMPANY	MUNI BLDG	Q2	9/20/1999	2			
1225001	MIDDLESEX WATER COMPANY	MUNI BLDG	Q3	10/12/1999	15	0.87	1.4	
1225001	MIDDLESEX WATER COMPANY	MUNI BLDG	Q3-2	11/9/1999	1.2			
1302001	ALLENTOWN WATER	28 PROBASCO DRIVE	CP	4/7/1998				
1302001	ALLENTOWN WATER	WELLS #1 & #2 - POE	POE	7/27/1998	3.5			
1304001	ATLANTIC HIGHLANDS	LINCOLN TP WELLS 5&6	POE	7/22/1998	0.3			
1305001	AVON BY THE SEA WATER	SOUTH STATION AVE	CP	3/1/2000				
1305001	AVON-BY-THE-SEA WATER	WELLS #1 & #2	POE	8/5/1998	1.1			
1306001	BELMAR TOWNSHIP WATER	WELLS #10,#12 & #14	POE	7/20/1998	1.5			
1308001	BRIELLE BOROUGH	WELLS #1 & #2	POE	7/27/1998	4.5			
1308001	BRIELLE BOROUGH	601 UNION LANE	CP	3/17/1999				
1309001	U.S. NAVAL WEAPON STATION	DISTRIBUTION	D	7/15/1998	-0.73			
1309001	U.S. NAVAL WEAPON STATION	RTE 34	CP	4/28/1999				
1309002	S&B WATER AND SEWER	2 GOVERNOR TOWNSHIP	CP	5/12/1998				

1309002	S&B WATER AND SEWER	#8 BLACKSMITH	D	7/15/1998	-0.74		
1311001	FORT MONMOUTH - MAIN BASE	MALTERER AVE	CP	3/1/2000			
1311001	FORT MONMOUTH - MAIN BASE	US POST OFFICE	D	8/3/1998	0.53		
1312001	ENGLISHTOWN WATER	15 MAIN STREET	CP	2/19/1998	3.9		
1312001	ENGLISHTOWN WATER	WELLS #2 & #3 - POE	POE	8/3/1998	1.2		
1314001	FARMINGDALE WATER	35 WEST MAIN STREET	CP	4/7/1998			
1314001	FARMINGDALE WATER	WELLS #1 & #2 - POE	POE	7/27/1998	2		
1315001	FREEHOLD BOROUGH WATER	49 W. MAIN ST	CP	4/25/2000			
1315001	FREEHOLD BORO WATER	WELLS #7 & #8 - POE	POE	7/15/1998	1.1		
1316001	FREEHOLD TWP UTILITIES	68 JACKSON MILLS RD	D	12/12/2000	0.6		
1316001	FREEHOLD TOWNSHIP WATER	JACKSON MILLS WELL15	NWT	5/4/1998	1		
1316001	FREEHOLD TOWNSHIP WATER	JACKSONMILLS-9,10,11	POE	7/15/1998	2.2		
1316001	FREEHOLD TOWNSHIP WATER	WELL #13	POE	7/15/1998	0.1		
1316001	FREEHOLD TOWNSHIP WATER	WELL #14	POE	7/15/1998	0.98		
1316001	FREEHOLD TOWNSHIP WATER	POINT IVY - WELL #3	POE	7/15/1998	1.1		
1319001	ADELPHIA WATER COMPANY	WELL #4B	POE	6/29/1998	0.71		
1319002	NJAWC - HOWELL	4611 ROUTE 9N	CP	2/4/1998	0.4		
1319002	NJAWC - HOWELL	TREATMENT PLANT-POE	P	6/29/1998	0.45		
1319002	NJAWC - HOWELL	WELL #5 - POE	P	6/29/1998	0.69		
1319002	NJAWC - HOWELL	SPRUCE RD - WELL #2	POE	6/29/1998	0.52		
1319003	ANGLE INN MOTOR COURT	#33 E OFF RTE 33	CP	4/23/1998			
1319003	ANGLE INN MOTOR COURT	WELL #1 – POE	P	6/29/1998	3		
1319004	GREEN ACRES MANOR	20 ASTER LANE	CP	3/12/1998	0.51		
1319007	PARKWAY WATER COMPANY	157 NEWTON CORNER RD	CP	2/16/2000			
1319007	KIRKWOOD AQUIFER	WESTERN DR. SHORE	D	10/19/1901		2.2	2
1319007	PARKWAY WATER COMPANY	WELL #7 - POE	P	8/12/1998	16	1.9	2.2
1319007	PARKWAY WATER COMPANY	WELL #1A	POE	8/12/1998	1.4		
1319007	PARKWAY WATER COMPANY	PLANT #2	POE	8/12/1998	14	2.9	1.1
1319007	PARKWAY WATER COMPANY	RAMTOWN PLAZA	Q1	12/21/1998	10	2.1	2.1
1319007	PARKWAY WATER COMPANY	RAMTOWN PLAZA	Q2	3/9/1999	12	1.9	1.7
1319007	PARKWAY WATER COMPANY	RAMTOWN PLAZA	Q3	6/1/1999	12	2.3	1.5
1319007	PARKWAY WATER COMPANY	RAMTOWN PLAZA	Q4F	7/21/1999	12	2.4	1.6
1319008	WINDING BROOK MHP - SYSTEM	HOWELL TOWNSHIP	CP	2/16/2000			
1319008	WINDING BROOK MHP - SYSTEM	WELL #1 - POE	P	6/29/1998	0.62		
1319009	WINDING BROOK MHP - SYSTEM	WELL #2 - POE	POE	6/29/1998	1.5		
1319009	WINDING BROOK MHP - SYSTEM	#18	D	12/7/1998	0.73		
1319010	GREEN ACRES MHP	WELL #2 - POE	P	6/29/1998	0.67		

1321001	KEANSBURG MUA	192 CARR AVENUE	CP	2/19/1998	1.1
1321001	KEANSBURG MUA	WELL #5 - POE	POE	7/22/1998	1.4
1322001	KEYPORT WATER	PERRTY ST WELL #7	POE	7/22/1998	1.3
1326001	GORDONS CORNER WATER CO.	MARLBORO MUN COMP	D	12/22/2000	0.33
1326001	GORDON'S CORNER WATER	P.O. BOX 145	D	4/17/1997	0.34
1326001	GORDONS CORNER WATER	LOCUST GR TP 2,4,10	POE	8/12/1998	0.5
1326002	MANALAPAN TOWNSHIP	LAMB LANE - WELL #1	POE	7/15/1998	-0.41
1326002	MANALAPAN TOWNSHIP	108 WOODWARD RD	CP	11/4/1999	
1326004	UNITED WATER MATCHAPONIX	103 WILSON AVE	D	11/15/2000	0.53
1326004	UNITED WATER RESOURCES -	POE	POE	7/15/1998	-0.65
1326005	MANALAPAN TWP WATER	155 MILLHURST AVENUE	CP	2/28/2000	
1326005	MANALAPAN TWP WATER	MANALAPAN MIDDLE SCH	D	8/3/1998	0.34
1327001	MANASQUAN WATER	WELLS #2,#6 & #7	POE	7/27/1998	5
1327001	MANASQUAN WATER	15 UNION AVENUE	CP	3/15/1999	
1328002	MARLBORO MUA	WELLS #1,#2,#3,#4POE	POE	7/22/1998	0.19
1328002	MARLBORO MUA	352 SALINGER CT	CP	11/4/1999	
1328003	MARLBORO STATE HOSPITAL	CIRCLE DR	CP	7/5/2000	
1328003	MARLBORO STATE HOSPITAL	WELL #17 - POE	POE	7/22/1998	2.6
1329001	MATAWAN BORO WATER	201 BROAD STREET	CP	3/1/2000	
1329001	MATAWAN BORO WATER	WELL #3 & #4 - POE	POE	7/22/1998	1.5
1330002	ABERDEEN TOWNSHIP WATER	ABERDEEN MUNIC BLDG	D	7/22/1998	0.51
1330002	ABERDEEN TOWNSHIP WATER	CLIFFWOOD AVE SCHOOL	D	6/15/1999	0.48
1331001	GATEWAY NATIONAL	FORT HANCOCK	CP	6/10/1998	
1331001	GATEWAY NATIONAL	WELL #5 - POE	POE	8/5/1998	2.3
1339001	SHORELANDS WATER	372 MIDDLE ROAD	CP	6/10/1998	
1339001	SHORELANDS WATER	HAZLET PLANT WELL1&2	POE	7/22/1998	-0.32
1340001	RED BANK BOROUGH	90 MONMOUTH ST	D	11/14/2000	0.27
1340001	RED BANK WATER	WELL #4 - POE	POE	8/5/1998	1.2
1341001	ROOSEVELT WATER	33 ROCHDALE AVE	CP	8/14/2000	
1341001	ROOSEVELT WATER	WELLS #3 & #4 - POE	POE	8/3/1998	0.81
1344001	SEA GIRT WATER	WELL #6 - POE	POE	7/20/1998	1.4
1345001	NJ AMERICAN WATER	SUNOCO, RT 34	D	12/27/2000	0.2
1345001	NJAWC - MONMOUTH SYSTEM	SWIMMING RIVER TP	POE	8/3/1998	0.29
1345001	NJAWC - MONMOUTH SYSTEM	556 TINTON AVENUE	CP	12/16/1999	
1347001	SOUTH BELMAR WATER	1730 MAIN STREET	CP	1/26/2000	
1347001	SOUTH BELMAR WATER	MUNICIPAL BLDG	D	7/20/1998	4.1
1348001	SPRINGLAKE BOROUGH	WELLS #1 & #2	POE	7/20/1998	1.4

1348001	SPRING LAKE WATER	3RD AVE & MADISON	CP	10/22/1998			
1349001	SPRINGLAKE HEIGHTS	555 BRIGHTON AVENUE	CP	1/26/2000			
1349001	SPRINGLAKE HEIGHTS	OLD MILL TP	POE	7/20/1998	2.2		
1350001	NJAWC - UNION BEACH	MUNI BLDG	D	8/5/1998	0.99		
1350001	NJAWC - UNION BEACH	650 POOLE AVENUE	CP	12/16/1999			
1352001	ARTHUR BRISBANE CHILD	WELL #2 - POE	POE	7/20/1998	0.25		
1352003	WALL TWP WATER DEPT	PUBLIC WORKS GARAGE	D	12/13/2000	1.7		
1352003	WALL TOWNSHIP WATER	2510 BELMAR BLVD	CP	5/12/1998			
1352003	WALL TOWNSHIP WATER	IMPERIAL PLANT W 1&7	POE	7/20/1998	1.2		
1352004	GARDEN STATE MOBILE HOME	#42 OFF RTE 138	D	4/23/1998			
1352004	GARDEN STATE MOBILE HOME	WELLS #1 & #2 - POE	P	7/20/1998	21	1.9	1.5
1352004	GARDEN STATE MOBILE HOME	PLANT #2 (#3&#4) POE	POE	7/20/1998	15	2	1.5
1352004	GARDEN STATE MOBILE HOME	#40	Q1	12/7/1998	11	2.1	1.1
1352004	GARDEN STATE MOBILE HOME	#40	Q2	3/9/1999	12	1.9	1.2
1352004	GARDEN STATE MOBILE HOME	#40	Q3	6/1/1999	15	2.6	2.3
1352004	GARDEN STATE MOBILE HOME	#40	Q4F	7/21/1999	11	2	1.4
1352005	NJ WATER SUPPLY	MANASQUAN WALL 2 MET	D	11/29/2000	0.45		
1352005	NJWSA - MANASQUAN	MANASQUAN RESERVOIR	POE	7/20/1998	1.5		
1401001	BOONTON WATER	WELLS #1,2,4,5	P	3/3/1998	1.4		
1401002	BOONTON TOWNSHIP WATER	155 POWERVILLE RD	CP	2/15/2000			
1401002	BOONTON TOWNSHIP WATER	MUNICIPAL BUILDING	D	11/4/1998	0.32		
1403001	BUTLER WATER DEPARTMENT	12 BELLEVIEW AVENUE	CP	5/13/1998			
1403001	BUTLER WATER DEPARTMENT	MUNICIPAL BUILDING	D	1/4/1999	0.09		
1404001	CHATHAM WATER	WELL #2 - POE	P	3/2/1999	1.6		
1406001	CHESTER BOROUGH WATER	WELL #3 - POE	P	11/10/1998	5.6	0.14	
1406002	WINDY ACRES MOBILE HOME	#16 OFF RTE 24	CP	5/18/1998			
1406002	WINDY ACRES MOBILE HOME	WELL #1 - POE	P	11/9/1998	1.5		
1407001	FOUR SEASONS AT CHESTER	WELL #1 - BROWN CT	NWT	9/27/1999	4.8		
1407001	FOUR SEASONS AT CHESTER	WELL #3	NWT	9/27/1999	14	0.22	0.04
1408001	DENVILLE TWP WATER DEPT	SOUTH SHORE TRL	D	12/7/2000	1.8		
1408001	DENVILLE TOWNSHIP WATER	WELL #5 - POE	P	11/4/1998	1.1		
1408001	DENVILLE TOWNSHIP WATER	WELL #6 - POE	P	11/4/1998	2.6		
1409001	DOVER WATER DEPT	37 N. SUSSEX ST	D	11/16/2000	1.7		
1409001	DOVER WATER DEPARTMENT	WELL #1 - POE	P	1/5/1999	2.2		
1410001	EAST HANOVER TWP WATER	WELLS #1 & #2	P	3/2/1999	3.8		
1410001	EAST HANOVER TWP WATER	323 RIDGEDALE AVE	CP	9/2/1999			
1411001	FLORHAM PARK BOROUGH	WELL #4 - POE	P	1/25/1999	3		

1411001	FLORHAM PARK BOROUGH	107 RIDGEDALE AVE	CP	9/2/1999	
1413001	LAKESHORE WATER COMPANY	DOGWWOOD&LAKE TRAIL	CP	6/2/1998	
1413001	LAKESHORE WATER COMPANY	#84 LAKE TRAIL EAST	D	11/30/1998	1.6
1414003	JEFFERSON TOWNSHIP WU -	IRON TOWN CIRCLE	CP	2/23/2000	
1414003	JEFFERSON TOWNSHIP WU -		P	10/20/1998	2.2
1414005	JEFFERSON TOWNSHIP WU -	22 PADEREWSKI ROAD	D	9/15/1997	1.2
1414005	JEFFERSON TOWNSHIP WU -		P	10/20/1998	0.12
1414006	LOZIERS TRAILER PARK	#11 OFF RIDGE RD	CP	6/24/1998	
1414006	LOZIERS TRAILER PARK	WELL #1	P	10/27/1998	1.3
1414007	JEFFERSON TOWNSHIP WD -	8 MADOC TRAIL	CP	2/28/2000	
1414007	JEFFERSON TOWNSHIP WD -	WELL #1	P	10/20/1998	2.1
1414008	OAK RIDGE MOBILE HOME PARK	43 MAKEPEACE TRAIL	D	9/15/1997	2.3
1414008	OAK RIDGE MOBILE HOME PARK	WELL #1	P	10/27/1998	1.2
1414009	MOUNTAIN SHORE WATER	12 RIDGEDALE ROAD	CP	7/21/1998	
1414009	MOUNTAIN SHORE WATER	#56 NOLAN POINT	D	1/5/1999	1.4
1414011	JEFFERSON TOWNSHIP WU -	900 RTE 15 NORTH	CP	1/28/1998	1.2
1414011	JEFFERSON TOWNSHIP WU -	WELL #1	P	10/20/1998	1.4
1414013	SUN VALLEY PARK CO	15 LARRY ROAD	CP	7/21/1998	
1414013	SUN VALLEY PARK CO	#12	D	10/27/1998	0.55
1414013	SUN VALLEY PARK CO	WELL #2 - LARRY ROAD	NWT	10/18/1999	2
1414014	SANDY POINT MOBILE HOME	18 SANDY POINT DRIVE	CP	3/22/2000	
1414014	SANDY POINT MOBILE HOME	WELL #1	P	10/27/1998	3.6
1414015	JEFFERSON TOWNSHIP WU -	WELL #1	P	10/20/1998	3.1
1414016	JEFFERSON TOWNSHIP WU -	WELL #1	P	10/20/1998	1
1414016	JEFFERSON TOWNSHIP WU -	30 VASSAR ROAD	CP	10/12/1999	
1414018	JEFFERSON TOWNSHIP - DMH	WELL #1	P	10/20/1998	0.3
1414019	JEFFERSON TOWNSHIP -	ONEIDA WELL	R	1/28/1998	3.5
1414019	JEFFERSON TOWNSHIP -	WELL #1 - POE	P	10/20/1998	6.7
1414020	JEFFERSON TOWNSHIP -		P	10/20/1998	2.3
1415001	FAYSON LAKES WATER	WELLS #3,4,5 & 6	P	3/3/1998	1.4
1415002	KINNELON WATER	PUMP HOUSE	D	1/4/1999	0.06
1415002	KINNELON WATER	KAKEOUT ROAD	CP	1/27/1999	
1416001	BORO LINCOLN PARK	1 GARDEN CT.	D	12/21/2000	0.38
1416001	LINCOLN PARK WATER	MUNICIPAL BUILDING	D	11/4/1998	0.17
1416001	LINCOLN PARK WATER	34 CHAPEL HILL ROAD	CP	9/2/1999	
1416004	BORO LINCOLN PARK	JACKSONVILLE CHAPEL	D	12/21/2000	2.5
1416004	LINCOLN PARK WD -	JARDINE & ROUTE 202	D	11/4/1998	2.8

1416004	LINCOLN PARK WD -	264 JACKSONVILLE RD	CP	10/18/1999		
1417001	BOROUGH OF MADISON	MADISON AVE	D	12/21/2000	2.1	
1417001	MADISON WATER	WELL #E - POE	P	11/30/1998	1.3	
1418002	SISTERS OF CHRISTIAN	350 BERNARDSVILLE RD	CP	2/8/2000		
1418002	SISTERS OF CHRISTIAN	WELLS #1 & #2 - POE	P	11/30/1998	1.1	
1420001	MINE HILL TWP WATER	10 BAKER ST	CP	4/6/2000		
1420001	MINE HILL TWP WATER	MUNICIPAL BUILDING	D	11/23/1998	0.12	
1421003	MONTVILLE MUA	MUN BLDG, OFC SINK	D	12/21/2000	2	
1421003	MONTVILLE TOWNSHIP MUA	88 RIVER ROAD	CP	8/4/1997	-0.75	-0.05
1421003	MONTVILLE TOWNSHIP MUA	INDIAN LANE #1 & #2	P	1/4/1999	2.1	
1421004	PLAUSHA PARK WATER	12 FOREST PLACE	CP	8/4/1997	0.62	0.1
1421004	PLAUSHA PARK WATER	WELL #1 - POE	P	3/8/1999	5.8	0.16
1422001	SISTERS OF ST ELIZABETH	WELL #1 - POE	P	11/30/1998	1.7	
1424001	SOUTHEAST MORRIS CO. MUA	MORRISTOWN LIBRARY	D	12/20/2000	1.1	
1424001	SOUTHEAST MORRIS MUA	WING WELL	P	11/30/1998	2.2	
1425001	MOUNTAIN LAKES WATER	WELL #5 - POE	P	1/28/1998	0.45	
1425001	MOUNTAIN LAKES WATER	POCONO RD & THE BLVD	CP	2/3/1999		
1426001	MOUNT ARLINGTON DPW -	WELL #1 - DPW	P	11/23/1998	0.16	
1426002	MOUNT ARLINGTON DPW -	WELLS #1 & #2 - POE	P	11/23/1998	0.39	
1426003	LEES PARK	#12	CP	3/31/1998	0.55	
1426003	LEES PARK	WELL #1 - POE	P	11/23/1998	0.17	
1426004	UNITED WATER - ARLINGTON	1 COMMUNITY LANE	CP	2/15/2000		
1426004	UNITED WATER - ARLINGTON	WELL #1 - POE	P	11/23/1998	1.6	
1426005	MOUNT ARLINGTON BORO DPW	MUNI BLDG	D	11/23/1998	0.22	
1427001	MOUNT OLIVE VILLAGES	WELL #1 - POE	P	1/5/1998	0.23	
1427001	MOUNT OLIVE VILLAGES	WOLFE ROAD	CP	2/5/1998	0.69	
1427002	MOUNT OLIVE TOWNSHIP WD -	48 MADISON AVE	CP	3/22/2000		
1427002	MOUNT OLIVE TOWNSHIP WD -	WELL #1	P	10/28/1998	0.32	
1427003	MOUNT OLIVE TOWNSHIP WD -	WELL #2	P	10/28/1998	0.15	
1427003	MOUNT OLIVE TOWNSHIP WD -	39 RIDGE ROAD	CP	11/18/1999		
1427005	MOUNT OLIVE TOWNSHIP WD -	4 DEERFIELD PL	CP	4/17/2000		
1427005	MOUNT OLIVE TOWNSHIP WD -	WELL #1(BARTLEY)-POE	P	1/21/1998	1.5	
1427006	MOUNT OLIVE TOWNSHIP WD -	46 ALCREST AVE.	CP	5/3/2000		
1427006	MOUNT OLIVE TOWNSHIP WD -	WELL #1	P	10/28/1998	0.51	
1427007	MT OLIVE TWP WATER	HICKORY WOOD CIRCLE	D	6/28/1901		
1427007	MOUNT OLIVE TOWNSHIP WD -	WELL #3(ARTESIAN)-R	R	1/21/1998	0.59	
1427008	MOUNT OLIVE TOWNSHIP WD -	28 WOODSEDGE AVE	CP	4/17/2000		

1427008	MOUNT OLIVE TOWNSHIP WD -	WELL #1	P	10/28/1998	0.8
1427009	WEST JERSEY WATER	19 MANOR HOUSE ROAD	D	9/4/1997	0.12
1427010	NJ VASA HOME WATER	42 SCANDIA ROAD	D	6/28/1901	
1427010	NJ VASA HOME WATER	WELL #1 - POE	P	12/2/1998	0.43
1427012	MOUNT OLIVE TOWNSHIP WD -	WELLS #1 & #2	P	10/28/1998	0.99
1427012	MOUNT OLIVE TOWNSHIP WD -	24 CARSON ROAD	CP	10/26/1999	
1427013	MOUNT OLIVE TOWNSHIP WD -	WELL #1	P	10/28/1998	0.59
1427013	MOUNT OLIVE TOWNSHIP WD -	14 PINE STREET	CP	10/26/1999	
1427014	MOUNT OLIVE TOWNSHIP WD -	WELL #1	P	10/28/1998	1.2
1427014	MOUNT OLIVE TOWNSHIP WD -	13 CARLTON ROAD	CP	10/26/1999	
1427015	MOUNT OLIVE TOWNSHIP WD -	WELL #3	NWT	4/8/1998	0.81
1427015	MOUNT OLIVE TOWNSHIP WD -	WELL #4	NWT	4/8/1998	0.88
1427015	MOUNT OLIVE TOWNSHIP WD -	WELL #1	P	10/28/1998	0.27
1427015	MOUNT OLIVE TOWNSHIP WD -	6 GAIL DRIVE	CP	11/18/1999	
1427016	AWM COUNTRY OAKS	83 CONNELLY AVENUE	CP	2/28/2000	
1427017	NJ AMERICAN WATER	WELL #2 INTERNAT. DR	NWT	5/3/2000	0.94
1427019	NJAWC - WEST JERSEY	WELL #1 - POE	P	1/5/1999	0.58
1428001	NETCONG WATER	19 MAPLE AVE	CP	8/1/2000	
1428001	NETCONG WATER	WELL #1A	NWT	2/5/1998	2
1428001	NETCONG WATER	WELL #2 - POE	P	12/2/1998	0.65
1429001	PARSIPPANY-TROYHILLS	WELL #1 - R	R	1/21/1998	0.68
1431001	PEQUANNOCK TWP	530 TPK	D	11/14/2000	1.7
1431001	PEQUANNOCK TOWNSHIP	WELL #1	P	1/4/1999	1.1
1431001	PEQUANNOCK TOWNSHIP	530 NEWARK/POMPTON	CP	5/10/1999	
1432001	MORRIS COUNTY MUA	387 DOVER CHESTER RD	CP	2/8/2000	
1432001	MORRIS COUNTY MUA	WELLS #1 & #2 - POE	P	12/2/1998	0.3
1432003	RANDOLPH TWP	1345 SUSSEX TPK	D	11/16/2000	0.29
1432003	RANDOLPH TOWNSHIP PUBLIC	MUNICIPAL BUILDING	D	11/16/1998	0.7
1432003	RANDOLPH TOWNSHIP PUBLIC	MUNI BLDG	D	12/2/1998	0.28
1432003	RANDOLPH TOWNSHIP PUBLIC	502 MILLBROOK AVENUE	CP	12/1/1999	
1433001	RIVERDALE BORO WATER	WELL #1 - POE	P	3/3/1998	3.1
1433001	RIVERDALE BORO WATER	107 NEWARK/POMPTON T	CP	5/13/1998	
1434001	ROCKAWAY BORO WATER	WELLS#1,5,6(JACKSON)	P	1/28/1998	1.1
1435001	HOFFMAN HOMES	WELL #2 - POE	P	1/5/1999	0.36
1435002	ROCKAWAY TOWNSHIP	MT HOPE RD	CP	6/6/2000	
1435002	ROCKAWAY TOWNSHIP	WELL #8 - POE	P	11/4/1998	1
1435002	ROCKAWAY TOWNSHIP	WELLS #6 & #7 - POE	P	11/4/1998	2.5

1435003	PICATINNY ARSENAL - ARDC	FARLEY AVE	CP	4/6/2000			
1435003	PICATINNY ARSENAL - ARDC	WELL #410	R	1/28/1998	0.99		
1435003	PICATINNY ARSENAL - ARDC	WELL #131	NWT	8/4/1998	1		
1436001	ALLIANT TECH SYSTEMS INC.	WELLS #1 & #2 - POE	P	3/2/1999	5.4		
1436002	ROXBURY WATER COMPANY	WELL #7A	P	11/10/1998	0.14		
1436002	ROXBURY WATER COMPANY	WELL #8	P	11/10/1998	0.27		
1436002	ROXBURY WATER COMPANY	122 MAIN STREET	CP	12/1/1999			
1436003	ROXBURY TOWNSHIP WD -	WELL #12 - POE	P	11/9/1998	1.3		
1436003	ROXBURY TOWNSHIP WD -	527 DELL RD	CP	9/7/1999			
1436004	ROXBURY TWP WATER	33 PATRICIA DRIVE	CP	8/1/2000			
1436004	ROXBURY TOWNSHIP WD -	WELLS #5 & #6 - POE	P	11/9/1998	1.3		
1436006	ROXBURY TOWNSHIP WD -	WELL #7 - POE	P	11/9/1998	0.38		
1436006	ROXBURY TOWNSHIP WD -	10 EVERGREEN AVE	CP	9/7/1999			
1436007	ROXBURY TOWNSHIP WD -	WELL #10 - POE	P	11/9/1998	0.05		
1436007	ROXBURY TOWNSHIP WD -	25 LOOKOUT DRIVE	CP	9/7/1999			
1438001	CLIFFSIDE PARK ASSOCIATES	5 ROOSEVELT AVENUE	CP	4/15/1998			
1438001	CLIFFSIDE PARK ASSOCIATES	WELL #1 - POE	P	11/16/1998	2.4		
1438001	CLIFFSIDE PARK ASSOCIATES	WELL #1	NWT	8/5/1999			
1438001	CLIFFSIDE PARK ASSOCIATES	WELL #2	NWT	8/5/1999			
1438003	WASHINGTON TOWNSHIP MUA -	ADMIN BLDG	Q3	2/23/2000	13	-0.38	0.1
1438003	WASHINGTON TOWNSHIP MUA -	ADMIN BUILDING	Q4	6/20/2000	0.08		
1438003	WASHINGTON TOWNSHIP MUA -	24 SCHOOLEY MT ROAD	CP	8/15/2000			
1438003	WASHINGTON TOWNSHIP MUA -	WELL #7 - POE	P	11/16/1998	0.01		
1438003	WASHINGTON TOWNSHIP MUA -	WELL #8	NWT	4/27/1999	11		
1438003	WASHINGTON TOWNSHIP MUA -	WELL #8 - R	NWT	7/28/1999	8.9	0.5	0.17
1438003	WASHINGTON TOWNSHIP MUA -	ADMINISTARTION OFFIC	Q1	9/29/1999	4.8		
1438003	WASHINGTON TOWNSHIP MUA -	ADMIN BLDG	Q2	11/17/1999	0.41		
1438004	WASHINGTON TOWNSHIP MUA -	22 WELLINGTON DRIVE	CP	8/15/2000			
1438004	WASHINGTON TOWNSHIP MUA -	WELL #11 - R	R	1/28/1998	0.56		
1438004	WASHINGTON TOWNSHIP MUA -	WELL #17	R	6/17/1998			
1438004	WASHINGTON TOWNSHIP MUA -	WELL #18A	NWT	4/27/1999	1.4		
1438005	WASHINGTON TOWNSHIP MUA -	90 FLOCKTOWN ROAD	CP	3/2/2000			
1438005	WASHINGTON TOWNSHIP MUA -	WELL #7 - POE	P	11/16/1998	0.53		
1438005	WASHINGTON TOWNSHIP MUA -	WELL #19 - RAW	NWT	5/27/1999	0.45		
1438006	SHERWOOD MHP	#7 OFF RTE 24	D	6/17/1998	0.58		
1438006	SHERWOOD MHP	WELL #1 - POE	P	11/16/1998	0.12		
1439001	WHARTON WATER	99 NO. MAIN ST.	CP	6/6/2000			

1439001	WHARTON WATER	WELL #3 - POE	P	11/23/1998	2		
1501001	BARNEGAT LIGHT WATER	WELLS #3	POE	9/21/1998	0.65		
1501001	BARNEGAT LIGHT WATER	10 WEST 10TH STREET	CP	9/9/1999			
1502001	NJAWC	88 BRIDGE AVE	D	12/14/2000	2.5		
1502001	NJAWC - OCEAN COUNTY	WELLS #12 & #13	POE	10/5/1998	2.4		
1502001	NJAWC - OCEAN COUNTY	81 BRIDGE STREET	CP	9/15/1999			
1503001	BEACH HAVEN WATER	WELL #10	R	5/8/2000	-0.09		
1503001	BEACH HAVEN WATER	WELLS #7,#8 & #9	POE	9/21/1998	1.2		
1503001	BEACH HAVEN WATER	300 ENGLESIDE AVENUE	CP	11/10/1999			
1504001	BEACHWOOD WATER	1133 BEACH AVENUE	CP	2/26/1998	2.4		
1504001	BEACHWOOD WATER	WELLS #5 & #6	POE	9/30/1998	0.69		
1505002	BERKELEY WATER COMPANY	PLANT TAP (POE)	P	6/7/2000			
1505002	BERKELEY WATER COMPANY	WELL #5	R	6/18/1997	1.5		
1505002	BERKELEY WATER COMPANY	WELL #4	R	2/26/1998	4.4		
1505002	BERKELEY WATER COMPANY	WELLS #3 & #5	POE	9/30/1998	1.1		
1505002	BERKELEY WATER COMPANY	645 RTE 9	CP	6/23/1999			
1505003	SHORE WATER COMPANY		POE	10/5/1998	-0.98		
1505003	SHORE WATER COMPANY	CENTRAL AVE @ 24TH	CP	10/27/1999			
1505004	BERKELEY TOWNSHIP MUA	WELL #3 STATION RD	NWT	4/18/2000	0.31		
1505004	BERKELEY TOWNSHIP MUA	221 REDWOOD DR. - D	CP	1/26/1998	1.1		
1505004	BERKELEY TOWNSHIP MUA	WELLS #1 & #2	POE	9/30/1998	0.24		
1506001	BRICK TOWNSHIP MUA	165 CHAMBERSBRIDGERD	CP	10/2/1997	0.63		
1506001	BRICK TOWNSHIP MUA	WELL #9	POE	10/6/1998	2.4		
1507005	UNITED WATER TOMS RIVER	POE WELL 30	USGS	5/31/2000	9.7	0.37	0.11
1507005	UNITED WATER TOMS RIVER	RAW WELL 30	USGS	5/31/2000	2.4	0.11	0.28
1507005	UNITED WATER TOMS RIVER	MUNICIPAL BLDG - D	USGS	5/31/2000	10	0.39	0.09
1507005	UNITED WATER	POE #2	P	9/27/1901	0.76		
1507005	UNITED WATER	POE #3	P	9/27/1901	5.1		
1507005	UNITED WATER	POE #5	P	9/27/1901	2.9		
1507005	UNITED WATER	POE #8	P	9/27/1901	2.5		
1507005	UNITED WATER - TOMS RIVER	WELL #31	R	5/4/1997	11	1.7	
1507005	UNITED WATER - TOMS RIVER	WELL #31 - POE	POE	5/7/1997	0.38	0.13	
1507005	UNITED WATER - TOMS RIVER	WELL #31	R	5/7/1997	10.3	1.7	
1507005	UNITED WATER - TOMS RIVER	WELL #31	R	5/21/1997	11.9	1.8	1.3
1507005	UNITED WATER - TOMS RIVER	WELL #31	R	5/21/1997	11.9	1.8	1.3
1507005	UNITED WATER - TOMS RIVER	WELL #31	POE	5/21/1997	0.23	0.01	
1507005	UNITED WATER - TOMS RIVER	WELL #31	POE	5/21/1997	0.36	-0.14	

1507005	UNITED WATER - TOMS RIVER	PARKWAY - POE	POE	6/11/1997	12	1.2	
1507005	UNITED WATER - TOMS RIVER	WELL #33	USGS	11/24/1997	10.5	0.97	1.6
1507005	UNITED WATER - TOMS RIVER	WELL #44	USGS	12/3/1997	15.4	2.2	1.5
1507005	UNITED WATER - TOMS RIVER	WELL #28	USGS	12/8/1997	15.2	1.7	1.6
1507005	UNITED WATER - TOMS RIVER	WELL #22	USGS	12/17/1997	12	1.4	1.5
1507005	UNITED WATER - TOMS RIVER	WINDSOR AVE WELL #40	USGS	5/18/1998	0.45	-0.03	
1507005	UNITED WATER - TOMS RIVER	WELL #21	USGS	6/22/1998	12	0.9	1.8
1507005	UNITED WATER - TOMS RIVER	WELL #41	USGS	6/24/1998	0.95	-0.01	
1507005	UNITED WATER - TOMS RIVER	DOVER TWP MUNI BLDG	D	10/6/1998	6.3	0.2	
1507005	UNITED WATER - TOMS RIVER	MUNICIPAL BUILDING	Q1	12/16/1998	9.5	0.45	0.72
1507005	UNITED WATER - TOMS RIVER	MUNI BLDG	Q2	3/16/1999	13	0.96	0.9
1507005	UNITED WATER - TOMS RIVER	WELL #20	R	6/9/1999	15	2.4	2.4
1507005	UNITED WATER - TOMS RIVER	COLUMBINE&PRIMROSE	D	6/9/1999	8.2	1.1	1.4
1507005	UNITED WATER - TOMS RIVER	RTE 571 - PATHMARK	D	6/9/1999	6.2	1.5	1.1
1507005	UNITED WATER - TOMS RIVER	MUNI BLDG	Q3	6/22/1999	6.8	0.5	
1507005	UNITED WATER - TOMS RIVER	3473 VICARI AVENUE	D	7/1/1999	11.5	3.4	2.1
1507005	UNITED WATER - TOMS RIVER	RTE 571	CP	7/7/1999			
1507005	UNITED WATER - TOMS RIVER	MUNI BLDG	Q4F	8/9/1999	8.8	0.5	0.04
1507005	UNITED WATER - TOMS RIVER	DUGAN LANE	P	12/8/1999	13	2.4	1.8
1507005	UNITED WATER - TOMS RIVER	2251 LAKERIDGE BLVD	D	12/8/1999	8.6	2.1	0.31
1508001	EAGLESWOOD VILLAGE	WELLS #1 & #2	POE	9/23/1998	1.3		
1509001	HARVEY CEDARS BOROUGH	WELL #4 - POE	POE	9/21/1998	0.14		
1509001	HARVEY CEDARS BOROUGH	HUDSON AVE & LB BLVD	CP	4/22/1999			
1510001	ISLAND HEIGHTS WATER	WELLS #7 & #8 - POE	POE	10/6/1998	0.49		
1511001	JACKSON TWP MUA	135 MANHATTEN ST	P	11/16/2000	0.13		
1511001	JACKSON TOWNSHIP MUA	2 KEVIN DALE PLACE	CP	3/3/1998			
1511001	JACKSON TOWNSHIP MUA	WELL #8 - POE	POE	8/17/1998	0.33		
1511001	JACKSON TOWNSHIP MUA	WELL #6 - POE	POE	8/17/1998	0.51		
1511001	JACKSON TOWNSHIP MUA	125 MANHATTAN STREET	CP	9/1/1999			
1511002	JACKSON ESTATES	WELL #1 - POE	POE	8/19/1998	5		
1511003	LAND OF PINES MOBILE HOME	WELL #3 - POE	POE	8/19/1998	0.16		
1511004	MAPLE GLEN MOBILE HOME	WELL #2	NWT	2/23/2000	0.91		
1511004	MAPLE GLEN MOBILE HOME	BOXWOOD DRIVE	CP	3/12/1998	2.2		
1511004	MAPLE GLEN MOBILE HOME	WELL #1 - POE	POE	8/19/1998	1.1		
1511005	OAK TREE MOBILE HOME PARK	112 ANTONIS DR.	CP	5/8/2000			
1511005	OAK TREE MOBILE HOME PARK	WELL #2 - POE	POE	8/19/1998	0.15		
1511006	SHADY LAKE TRAILER PARK	WELL #1 - POE	POE	8/19/1998	0.82		

1511006	SHADY LAKE TRAILER PARK	#31 SHADYLAKE CIRCLE	CP	3/8/1999				
1511007	SHADY OAK TRAILER PARK	WELL #3 - POE	POE	8/19/1998	4			
1511008	SOUTH WIND MOBILE HOME	JACKSON TOWNSHIP	POE	8/17/1998	0.36			
1511009	PLEASANT GARDENS WATER	WELL #G - POE	P	8/17/1998	16	2.2	1.9	
1511009	PLEASANT GARDENS WATER	#1080	Q1	12/16/1998	25	3.3	3.6	
1511009	PLEASANT GARDENS WATER	OFFICE	Q2	3/16/1999	15	1.9	3.2	0.29
1511009	PLEASANT GARDENS WATER	OFFICE	Q3	6/22/1999	16	2.4	3	0.11
1511009	PLEASANT GARDENS WATER	OFFICE	Q4F	8/4/1999	17	2.8	2.9	0.17
1511010	NAVAL AIR ENGINEERING	VISITORS BLDG	Q3	2/16/2000	5.4			
1511010	NAVAL AIR ENG. STATION	VISITORS CENTER	Q4F	6/14/2000	34			
1511010	NAVAL AIR ENGINEERING	WELL #37	USGS	4/27/1998	5.2	0.67	0	
1511010	NAVAL AIR ENGINEERING	WELL #40	USGS	4/29/1998	1.9	0.43	0	
1511010	NAVAL AIR ENGINEERING	WELL #44 POE	P	10/6/1998	7.9	1.9	0.88	
1511010	NAVAL AIR ENGINEERING	WELL #5 - POE	P	10/6/1998	16	3.3	1.3	
1511010	NAVAL AIR ENGINEERING	VISITORS BLDG	Q1	9/1/1999	3			
1511010	NAVAL AIR ENGINEERING	GUARD HOUSE	Q2	10/13/1999	2.4			
1511011	LUXURY MOBILE TERRACE	WELL #1 - POE	POE	8/19/1998	5.4			
1511011	LUXURY MOBILE TERRACE	5 LUXURY CIRCLE	CP	8/24/1998				
1511012	JACKSON TOWNSHIP WATER	WELLS #1 & #3	POE	8/17/1998	0.59			
1511012	JACKSON TOWNSHIP WATER	988 LAKEHURST AVE	CP	10/13/1999				
1511013	FOUNTAINHEAD PARKS INC.	#8	D	8/19/1998	0.16			
1511014	CONCORD VILLAGE	14B PRIMROSE LN	CP	5/10/2000				
1511014	CONCORD VILLAGE	WELL #2 - POE	P	8/26/1998	16	1.5	2.4	
1511014	CONCORD VILLAGE	#14 D	Q1	12/16/1998	15	1.6	2.8	
1511014	CONCORD VILLAGE	#7A	Q2	3/16/1999	11	1.7	2.7	
1511014	CONCORD VILLAGE	#2A	Q3	6/2/1999	12	1.5	2.5	
1511014	CONCORD VILLAGE	#8A	Q4F	8/4/1999	11.8	2.1	1.6	
1511015	LEXINGTON COMMONS	2506 LEXINGTON COURT	CP	10/16/1997	7.6	1.8	1.2	
1511015	LEXINGTON COMMONS	WELL #1 - POE	POE	8/26/1998	9.2	2.1	1.2	
1511015	LEXINGTON COMMONS	#2524	Q1	12/16/1998	5.3			
1511015	LEXINGTON COMMONS	#2545	Q2	3/16/1999	5.8	1.3	0.87	
1511015	LEXINGTON COMMONS	#2547	Q3	6/2/1999	5.1			
1511015	LEXINGTON COMMONS	#2542	Q4F	8/4/1999	5.8	1.4	0.52	
1511016	MEADOWBROOK CO-OP INC.	WELL #1 - POE	POE	8/26/1998	0.4			
1511016	MEADOWBROOK CO-OP INC	30 DIXIE LANE	CP	2/2/1999				
1511017	JACKSON COLONIAL ARMS	80 WEST VETERANS HWY	CP	3/3/1998	0.33			
1511017	JACKSON COLONIAL ARMS	WELL #1 - POE	POE	8/17/1998	0.59			

1511019	DOVE MILLS APARTMENTS	WELLS #1,2,3,4 - POE	P	10/6/1998	9.3	2.4	1.1
1511019	DOVE MILLS APARTMENTS	401 BENNETTS MILLS	CP	1/6/1999			
1511019	DOVE MILLS APARTMENTS	OFFICE	Q1	3/16/1999	8.5	2.6	1.3
1511019	DOVE MILLS APARTMENTS	#11	Q2	6/2/1999	9	2.7	1.1
1511019	DOVE MILLS APARTMENTS	#8	Q3	8/4/1999	9.1	2.4	1.1
1511019	DOVE MILLS APARTMENTS		Q4F	10/13/1999	8	2.2	0.63
1511020	PLEASANT GARDENS SOUTH	#24C	D	8/17/1998	5.1		
1511300	SIX FLAGS - GREAT	WELL #14 - R	NWT	3/25/1999	1.9		
1512001	LACEY TOWNSHIP MUA	MUNI BLDG	Q3	2/15/2000	2.1		
1512001	LACEY TOWNSHIP MUA	MUNIC BLDG	Q4F	4/18/2000	2.8		
1512001	LACEY MUNICIPAL UTILITIES	FORKED RIVER	D	11/16/2000	1.6		
1512001	LACEY TOWNSHIP MUA	WELLS #1 & #2 - POE	P	9/23/1998	11	1	1.4
1512001	LACEY TOWNSHIP MUA	MUNI BLDG	Q1	9/28/1999	3.2		
1512001	LACEY TOWNSHIP MUA	MUNI BLDG	Q2	12/21/1999	0.47		
1513001	LAKEHURST WATER	WELLS 1A,2,11,12,14,	POE	10/6/1998	1.9		
1513001	LAKEHURST WATER	WELL #15 - R	NWT	3/25/1999	4		
1514001	NJAWC - LAKEWOOD SYSTEM	300 RIVER AVENUE	CP	1/14/1998	8.5	1.1	0.98
1514001	NJAWC - LAKEWOOD SYSTEM	WELLS 12,13&14 - POE	P	9/28/1998	8.9	1	0.85
1514001	LAKEWOOD TOWNSHIP MUA	MUNICIPAL BUILDING	Q1	12/16/1998	12	1.8	4.2
1514001	LAKEWOOD TOWNSHIP MUA	MUNI BLDG	Q2	6/15/1999	9.7	1	0
1514001	LAKEWOOD TOWNSHIP MUA	MUNI BLDG	Q3	8/9/1999	5.6	0.46	0.13
1514001	LAKEWOOD TOWNSHIP MUA	MUNI BLDG	Q4F	11/22/1999	8.2	0.54	0.16
1514002	LAKEWOOD TOWNSHIP MUA	RTE 70 & TOWBIND	Q3	2/15/2000	5.3		
1514002	LAKEWOOD TOWNSHIP MUA	TOWBIN AVE	Q4F	4/18/2000	4.5		
1514002	LAKEWOOD TOWNSHIP MUA	WELL #5	USGS	4/20/1998	5.1	0.93	1.05
1514002	LAKEWOOD TOWNSHIP MUA	WELL #10	USGS	4/22/1998	4.6	1.6	0.56
1514002	LAKEWOOD TOWNSHIP MUA	WELL #5 - POE	POE	9/28/1998	3		
1514002	LAKEWOOD TOWNSHIP MUA	WELLS #6,8,9,10	POE	9/28/1998	4		
1514002	NJAWC - LAKEWOOD SYSTEM	#691 NEW HAMPSHIRE	Q1	9/1/1999	3.1		
1514002	LAKEWOOD TOWNSHIP MUA	#3 TOWBIN AV& RTE 70	Q2	12/21/1999	3.8		
1515001	LAVALETTE WATER	WELL #5 - POE	POE	10/5/1998	2		
1515001	LAVALETTE WATER	1306 GRAND CENTRAL	CP	3/31/1999			
1516001	LITTLE EGG HARBOR MUA	965 RADIO RD	D	12/6/2000	0.19		
1516001	LITTLE EGG HARBOR TWP MUA	WELL #6 - POE	POE	9/23/1998	0.38		
1517001	LONG BEACH TOWNSHIP -	WELLS #3 & #4 - POE	POE	8/12/1998	0.48		
1517002	LONG BEACH TOWNSHIP -	ROOSEVELTAVE-WELL #2	POE	8/12/1998	0.21		
1517002	LONG BEACH TOWNSHIP -	23 WASHINGTON AVE	CP	11/10/1999			

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1517003	LONG BEACH TOWNSHIP -	#8 LAGOON DRIVE N.	D	8/12/1998	0.54			
1517003	LONG BEACH TOWNSHIP -	3 STARBOARD RD	CP	9/9/1999				
1517004	LONG BEACH TOWNSHIP -	#57 LONG BEACH BLVD	D	8/12/1998	0.32			
1517004	LONG BEACH TOWNSHIP -	59 LONG BEACH BLVD	CP	9/9/1999				
1517005	LONG BEACH TOWNSHIP -	#107A LONGBEACH BLVD	D	8/12/1998	1.3			
1517005	LONG BEACH TOWNSHIP -	120 LONG BEACH BLVD	CP	10/25/1999				
1517006	LONG BEACH TOWNSHIP - HIGH	#212 ALMA	D	8/12/1998	0.8			
1517006	LONG BEACH TOWNSHIP - HIGH	35 SUNSET BLVD	CP	10/25/1999				
1518001	CEDAR GLEN HOMES INC.	WELLS #2 & #3 - POE	POE	8/24/1998	4.9			
1518002	CEDAR GLEN LAKES	MICHIGAN AVE	D	6/26/1901				
1518002	CEDAR GLEN LAKES WATER	WELL #1	USGS	5/11/1998	0.98	0.07		
1518002	CEDAR GLEN LAKES WATER	WELL #2 - POE	POE	8/24/1998	1.2			
1518003	CEDAR GLEN WEST WATER	WELL #2 - POE	POE	8/24/1998	10	1.3	1.1	
1518003	CEDAR GLEN WEST WATER	REC CENTER	Q1	12/9/1998	7.9	1.4	0.8	
1518003	CEDAR GLEN WEST WATER	COMMUNITY CENTER	Q2	3/15/1999	5.6	0.89		
1518003	CEDAR GLEN WEST WATER	COMMUNITY CENTER	Q3	5/26/1999	6.5	0.95		
1518003	CEDAR GLEN WEST WATER	REC CENTER	Q4F	8/2/1999	12	1.4	1.6	
1518004	CRESTWOOD VILLAGE WATER	INDEPENDENCE HALL	D	12/13/2000	41.3	3.84	6.37	
1518004	CRESTWOOD VILLAGE WATER	WELL #8	USGS	11/17/1997	10.1	0.95	1.4	
1518004	CRESTWOOD VILLAGE WATER	WELL #10 - POE	POE	8/24/1998	5.4			
1518004	CRESTWOOD VILLAGE WATER	WELLS #3,#4,#5 - POE	POE	8/24/1998	7.7	1.4		
1518004	CRESTWOOD VILLAGE WATER	UNITY HALL #3	Q1	12/9/1998	10	0.76	1.2	
1518004	CRESTWOOD VILLAGE WATER	UNITY HALL #3	Q2	3/16/1999	11	0.6	0.86	
1518004	CRESTWOOD VILLAGE WATER	UNITY HALL	Q3	6/22/1999	17	1.9	1.8	0.22
1518004	CRESTWOOD VILLAGE WATER	IND HALL	Q4F	10/13/1999	7.3	0.99	1.5	
1518005	MANCHESTER TWP	MANCHE VOL FIRE CO 1	D	11/14/2000	5.7	0.96	0.78	
1518005	MANCHESTER TOWNSHIP	WELL #1	USGS	5/4/1998	14.9	3.4	1.16	
1518005	MANCHESTER TOWNSHIP	WELLS #1,#2,#3 - POE	POE	8/24/1998	9.5	3.5	0.79	
1518005	MANCHESTER TOWNSHIP	WELL #7	POE	8/24/1998	8.4	0.74		
1518005	MANCHESTER TOWNSHIP	MUNICIPAL BUILDING	Q1	12/9/1998	6.1	2	0.48	
1518005	MANCHESTER TOWNSHIP	MUNI BLDG	Q2	3/15/1999	9.5	2.9		
1518005	MANCHESTER TOWNSHIP	MUNI BLDG	Q3	5/26/1999	8.5	2.6		
1518005	MANCHESTER TOWNSHIP	MUNI BLDG	Q4F	8/2/1999	9.1	3.6	1	
1518007	RIDGEWAY PARK SYSTEM #1	1A RIDGEWAY LANE	CP	10/16/1997	9.1	2.5	1.7	
1518007	RIDGEWAY PARK SYSTEM #1	WELL #1 - POE	P	8/24/1998	16	2.4	1.8	
1518007	RIDGEWAY PARK SYSTEM #1	#28 CIRCLE WAY	Q1	12/9/1998	9.5	2.3	2.3	
1518007	RIDGEWAY PARK SYSTEM #1	#103	Q2	3/15/1999	14	2.9	2.3	

1518007	RIDGEWAY PARK SYSTEM #1		Q2-2	5/26/1999	14	2.6	2.2	
1518007	RIDGEWAY PARK SYSTEM #1	101 CIRCLE DRIVE	Q3	8/2/1999	12	2.2	2	
1518007	RIDGEWAY PARK SYSTEM #1	#153 ARNOLD	Q4F	10/13/1999	14	2.3	2	0.13
1518009	RIDGEWAY PARK SYSTEM #2	WELL #2 - POE	P	8/24/1998	16	1.8	1.8	
1518009	RIDGEWAY PARK SYSTEM #2	#170 ARNOLD	Q1	1/26/1999	14	2.4	2.3	
1518009	RIDGEWAY PARK SYSTEM #2	#77	Q2	3/15/1999	13	2.5	2.2	
1518009	RIDGEWAY PARK SYSTEM #2	#26	Q3F	8/2/1999	14	2.6	1.9	
1518010	BECKERVILLE PINES	#11-2	D	8/24/1998	7.5	0.8		
1518010	BECKERVILLE PINES	11-4	Q1	12/9/1998	7.4	0.38	1.2	
1518010	BECKERVILLE PINES	#20-2	Q2	3/15/1999	4.4			
1518010	BECKERVILLE PINES	#1	Q3	5/26/1999	3.8			
1518010	BECKERVILLE PINES	17-2 MANOR DRIVE	CP	5/26/1999				
1518010	BECKERVILLE PINES	#20	Q4F	8/2/1999	5.5			
1520001	OCEAN TOWNSHIP MUA	WELL #6 - POE	POE	9/23/1998	0.48			
1520001	OCEAN TOWNSHIP MUA	WELLS #3 & #4 - POE	POE	9/23/1998	3			
1521001	OCEAN GATE WATER	WELLS #2 & #4 - POE	POE	9/30/1998	0.29			
1521001	OCEAN GATE WATER	151 E. LONGPORT AVE	D	1/20/1999				
1522001	PINE BEACH WATER	RIVERSIDE DRIVE	D	6/18/1997	4.8			
1522001	PINE BEACH WATER	WELLS #1 & #2 - POE	P	9/30/1998	5.7	0.86	0.73	
1523001	COLLIERS MOBILE ESTATES	MAIN WELL - POE	POE	9/28/1998	0.18			
1523002	JENSEN'S DEEP RUN ADULT	WELL #2 - POE	POE	9/28/1998	0.2			
1523002	JENSEN'S DEEP RUN ADULT	WELLS #3 & #4 - POE	P	9/28/1998	0.22			
1523003	NEW EGYPT WATER COMPANY	WELL #2 - POE	POE	10/7/1998	2.9			
1523003	NEW EGYPT WATER COMPANY	61 MAIN STREET	CP	4/14/1999				
1523004	OAK GROVE MOBILE HOME	#217 0FF RTE 528	CP	8/24/1998				
1523004	OAK GROVE MOBILE HOME	WELL #1 - POE	POE	9/28/1998	0.67			
1524001	POINT PLEASANT WATER	BEAVER DAM RD	CP	4/18/2000				
1524001	POINT PLEASANT WATER	WELL #4 - POE	P	10/5/1998	10	1.8	2.1	
1524001	POINT PLEASANT WATER	MUNI BLDG	Q1	3/16/1999	12	1.2	0.94	
1524001	POINT PLEASANT WATER	MUNI BLDG	Q2	6/15/1999	10	1.1	1.2	
1524001	POINT PLEASANT WATER	MUNI BLDG	Q3	8/9/1999	12	0.86	1.1	
1524001	POINT PLEASANT WATER	MUNI BLDG	Q4F	11/22/1999	9.3	1.6	1.1	
1525001	POINT PLEASANT BEACH	WELL #12 - POE	POE	10/5/1998	3			
1526001	SEASIDE HEIGHTS WATER	WELLS #2 & #6 - POE	POE	10/5/1998	-5.2			
1526001	SEASIDE HEIGHTS WATER	WELL #7 - RAW	NWT	12/16/1998	1.8			
1527001	SEASIDE PARK WATER	WELL #6 - POE	POE	10/5/1998	-0.75			
1528001	SHIP BOTTOM WATER	WELLS #4 & #5	POE	9/21/1998	0.05			

1528001	SHIP BOTTOM WATER	1621 LONG BEACH BLVD	CP	10/25/1999			
1530001	WEST BAY VILLAGE	WELLS #1 & #2	POE	8/26/1998	1.3		
1530001	WEST BAY VILLAGE	270 TREE LANE	CP	6/17/1999			
1530003	STAFFORD TOWNSHIP MUA -	MUNICIPAL BLDG	D	8/26/1998	0.22		
1530003	STAFFORD TOWNSHIP MUA -	43 RAILROAD AVENUE	CP	8/30/1999			
1530004	STAFFORD TOWNSHIP MUA -	WELLS #5 & #6	POE	8/26/1998	0.84		
1530004	STAFFORD TOWNSHIP MUA -	1199 MILL CREEK RD	CP	8/30/1999			
1530005	STAFFORD TOWNSHIP MUA -	WELLS #1 & #2 - POE	POE	8/26/1998	1.3		
1530005	STAFFORD TOWNSHIP MUA -	1502 FORECASTLE AVE	CP	9/10/1998			
1530007	CEDAR RUN SENIOR CITIZEN	WELLS #1 & #2 - POE	POE	8/26/1998	1.3		
1530007	CEDAR RUN SENIOR CITIZEN	240 RTE 9	CP	8/30/1999			
1531001	SURF CITY WATER	WELL #4	POE	9/21/1998	1.1		
1532002	TUCKERTON WATER & SEWER	WELLS #2 - POE	POE	9/23/1998	0.29		
1532002	TUCKERTON WATER & SEWER	WELL #3	NWT	10/28/1998	0.04		
1533001	BARNEGAT TOWNSHIP WATER	WELL #5 MIRAGE BLVD	R	3/7/2000	6	1	0.46
1533001	BARNEGAT TOWNSHIP WATER	WELL #4	POE	9/21/1998	3.5		
1533001	BARNEGAT TOWNSHIP WATER	219 PINE OAK BLVD	CP	11/16/1998			
1533002	PINEWOOD ESTATES	WELL #1 – POE	POE	9/21/1998	0.34		
1601001	BLOOMINGDALE WATER	MUNICIPAL BUILDING	D	5/20/1998	0.4		
1601001	BLOOMINGDALE WATER	101 HAMBURG TPK	CP	5/10/1999			
1603001	HALEDON WATER	DISTRIBUTION	D	6/3/1998	0.99		
1603001	HALEDON WATER	WILLOWBROOK COURT	CP	7/6/1999			
1604001	HAWTHORNE WATER	WELLS3,4,5,6,7,8& CM	P	1/7/1998	0.23		
1604001	HAWTHORNE WATER	345 LAFAYETTE AVENUE	CP	2/17/1998	2		
1605001	NJ AMERICAN WATER	19 WARRON ST	D	6/28/1901			
1605001	NEW JERSEY AMERICAN	MUNICIPAL BUILDING	D	5/20/1998	0.31		
1605002	PASSAIC COUNTY WATER	POE	P	5/20/1998	0.97		
1609001	POMPTON LAKES MUA	25 LENOX AVE	CP	7/11/2000			
1609001	POMPTON LAKES MUA	WELL #3 - POE	POE	6/3/1998	3.2		
1611002	RINGWOOD WATER	WELL #9R	POE	7/8/1998	0.88		
1611002	RINGWOOD WATER	4 COUNTRYSIDE LANE	CP	10/27/1998			
1612001	TOTOWA WATER	UNION BOULEVARD	CP	2/17/1998	0.31		
1612001	TOTOWA WATER	MUNICIPAL BUILDING	D	6/3/1998	0.46		
1613001	NJDWSC WANAQUE NORTH	1 F.A. ORECHIO DR	CP	3/9/2000			
1613001	NEW JERSEY DISTRICT	1 F.A. ORRECHIO DR	P	11/16/2000			
1613001	NJWDSC WANAQUE NORTH	TREATMENT PLANT	POE	5/20/1998	0.52		
1613002	WANAQUE WATER DEPT	661 RINGWOOD AVE	D	8/9/190			

1613002	WANAQUE WATER	WELL #1 - RAW	R	1/7/1998	2.1			
1614001	WAYNE WATER DEPARTMENT	475 VALLEY RD	D	11/30/2000	0.4			
1614001	WAYNE TOWNSHIP - DIVISION	MUNICIPAL BLDG	D	6/3/1998	-0.03			
1614001	WAYNE TOWNSHIP - DIVISION	475 VALLEY ROAD	NGL	1/25/1999				
1615001	BIRCH HILL MUNICIPAL WATER	30 McKINLEY PLACE	CP	2/17/2000				
1615001	BIRCH HILL MUNICIPAL WATER		POE	5/18/1998	7.7	0.1		
1615001	BIRCH HILL MUNICIPAL WATER	#30 McKINLEY	Q1	9/9/1998	7.6	0.11		
1615001	BIRCH HILL MUNICIPAL WATER	#30 MCKINLEY	Q2	12/8/1998	7.1	-0.04		
1615001	BIRCH HILL MUNICIPAL WATER	#30 McKINLEY	Q3	3/17/1999	8.9	0.26		
1615001	BIRCH HILL MUNICIPAL WATER	#30 McKINLEY	Q4	6/21/1999	6.3	0.37		
1615001	BIRCH HILL MUNICIPAL WATER	#30 MC KINLEY	Q5F	8/11/1999	13	0.34	0.07	
1615002	WEST MILFORD TWP MUA -	WELL #2 - POE	P	5/18/1998	12	1.3		
1615002	WEST MILFORD TWP MUA -	#8 GREENBROOK	Q1	9/9/1998	2			
1615002	WEST MILFORD TWP MUA -	POST OFFICE	Q2	12/8/1998	6.3	1.5	0.44	
1615002	WEST MILFORD TWP MUA -	30 GREENBROOK DRIVE	CP	12/15/1998				
1615002	WEST MILFORD TWP MUA -	POST OFFICE	Q3	3/17/1999	4.3			
1615002	WEST MILFORD TWP MUA -	US POST OFFICE	Q4	6/21/1999	6	1.2		
1615002	WEST MILFORD TWP MUA -	POST OFFICE	Q5F	8/11/1999	7.6	1.8	0.27	
1615003	PASSAIC VALLEY WATER CO -	160 HIGHCREST DR	CP	5/11/2000				
1615003	PASSAIC VALLEY WC - HIGH	NOT INDICATED	D	5/20/1998	0.38			
1615006	WEST MILFORD TOWNSHIP	WELL #1 - POE	P	5/18/1998	3.4			
1615006	WEST MILFORD TOWNSHIP	12 MAISIE LANE	CP	4/29/1999				
1615008	PASSAIC VALLEY WC -	1 POST BROOK N.	CP	4/6/1998	1.4			
1615008	PASSAIC VALLEY WC -	GORMLY & RIDAN WELLS	P	5/20/1998	2.6			
1615009	REFLECTION LAKES GARDEN	B6 1181 UNION VAL RD	CP	6/21/2000				
1615009	REFLECTION LAKES	WELL #1 - POE	POE	7/8/1998	0.63			
1615012	WEST MILFORD TOWNSHIP	16 BOARD ROAD	CP	2/17/2000				
1615012	WEST MILFORD TOWNSHIP	WELLS 3 & 3A - POE	P	5/18/1998	1.8			
1615014	WEST MILFORD TOWNSHIP	WELL #3 - POE	P	5/18/1998	1.2			
1615016	WEST MILFORD TOWNSHIP	196 VREELAND RD	CP	6/21/2000				
1615016	WEST MILFORD TOWNSHIP	WELLS #1,2 & 3 - POE	P	5/18/1998	2.5			
1615016	WEST MILFORD TOWNSHIP	WELL #5 - POE	P	5/18/1998	4.8			
1615017	WONDER LAKE PROPERTIES	5 WALKER AVE	CP	4/6/1998	1.4			
1615017	WONDER LAKE PROPERTIES	WELL #1 - POE	POE	7/8/1998	0.1			
1615018	WEST MILFORD TOWNSHIP	WELL #1 - POE	P	5/18/1998	1.2			
1615020	UNITED WATER - WEST	RICHMOND RD	CP	3/9/2000				
1615020	UNITED WATER - WEST	WELL A	NWT	1/15/1998	22	0.6		4.2

1615020	UNITED WATER - WEST	T3	NWT	1/15/1998	23	1.2	1.3	11.7
1615020	UNITED WATER - WEST	WELL #2 - RICHMOND P	P	5/18/1998	9.2	0.09		
1615020	UNITED WATER - WEST	GRANGE HALL	Q1	9/9/1998	7.1	0.08		
1615020	UNITED WATER - WEST	HERITAGE HOUSE	Q2	12/8/1998	4.8			
1615020	UNITED WATER - WEST	#5 RICHMOND	Q3	3/17/1999	5.7	0.18		
1615020	UNITED WATER - WEST	HERITAGE HOUSE	Q4	6/21/1999	6.3	0.09		
1615020	UNITED WATER - WEST	HERITAGE HOUSE	Q5F	8/11/1999	11	0.19	0.02	
1616001	WEST PATERSON WATER	MUNICIPAL BLDG	D	6/3/1998	0.41			
1616001	WEST PATERSON WATER	50 LINCOLN LANE	CP	10/7/1999				
1702001	ELMER BORO WATER	DISTRIBUTION	D	10/1/1997	0.19			
1702001	ELMER BORO WATER	120 SOUTH MAIN ST	CP	12/10/1997	1.1			
1704001	LEISURE ARMS COMPLEX	WELLS #1 & #2 POE	P	9/29/1997	0.21			
1704001	LEISURE ARMS COMPLEX	622 NEW BRIDGE ROAD	CP	5/6/1999				
1706001	AUBURN VILLAGE WATER	39 MAIN ST	CP	5/2/2000				
1706001	AUBURN VILLAGE WATER	WELL #2	R	7/22/1997	2.2			
1706001	AUBURN VILLAGE WATER	WELL #1 - POE	P	10/1/1997	1.7			
1707001	PENNS GROVE WATER	MUNICIPAL BLDG D	USGS	6/5/2000	27	1.2	1.1	
1707001	PENNS GROVE WATER	RAW	USGS	6/5/2000	11	1.4	2	
1707001	PENNS GROVE WATER	POE	USGS	6/5/2000	11	0.96	2	
1707001	PENNS GROVE WATER	WELL #7 - POE	P	9/29/1997	2.1			
1707001	PENNS GROVE WATER	WELLS #2 & #11 - POE	P	9/29/1997	2.5			
1708001	PENNSVILLE WATER DEPT	640 GREENWOOD AVE	P	12/13/2000	0.36			
1708001	PENNSVILLE WATER	WELLS #4 & #5 -POE	P	9/29/1997	0.45			
1708001	PENNSVILLE WATER	WELLS 1 & 2 - POE	P	9/29/1997	1.4			
1708001	PENNSVILLE WATER	WELLS #3A & 6 - POE	P	9/29/1997	1.9			
1708001	PENNSVILLE TOWNSHIP	90 N. BROADWAY	CP	5/14/1998				
1708001	PENNSVILLE TOWNSHIP	WELL #8 - R	NWT	7/14/1999	5.2			
1708001	PENNSVILLE TOWNSHIP	WELL #7 - R	NWT	7/14/1999	15	1.4	0.17	
1710001	HARDING WOODS MHP	SALES OFFICE	Q3	1/5/2000	8	1.4	0.4	
1710001	HARDING WOODS MHP	SALES OFFICE	Q4F	4/10/2000	3.3			
1710001	HARDING WOODS MHP	WELLS #1 & #2 - POE	P	10/6/1997	4.1			
1710001	HARDING WOODS MHP	HARDING DRIVE	CP	1/22/1998	8.3	1.4	0.91	
1710001	HARDING WOODS MHP	#4 HAZELWOOD	Q1	9/8/1999	6.4	1.7	0.26	
1710001	HARDING WOODS MHP	SALES OFFICE	Q2	10/18/1999	4.3			
1710002	HOLLY TREE ACRES MHP	WELL #1 - POE	P	10/6/1997	1.3			
1710002	HOLLY TREE ACRES MHP	WELL #2 - POE	P	10/6/1997	3.6			
1710002	HOLLY TREE ACRES MHP	WELL #3 & #4 - POE	P	10/6/1997	8.5	4.1	1.6	

1710002	HOLLY TREE ACRES MHP	#90 DOGWOOD	Q1	2/10/1998	16.6	5	1.7	
1710002	HOLLY TREE ACRES MHP	#2 DOGWOOD	Q2	6/30/1998	18	6.1	1.8	
1710002	HOLLY TREE ACRES MHP	#20	Q3	9/14/1998	2.6			
1710002	HOLLY TREE ACRES MHP	#11 BURD	Q4F	12/28/1998	1.4			
1710002	HOLLY TREE ACRES MHP	#12 DOGWOOD LANE	D	1/19/1999				
1710003	PICNIC GROVE	#6 DENNIS PL.	D	1/9/1902				
1710003	PICNIC GROVE MOBILE HOME	WELL #2 - POE	P	10/6/1997	2.1			
1710003	PICNIC GROVE MOBILE HOME	WELL #3 - POE	P	10/6/1997	4.8			
1710003	PICNIC GROVE MOBILE HOME	WELL #1 - POE	P	10/6/1997	7	1.4	1.2	
1710006	HARRISON MOBILE HOME PARK	WELL #1 - POE	P	10/6/1997	13	3.7	3.2	
1710006	HARRISON MOBILE HOME PARK	WELL #2 - POE	P	10/6/1997	3.2			
1710006	HARRISON MOBILE HOME PARK	#7	Q1	2/10/1998	28	3.3	2.7	
1710006	HARRISON MOBILE HOME PARK	#23	Q2	6/17/1998	24	3.3	2.8	
1710006	HARRISON MOBILE HOME PARK	#23	Q3	9/14/1998	19	3.6	2.3	
1710006	HARRISON MOBILE HOME PARK	#23	Q4F	12/28/1998	13	3.4	2.6	
1710006	HARRISON MOBILE HOME PARK	WELL #2 - STELK DR.	R	7/26/1999	7.3	1.1	1.1	
1710006	HARRISON MOBILE HOME PARK	WELL #1 - STELLA DR.	R	7/26/1999	19	4	3.1	0.25
1710007	HOLLY TREE ACRES MHP	#2 DOGWOOD	Q1	12/28/1998	17	5.6	1.8	
1710007	HOLLY TREE ACRES MHP	#11	Q2	3/31/1999	1			
1710007	HOLLY TREE ACRES MHP	#1 BUDD	Q3	6/22/1999	3.1			
1710007	HOLLY TREE ACRES MHP	LOT #1	Q4F	8/23/1999	3.1			
1712001	SALEM WATER DEPARTMENT	5TH & GRIFFITH STS	CP	5/2/2000				
1712001	SALEM CITY WATER	GROUND & SURFACE POE	P	9/29/1997	2.2			
1712001	SALEM CITY WATER	WELL #5 - RAW	R	9/29/1997	1.4			
1713001	HANDY'S MOBILE HOME PARK	WELL #2 - POE	P	10/1/1997	0.69			
1713001	HANDY'S MOBILE HOME PARK	WELL #1 - POE	P	10/1/1997	0.24			
1713001	HANDY'S MOBILE HOME PARK	#129 E.QUILLYTOWN RD	CP	5/14/1998				
1714001	COUNTRY CLUB ESTATES MHP	WELL #2 - POE	P	10/1/1997	0.88			
1714001	COUNTRY CLUB ESTATES MHP	WELL #1 - POE	P	10/1/1997	3.3			
1714001	COUNTRY CLUB ESTATES MHP	F11 WELKER DRIVE	CP	4/29/1998				
1714001	COUNTRY CLUB ESTATES MHP	195A PLACID PINE LAN	CP	7/14/1999				
1715001	WOODSTOWN WATER	MUNI BLDG	Q3	1/5/2000	2.3			
1715001	WOODSTOWN WATER	MUNIC BLDG	Q4F	4/10/2000	4.3			
1715001	WOODSTOWN WATER	WELL #2 - POE	P	10/1/1997	2.4			
1715001	WOODSTOWN WATER	WELL #3 - RAW	R	10/1/1997	5.7	0.13		
1715001	WOODSTOWN WATER	WEST AVE & N. MAIN	CP	12/10/1997	7.9	-0.18		
1715001	WOODSTOWN WATER	WELL #5 - NWT	NWT	4/29/1998	1.4			

1715001	WOODSTOWN WATER	MUNI BLDG	Q1	9/8/1999	2.9		
1715001	WOODSTOWN WATER	MUNI BLDG	Q2	10/18/1999	3		
1803002	TWIN LAKES ASSOCIATION	11 HILLSIDE AVENUE	D	11/19/1997	2.7		
1808001	FRANKLIN TOWNSHIP DPW	505 DEMOTT LANE	CP	1/31/2000			
1808001	FRANKLIN TOWNSHIP DPW	475 DEMOTT LANE	D	11/19/1997	1.1		
1811001	MANVILLE WATER	429 S. MAIN STREET	Q1	10/30/1997	4.8		
1811001	MANVILLE WATER	WELLS #9, #12, C1	P	11/19/1997	8	0.14	
1811001	MANVILLE WATER	MUNICIPAL BUILDING	Q2	2/4/1998	0.39		
1811001	MANVILLE WATER	MUNICIPAL BUILDING	Q3	6/22/1998	0.64		
1811001	MANVILLE WATER	MUNI BLDG	Q4	9/9/1998	0.49		
1811001	MANVILLE WATER	MUNI BLDG	Q5F	6/21/1999	0.15		
1817001	ROCKY HILL WATER	152/154 WASHINGTON A	CP	10/30/1997	2.5		
1817001	ROCKY HILL WATER	WELL #2 - POE	P	11/19/1997	1.8		
1901001	ANDOVER BORO WATER	137 MAIN STREET	CP	2/18/1998	2.7		
1901001	ANDOVER BORO WATER	WELL #1 - POE	P	12/20/1999	2.9		
1902003	LAKE LENAPE WATER	WELL #1 - POE	POE	5/6/1998	2.6		
1902004	ANDOVER WATER	WELL #1 - POE	P	11/24/1997	1.5		
1902004	ANDOVER WATER	WELL #1 - POE	POE	4/29/1998	1.2		
1902004	ANDOVER WATER	WELL #1 - POE	P	12/20/1999	1.2		
1902005	ASCOT PARK APARTMENTS	WELL #2 - POE	P	11/24/1997	4.1		
1902007	ROLLING HILLS CONDOMINIUMS	WELLS #1 & #2	POE	4/29/1998	0.79		
1903001	BRANCHVILLE WATER	MAIN STREET DELI	Q3	2/28/2000	4.1		
1903001	BRANCHVILLE WATER	LUNCHEONETTE	Q4F	6/25/2000	1.1		
1903001	BRANCHVILLE WATER	WELL #1	R	3/18/1998	2.4		
1903001	BRANCHVILLE WATER	RAILROAD	NWT	11/17/1998	16		17.3
1903001	BRANCHVILLE WATER	AG RESTAURANT	Q1	6/23/1999	3.7		
1903001	BRANCHVILLE WATER	#11 MAIN STREET	Q2	12/7/1999	1.4		
1904001	BROOKWOOD MUSCONETCONG	26 MAYNE	D	11/24/1997	3.1		
1904001	BROOKWOOD MUSCONETCONG	75 RIVER ROAD	CP	5/20/1999			
1904002	EAST BROOKWOOD PROPERTY	9 BROOKWOOD ROAD	D	11/24/1997	4.1		
1904003	FOREST LAKES WATER	43 SLEEPY HOLLOW RD	CP	6/8/2000			
1904003	FOREST LAKES WATER	WELL #1 - POE	P	11/24/1997	1.1		
1904004	NORTH SHORE WATER	WELL #1 - POE	P	11/24/1997	4.3		
1904004	NORTH SHORE WATER	28 ALLAMUCHY TWP	CP	9/14/1998			
1904006	STRAWBERRY POINT	32 STRAWBERRY PT DR.	CP	4/24/2000			
1904006	STRAWBERRY POINT	WELL #2 - POE	P	11/24/1997	1.4		
1904007	COLBY WATER COMPANY	WELL #7 - POE	P	11/24/1997	0.99		

1904007	COLBY WATER COMPANY	4 COLBY DRIVE	CP	9/14/1998				
1904008	WILLOR MANOR WATER	#16 BIRCH DRIVE	D	11/24/1997	8	0.24		
1904008	WILLOR MANOR WATER	#14 BIRCH	Q1	3/9/1998	6.9	0.44		
1904008	WILLOR MANOR WATER	#14 BIRCH	Q2	6/24/1998	7.9	0.34		
1904008	WILLOR MAN0R WATER	#14 BIRCH	Q3	9/16/1998	17	0.12		6.6
1904008	WILLOR MANOR WATER	16 BIRCH	Q4F	12/29/1998	3.3			
1904009	BYRAM HOMEOWNERS	10 CARLISLE DR.	CP	4/24/2000				
1904009	BYRAM HOMEOWNERS	WELL #1	P	11/24/1997	12	0.07		
1904009	BYRAM HOMEOWNERS	94 LYNN DRIVE	Q1	3/9/1998	13.8	0.14		
1904009	BYRAM HOMEOWNERS	#20	Q2	6/24/1998	9.8	0.12		
1904009	BYRAM HOMEOWNERS	#20 LYNN DRIVE	Q3F	9/16/1998	36	5.2	1.6	24
1905002	CULVER LAKE WATER		POE	5/13/1998	0.75			
1906001	HILLSIDE ESTATES AT	WELLS #1 & #2 - POE	P	5/6/1998	11	0.14		
1906001	HILLSIDE ESTATES AT	11 SKYVIEW	Q1	12/29/1998	5			
1906001	HILLSIDE ESTATES AT	#47 CEDAR	Q2	3/30/1999	8	0.03		
1906001	HILLSIDE ESTATES AT	#13 SKYVIEW	Q3	6/23/1999	23	0.26	1	2.9
1906001	HILLSIDE ESTATES AT	#28	Q4F	12/7/99	17	0.08	0.01	3.7
1906002	FRANKLIN BOARD OF PUBLIC	WELL #1 - POE	P	5/6/1998	9.9	0.65		
1906002	FRANKLIN BOARD OF PUBLIC	MUNICIPAL BLDG	Q1	12/29/1998	3.7			
1906002	FRANKLIN BOARD OF PUBLIC	MUNI BLDG	Q2	3/30/1999	3.5			
1906002	FRANKLIN BOARD OF PUBLIC	MUNI BLDG	Q3	6/23/1999	7.8	0.62		
1906002	FRANKLIN BOARD OF PUBLIC	MUNI BLDG	Q4F	12/7/1999	4.6			
1907001	GREEN HILL ESTATES	30 GLENN TERRACE	CP	2/18/1998	0.67			
1907001	GREEN HILL ESTATES	WELL #2 - POE	POE	4/29/1998	2.5			
1907002	BEAR BROOK VILLAGE	WELL #3	NWT	2/9/1999	3.1			
1907002	BEAR BROOK VILLAGE	WELL #2	NWT	2/9/1999	3.9			
1908001	TRANQUILITY SPRINGS	WELL #1 - MACKERLEY	NWT	9/14/1999	0.99			
1908001	TRANQUILITY SPRINGS	WELL #3A - MACKERLY	NWT	9/14/1999	1.4			
1908001	TRANQUILITY SPRINGS	WELL #4 - MACKERLY	NWT	9/14/1999	0.9			
1909001	HAMBURG BOARD OF PUBLIC	WELLS #2 & #3	POE	4/29/1998	1.5			
1910002	CARRIAGE MOBILE HOMES INC	WELL #1 - POE	POE	4/29/1998	1			
1910002	CARRIAGE MOBILE HOMES INC	12 BRIARWOOD LANE	CP	6/15/1998				
1910003	UNITED WATER HAMPTON INC.	ORIOLE TERRACE	CP	7/19/2000				
1910003	UNITED WATER - HAMPTON	WELL #2 - POE	POE	4/29/1998	4.8			
1911001	WALLKILL WATER COMPANY -	WELL #3 - POE	POE	5/4/1998	1.3			
1911002	LAKE STOCKHOLM INC	21 FERNWOOD	D	5/4/1998	0.3			
1911002	LAKE STOCKHOLM INC	19 FERNWOOD AVENUE	CP	8/26/1998				

1911003	LAKE TAMARACK WATER	WELL #3 - POE	POE	5/4/1998	1.3			
1911003	LAKE TAMARACK WATER	86 TAMARACK TRAIL	CP	8/26/1998				
1911004	SPARTA TOWNSHIP WU -	WELL #1 - POE	P	5/4/1998	6.4	0.3		
1911005	HARDYSTON TOWNSHIP MUA -	WELL #1 - POE	POE	5/4/1998	-0.54			
1911005	HARDYSTON TOWNSHIP MUA -	15 MEADOW POND ROAD	CP	3/10/1999				
1911006	HARDYSTON TOWNSHIP MUA -	CRYSTAL SPRINGS RD	CP	5/17/2000				
1911006	HARDYSTON TOWNSHIP MUA -	TREATMENT PLANT	POE	5/4/1998	0.93			
1912001	HOPATCONG WATER	WELL #4	POE	4/20/1998	1.6			
1912001	HOPATCONG WATER	111 RIVER STYX ROAD	CP	3/11/1999				
1912005	HOPATCONG WATER	126 BROOKLYN STAN RD	CP	4/4/2000				
1912005	HOPATCONG WATER	RAND STREET WELL	POE	4/20/1998	1.4			
1912007	ARTHUR ROAD WELL	WELL #1	POE	4/20/1998	0.39			
1912007	ARTHUR ROAD WELL	6 PHILIP ROAD	CP	7/28/1999				
1912008	FRANCIS AVENUE	WELL #1	POE	4/20/1998	0.43			
1912010	CHARLES ST COMMUNITY	11 CHARLES PLACE	CP	4/4/2000				
1912010	CHARLES STREET COMMUNITY	WELL #1 - POE	POE	4/20/1998	2.2			
1914002	MONTAGUE WATER COMPANY	WELLS #1,#2,#3-POE	P	1/5/1998	2.8			
1915001	NEWTON WATER & SEWER	MORRIS LAKE - POE	P	5/13/1998	0.26			
1915001	NEWTON WATER & SEWER	56 WOODSIDE AVE	CP	7/8/1999				
1916001	OGDENSBURG WATER	WELL #4 - POE	POE	5/13/1998	2.9			
1918003	SPARTA TOWNSHIP WATER -	90 CASTLEWOOD DR.	CP	5/17/2000				
1918003	SPARTA TOWNSHIP WATER	POE	POE	4/8/1998	0.96			
1918003	SPARTA TOWNSHIP WATER	WELL #2 - RAW	NWT	11/18/1998	3.4			
1918004	SPARTA TOWNSHIP WATER	WELL #1 - POE	POE	5/6/1998	2.3			
1918004	SPARTA TOWNSHIP WATER	25 WEST SHORE TRAIL	CP	6/21/1999				
1918007	CREST ROAD ASSOCIATION	WELL #1 - POE	P	5/6/1998	12	0.12		
1918007	CREST ROAD ASSOCIATION	SPARTA TOWNSHIP	Q1	12/29/1998	3.7			
1918007	CREST ROAD ASSOCIATION	#6 BRIAR TERRACE	Q2	3/30/1999	7.7	-0.21	1.1	
1918007	CREST ROAD ASSOCIATION	7 BRIAR TERRACE	CP	6/21/1999				
1918007	CREST ROAD ASSOCIATION	#7 BRIAR TERRACE	Q3F	6/23/1999	5.9	0.27		
1918008	ROAMIN ACRES WATER	#11 SOUTH KEY	D	5/13/1998	1.4			
1918011	INACTIVATED 02/01/99							
1918011	SPARTA TOWNSHIP WU -	WELLS #1,3 & 4 - POE	POE	4/8/1998	20			37.7
1918011	SPARTA TOWNSHIP WU -	CANTERBURY DRIVE	Q	9/16/1998	27			28.9
1918011	SPARTA TOWNSHIP WU -	#6 GRIST MILL	Q1*	3/30/1999	33	0.19	0.99	24
1918011	SPARTA TOWNSHIP WU -	#6 GRIST MILL	Q2*	6/23/1999	330	0.39	0.02	71
1918013	SPARTA TOWNSHIP WU -	MORNINGSTAR DRIVE	POE	4/8/1998	0.08			

1918013	SPARTA TOWNSHIP WU -	27 MORNINGSTAR RD	CP	8/26/1999				
1918014	SPARTA TOWNSHIP WU -	WELLS #1 & #2 - POE	POE	4/8/1998	0.11			
1918014	SPARTA TOWNSHIP WU -	10 STONEBRIDGE RD	CP	8/26/1999				
1918015	SPARTA TOWNSHIP WU -	POE	POE	4/8/1998	5.4			
1918015	SPARTA TOWNSHIP WU -	6 DAHN DRIVE	CP	8/26/1999				
1918016	SPARTA TOWNSHIP WATER		Q*	2/28/2000	340	0.07	0.04	66
1918016	SPARTA TOWNSHIP WATER	6 GRIST MILL	Q*	6/26/2000	102			78
1918016	SPARTA TOWNSHIP WU -	WELL #1 - POE	P	4/8/1998	6.9	0.13		
1918016	SPARTA TOWNSHIP WU -	142 SENECA LAKE RD	CP	8/9/1999				
1918016	SPARTA TOWNSHIP WU -	#6 GRIST MILL	SS	8/10/1999	223	-0.13	-0.01	69.3
1918016	SPARTA TOWNSHIP WU -	POE TREATED TAP	SS	8/10/1999	226	0.17	-0.01	66.5
1918016	SPARTA TOWNSHIP WU -		Q	8/18/1999	20			27
1918016	SPARTA TOWNSHIP WU -	WELLS #1 & #2 - POE	P	8/18/1999	64			73.9
1918016	SPARTA TOWNSHIP WU -	POE	Q3	8/18/1999	320	0.34	0.1	53.4
1918016	SPARTA TOWNSHIP WU -	#6 GRIST MILL	Q4	12/20/1999	42			46
1918019	SPARTA TWP WATER UTILITY	WELL #1 GAIL CT.	R	7/26/2000	2.2			
1918019	SPARTA TWP WATER UTILITY	WELL #2 GAIL CT.	R	7/26/2000	3.1			
1918019	SPARTA TOWNSHIP WU -	POE	POE	4/8/1998	2.2			
1918019	SPARTA TOWNSHIP WU	70 LAMBERT DRIVE	CP	8/9/1999				
1919001	STANHOPE WATER	WELL #5	POE	5/13/1998	0.59			
1920001	STILLWATER WATER	105 VALLEY VIEW TERR	CP	6/8/2000				
1920001	STILLWATER WATER	WELLS #10 & #11	P	9/16/1998	200	0.12		0.64
1920001	STILLWATER WATER	#906 RIDGE	Q1	12/29/1998	1.8			
1920001	STILLWATER WATER	906 RIDGE	Q2	3/30/1999	2.1			
1920001	STILLWATER WATER	#902 RIDGE	Q3	6/23/1999	8.2	1.6	1.8	
1920001	STILLWATER WATER	WELLS #10 & #11 - P	SS	8/3/1999	6.9	0.11	0.05	
1920001	STILLWATER WATER	936 WALNUT RD	SS	8/3/1999	8.7	0.36	0.08	
1920001	STILLWATER WATER	EDGEWOOD	P	9/15/1999	12	3	0.34	
1920001	STILLWATER WATER	914 DEER RUN	Q42	9/15/1999	6	0.54	0.19	
1920001	STILLWATER WATER	GRECO WELL - P	SS	9/15/1999	1.1			
1920001	STILLWATER WATER	WELL-SOUTH SHORE-P	SS	9/15/1999	1.2			
1920001	STILLWATER WATER	WELLS #10 & #11 -P	SS	9/15/1999	1.4			
1920001	STILLWATER WATER	37 VAIL DRIVE	Q4F	9/15/1999	0.76			
1920001	STILLWATER WATER	RIDGE WELL	P	9/15/1999	24	3.9	1.8	4.8
1921001	SUSSEX WATER DEPARTMENT		POE	5/13/1998	0.18			
1921001	SUSSEX WATER DEPARTMENT	74 FOUNTAIN SQUARE	CP	3/11/1999				
1922001	UNITED WATER VERNON HILLS	WELLS #1 & #2 - POE	P	9/22/1997	1.3			

1922003	UNITED WATER VERNON HILLS	WELL #1 - RAW	R	9/22/1997	17			18.9
1922003	UNITED WATER VERNON HILLS	#12 NIMBUS	Q1	12/15/1997	34	0.62		17.5
1922003	UNITED WATER VERNON HILLS	#12 NIMBUS	Q2	3/9/1998	21			18
1922003	UNITED WATER VERNON HILLS	#12 NIMBUS	Q3F	6/24/1998	17			18
1922003	UNITED WATER VERNON HILLS	11 NIMBUS DRIVE	CP	7/15/1999				
1922004	UNITED WATER VERN	WELL #1 - POE	P	9/22/1997	6.8	-0.04		
1922004	UNITED WATER VERN	7 BLUEBERRY LANE	CP	3/10/1999				
1922005	UNITED WATER VERN	WELL #1 - POE	P	9/22/1997	3			
1922005	UNITED WATER VERN	12 ANDREA DRIVE	CP	7/29/1999				
1922006	UNITED WATER VERN	WELL #1	P	9/22/1997	29	0.54	1.4	20.1
1922006	UNITED WATER VERN	#25 LAKE WALKILL	Q1	12/15/1997	37	0.34	1.1	23.7
1922006	UNITED WATER VERN	#29 LAKE WALKILL	Q2	3/9/1998	30	0.5	1.6	23.7
1922006	UNITED WATER VERN	#29 LAKE WALKILL	Q3F	6/24/1998	25			23.7
1922006	UNITED WATER VERN	1 PINE TERRACE WEST	CP	6/29/1999				
1922007	UNITED WATER VERN	WELL #1	P	9/22/1997	31	0.13		24.9
1922007	UNITED WATER VERN	#4 TIMBERLANE	Q1	12/15/1997	35	0.47		28
1922007	UNITED WATER VERN	#4 TIMBERVIEW	Q2	3/9/1998	36	0.27		28.9
1922007	UNITED WATER VERN	#4 TIMBERVIEW	Q3F	6/24/1998	21			29.8
1922007	UNITED WATER VERN	6 TIMBERVIEW DRIVE	CP	6/29/1999				
1922008	VERNON WATER COMPANY	WELLS #2,3,5 & 9-POE	P	9/24/1997	7.7	0.06		
1922008	VERNON WATER COMPANY	#81 WOODLAND	Q1	6/23/1999	17			14.8
1922008	VERNON WATER COMPANY	16 WOODLAND DRIVE	CP	7/29/1999				
1922008	VERNON WATER COMPANY	#81 WOODLAND	Q2	8/25/1999	32			35
1922008	VERNON WATER COMPANY	#36 WOODLAND	Q3	12/13/1999	180	0.72	1.4	52.4
1922009	VERNON WATER CO - OAK	#17 PARRISH	Q6*	2/28/2000	55	0.05	-0.02	13
1922009	VERNON WATER COMPANY -	WELL #31	POE	9/24/1997	18	0.13		11.9
1922009	VERNON WATER COMPANY -	#48 CEDAR BRIDGE	Q1	12/22/1998	20			24
1922009	VERNON WATER COMPANY -	WELL #48	Q2	3/23/1999	8.8	0.07		
1922009	VERNON WATER COMPANY -	#10 JANEL	Q3	6/23/1999	9.9	0.27		
1922009	VERNON WATER COMPANY -	VERNON TOWNSHIP	CP	6/29/1999				
1922009	VERNON WATER COMPANY	45 CEDAR RIDGE	Q4	8/25/1999	2.2			
1922009	VERNON WATER COMPANY -	#16 PARRISH	Q5	12/13/1999	39	0.1	0.08	10.3
1922010	LAKE GLENWOOD REALTY	33 LAKESHORE DR.	CP	5/22/2000				
1922010	LAKE GLENWOOD REALITY	WELL #6 HALLSHILL RD	R	6/20/2000	4.9			
1922010	LAKE GLENWOOD REALTY	WELL #1	P	9/24/1997	1			
1922011	SUNSET RIDGE WATER	#5 BLUE HERON - DIST	D	9/24/1997	10	0.19		
1922011	SUNSET RIDGE WATER	14 BLUE HERON	Q1	12/29/1998	4.2			

1922011	SUNSET RIDGE WATER	BLUE HERON #11	Q2	3/23/1999	6.9	0.28		
1922011	SUNSET RIDGE WATER	#11 BLUE HERON	Q3	6/23/1999	16	0.42	0.11	7.8
1922011	UNITED WATER VERNON HILLS	#11 BLUE HERON	Q4F	12/13/1999	21	0.42	0.13	7
1922012	UNITED WATER VERNON HILLS	WELLS #1&#2 - POE	P	9/24/1997	4.6			
1922012	UNITED WATER VERNON HILLS	10 CLOVER LANE	CP	5/25/1999				
1922013	DC WATER COMPANY	411 RTE 515	CP	9/8/1997	13	0.03		
1922013	DC WATER COMPANY	14 SUSAN DRIVE	D	9/24/1997	17			15.4
1922013	DC WATER COMPANY	#12 SUSAN VALLEY DR	Q1	12/22/1998	13	-0.03		
1922013	DC WATER COMPANY	#12 SUSAN VALLEY DR.	Q2	3/23/1999	22			17.5
1922013	DC WATER COMPANY	#12 SUSAN VALLEY	Q3F	6/23/1999	33	0.31	-0.05	17
1922013	DC WATER COMPANY	#12 SUSAN VALLEY	SS	8/17/1999	440	0.01	0.04	17
1922014	GREAT GORGE TERRACE	#37 OLD RUDETOWN RD.	CP	4/26/2000				
1922014	GREAT GORGE TERRACE	LAUNDRY ROOM	Q1	9/24/1997	206	10.8	30.7	132
1922014	GREAT GORGE TERRACE	LAUNDRY TAP	Q2	3/18/1998	230	28	12	150
1922014	GREAT GORGE TERRACE	LAUNDRY ROOM	Q3	6/24/1998	172	28	12	144
1922014	GREAT GORGE TERRACE	LAUNDRY ROOM	Q4F	9/16/1998	170	31	10.8	146
1922015	WALNUT HILLS ASSOCIATION	810 RTE 517	D	9/24/1997	1.2			
1922015	WALNUT HILLS ASSOCIATION	3 PRIMROSE LANE	CP	5/25/1999				
1922017	HIGHLAND LAKES	U.S POST OFFICE	D	1/5/1998	1			
1922017	HIGHLAND LAKES	205 WACONIA ROAD	CP	7/29/1999				
1922018	UNITED WATER VERNON HILLS	WELL #1	R	9/22/1997	23	0.25		9.2
1922018	UNITED WATER VERNON HILLS	#15 MOTT	Q1	12/15/1997	7.8	-0.1		
1922018	UNITED WATER VERNON HILLS	#15 MOTT AVE	Q2	3/9/1998	4			
1922018	UNITED WATER VERNON HILLS	#15 MOTT	Q3F	6/24/1998	2.1			
1922018	UNITED WATER VERNON HILLS	2 STAYMEN ROAD	CP	7/15/1999				
1922019	UNITED WATER VERNON HILLS	WELL #1 - POE	P	9/22/1997	13	0.15		
1922019	UNITED WATER VERNON HILLS	VERNON TOWNSHIP	Q1	12/15/1997	11	-0.2		
1922019	UNITED WATER VERNON HILLS	#3 THETA DRIVE	Q2	3/9/1998	11	0.28		
1922019	UNITED WATER VERNON HILLS	#3 THETA	Q3F	6/24/1998	7.6	0.33		
1922019	UNITED WATER VERNON HILLS	4 CHURCH ST	CP	5/20/1999				
1922021	UNITED WATER VERN	8 HOLDERNESS DR	CP	4/13/2000				
1922021	UNITED WATER VERN	WELL #2	R	9/22/1997	9.3	0.2		
1922021	UNITED WATER VERN	#1 HOLDERNESS	Q1	12/22/1998	8.4	0.33		
1922021	UNITED WATER VERN	#3 HOLDERNESS	Q2	3/23/1999	11	0.23		
1922021	UNITED WATER VERN	#3 HOLDERNESS	Q3	6/23/1999	11	0.1		
1922021	UNITED WATER VERN	#3 HOLDERNESS	Q4F	8/25/1999	6.8	0.19	0.1	
1922022	UNITED WATER VERNON HILLS	71 SAMMIS RD	CP	4/13/2000				

1922022	UNITED WATER VERNON HILLS	WELL #2	R	9/22/1997	20	0.32	0.86	13.1
1922022	UNITED WATER VERNON HILLS	#75 SAMMIS	Q1	12/15/1997	13			15.1
1922022	UNITED WATER VERNON HILLS	#75 SAMMIS	Q2	3/9/1998	13	0.52		
1922022	UNITED WATER VERNON HILLS	#75 SAMMIS	Q3F	6/24/1998	17			17.5
1922023	UNITED WATER VERNON HILLS	WELL #1 - POE	P	9/24/1997	7.1	0.11		
1922023	UNITED WATER VERNON HILLS		CP	7/15/1999				
1922026	UNITED WATER VERNON	SNOWMASS CT BLDG #1	CP	4/26/2000				
1922026	UNITED WATER VERNON	WELL #5 - POE	P	9/24/1997	2.3			
1922027	HIDDEN VALLEY CONDO	#7 CHAMINOIX - DIST	D	1/13/1998	1.6			
1922027	HIDDEN VALLEY CONDO	CURTIS ROAD	CP	2/22/1999				
1922028	VALLEY VIEW APARTMENTS	OMEGA DRIVE	D	3/16/1998	270	0.44		233
1922028	VALLEY VIEW APARTMENTS	#17	Q1	6/24/1998	280	0.01		224
1922028	VALLEY VIEW APARTMENTS	#24	Q2	9/16/1998	170			196
1922028	VALLEY VIEW APARTMENTS	APT #1	Q3	12/22/1998	42			57
1922028	VALLEY VIEW APARTMENTS	BLDG #2	Q3-2	12/22/1998	240			255
1922028	VALLEY VIEW APARTMENTS	BLDG #1 - RAW	R	12/22/1998	5.7	0.41		
1922028	VALLEY VIEW APARTMENTS	BLDG #2	RA	12/22/1998	180			248
1922028	VALLEY VIEW APARTMENTS	LAUNDRY ROOM	Q4F	3/23/1999	4.5			
1922028	VALLEY VIEW APARTMENTS	BLDG #2 - LAUNDRY	Q42	3/23/1999	218			228
1924002	SIMMONS WATER COMPANY	WELL #1	P	1/5/1998	0.57			
1924002	SIMMONS WATER COMPANY	20 RUTH DRIVE	CP	10/15/1998				
1924003	REGENCY AT SUSSEX	WELL #1	P	1/5/1998	1.9			
1924003	REGENCY AT SUSSEX	10 LAYTON ROAD	CP	10/15/1998				
1924004	UNITED WATER VERNON HILLS	17 BALDWIN DRIVE	CP	7/19/2000				
1924004	UNITED WATER VERN	WELL #1	P	1/5/1998	1			
2004001	LIBERTY WATER COMPANY	24 SOUTH BROAD ST	CP	3/14/2000				
2004001	CITY OF ELIZABETH WATER	MUNICIPAL BUILDING	D	10/27/1997	0.61			
2004002	ELIZABETHTOWN WATER	263 SOMERSET ST	CP	1/31/2000				
2004002	ELIZABETHTOWN WATER	RARITANMILLSTONE POE	P	10/29/1997	0.34			
2004002	ELIZABETHTOWN WATER	CRANBURY	POE	10/29/1997	24.1	1.4	2.6	
2004002	ELIZABETHTOWN WATER	PRINCETON YMCA	D	10/29/1997	0.41			
2004002	ELIZABETHTOWN WATER	GREENBROOK TP	P	10/29/1997	6.1	0.01		
2004002	ELIZABETHTOWN WATER	HUMMOCKS WELLS - POE	P	10/29/1997	2.9			
2004002	ELIZABETHTOWN WATER	NETHERWOOD - POE	P	10/29/1997	3.3			
2004002	ELIZABETHTOWN WATER	STONYBROOK - POE	P	10/29/1997	3.7			
2004002	ELIZABETHTOWN WATER	U.S. POST OFFICE	Q1	2/2/1998	52	1.1	1.8	
2004002	ELIZABETHTOWN WATER	CRANBURY - WELL 1A	POE	6/10/1998	13	1.1	2	

2004002	ELIZABETHTOWN WATER	MONTGOMERY #2	POE	6/10/1998	5.6	0.04	
2004002	ELIZABETHTOWN WATER	PLAINSBORO #2	POE	6/10/1998	5.2		
2004002	ELIZABETHTOWN WATER	CRANBURY WELL #3	R	6/10/1998	11	0.44	0.9
2004002	ELIZABETHTOWN WATER	PLAINSBORO #1	POE	6/10/1998	1.5		
2004002	ELIZABETHTOWN WATER	U.S. POST OFFICE	NGH	6/10/1998	5.1		
2004002	ELIZABETHTOWN WATER	MONTGOMERY #1	POE	6/10/1998	4.4		
2004002	ELIZABETHTOWN WATER	CRANBURY - WELL 1A	P	6/23/1998	19	1.6	1.5
2004002	ELIZABETHTOWN WATER	U.S. POST OFFICE	Q2	6/23/1998	17	1.6	1.3
2004002	ELIZABETHTOWN WATER	CRANBURY WELL #3	R	6/23/1998	7.2	0.6	1.4
2004002	ELIZABETHTOWN WATER	WELL #1	P	9/22/1998	5.9	0.5	1.1
2004002	ELIZABETHTOWN WATER	U.S. POST OFFICE	Q3F	9/22/1998	9	0.46	1.1
2004002	ELIZABETHTOWN WATER	U.S. POST OFFICE	D	10/13/1998	100	0.4	0.72
2013001	RAHWAY WATER	619 MAPLE AVENUE	CP	8/19/1997	0.99	0.08	
2013001	RAHWAY WATER	POE	P	10/27/1997	-0.56		
2021001	WINFIELD MUTUAL HOUSING	DISTRIBUTION	D	10/27/1997	0.26		
2021001	WINFIELD MUTUAL HOUSING	ROOSEVELT DRIVE	CP	1/29/1998	1.9		
2101001	ALLAMUCHY TOWNSHIP	PANTHER VALLEY GH	Q3	1/19/2000	9.4	1.2	0.32
2101001	ALLAMUCHY TOWNSHIP	PANTHER VALLEY	Q4F	6/21/2000	6.4	0.32	0.02
2101001	ALLAMUCHY TOWNSHIP	WELLS #2 & #3 - POE	P	5/18/1999	7.5	0.78	0.53
2101001	ALLAMUCHY TOWNSHIP	PANTHER VALLEY GUARD	Q1	9/14/1999	8	0.79	0.17
2101001	ALLAMUCHY TOWNSHIP	PANTHER VALLEY GUARD	Q2	12/14/1999	6.6	0.27	0.13
2101002	ALLAMUCHY WATER DISTRICT	86 MAIN STREET	CP	10/29/1997	4.2		
2101002	ALLAMUCHY WATER DISTRICT	GENERAL STORE	D	5/18/1999	3.2		
2102001	ALPHA MUNICIPAL WATER	WELL #1 - POE	P	5/18/1999	-0.23		
2103001	NJ AMERICAN WATER CO -	WELL #1 - POE	P	5/10/1999	1.9		
2104001	BLAIRSTOWN WATER	WELLL #1 - POE	P	5/19/1999	4		
2108001	HACKETTSTOWN MUA	WELL #6 - POE	P	5/12/1999	1		
2110001	BRAINARDS MUTUAL WATER	1030 3RD STREET	D	12/9/1997	1.5		
2110001	BRAINARDS MUTUAL WATER	WELL #1 - POE	P	5/18/1999	0.78		
2110003	HARKERS HOLLOW WATER	7 MARVEL ROAD	CP	2/9/1998	6.2	0.16	
2110003	HARKERS HOLLOW WATER	WELLS #1 & #2 - POE	P	5/17/1999	2.6		
2112001	INDEPENDENCE MUA -	#4 AUTUMN LANE	Q3	1/19/2000	8.2	0.29	0.06
2112001	INDEPENDENCE MUA -	12 AUTUMN LANE	Q4F	4/19/2000	4.4		
2112001	INDEPENDENCE MUA -	WELL #1 - POE	P	5/18/1999	8.1	0.03	
2112001	INDEPENDENCE MUA -	#16 AUTUMN LANE	Q1	9/14/1999	11	0.09	-0.09
2112001	INDEPENDENCE MUA -	#12	Q2	12/14/1999	4.9		
2112002	INDEPENDENCE MUA -	HIGHLANDS WELL #1	P	5/18/1999	1.1		

2113002	RIVERSIDE MOBILE HOME PARK	#27 OFF RTE 46	CP	6/22/1998				
2113002	RIVERSIDE MOBILE HOME PARK	WELLS #1 & #2 - POE	P	5/19/1999	0.8			
2113003	TRIPLE BROOK MOBILE HOME	#90-15 OFF NIGHTINGD	CP	6/22/1998				
2113003	TRIPLE BROOK MOBILE HOME	WELLS #1 & #2 - POE	P	5/19/1999	0.32			
2114001	TAMARACK ROAD MOBILE	#5 CIRCLE LN.	CP	6/14/2000				
2114001	TAMARACK ROAD MHP	WELL #1 - POE	P	5/19/1999	0.42			
2116001	DIAMOND HILL WATER	17 PARKVIEW DRIVE	CP	8/18/1998				
2116001	DIAMOND HILL WATER	25 MEADOW LANE	D	9/14/1999	1.3			
2116001	DIAMOND HILL WATER	WELL #1 - POE	P	12/20/1999	0.42			
2116002	HAPPY HILL MOBILE HOME	MANAGER'S HOME	Q3	3/27/2000	31	-0.29	0.07	4.2
2116002	HAPPY HILL MOBILE HOME	#14 KITCHEN SINK	Q4F	4/19/2000	3.7			
2116002	HAPPY HILL MOBILE HOME	#15 OFF CO RT. 625	CP	6/14/2000				
2116002	HAPPY HILL MOBILE HOME	WELL #1 - POE	P	5/10/1999	9.4	0.12		
2116002	HAPPY HILL MOBILE HOME	#48	Q1	9/14/1999	6	0.01	-0.12	
2116002	HAPPY HILL MOBILE HOME	#4	Q2	11/10/1999	166	0.17	0.1	3.7
2116003	MANSFIELD WATER	WINTERS AVE WELL	P	5/10/1999	1.8			
2116004	WARREN HAVEN NURSING	350 OXFORD ROAD	CP	2/9/1998	0.56			
2116004	WARREN HAVEN NURSING	MANSFIELD TOWNSHIP	P	5/10/1999	0.48			
117002	VALLEY VIEW ESTATES	WELL #1 - POE	P	5/10/1999	1.6			
2117003	OXFORD HERITAGE MANOR	WELL #1 - POE	P	5/17/1999	0.93			
2117004	NJ AMERICAN WATER CO -	17 KENT STREET	CP	8/18/1998				
2119001	CONSUMERS NJ WC -	WELLS A,C,D - POE	P	5/12/1999	1.5			
2120001	CONSUMERS NJ WC -	12 RIVER ROAD	CP	2/1/2000				
2120001	CONSUMERS NJ WC -	BRIDGE TAP	P	5/12/1999	1.1			
2120002	CONSUMERS NJ WC - WARREN	LARGE WELL	P	5/12/1999	1.6			
2121001	NJ AMERICAN WATER CO -	DALE AVE WELL	P	5/10/1999	0.99			
2121001	NJ AMERICAN WATER CO -	OXFORD WELL #3	P	5/10/1999	1.4			
2123002	WINDTRYST APARTMENTS	WYNDTRYSTWAY&RTE	CP	12/9/1997	2.5			
2123002	WINDTRYST APARTMENTS	WELL #1 - POE	P	5/17/1999	1.9			
2123003	COUNTRY VILLAGE SQUARE	LAMPLIGHTER CIRCLE	D	10/29/1997	1.20			
2123003	COUNTRY VILLAGE SQUARE	WELL #1 - POE	P	5/17/1999	2.7			

APPENDIX IV-B: Community Water Systems with Potential Gross Alpha or Radium MCL Exceedences
(1996 - 2000 Compliance Period)

PWSID	SYSTEM NAME	MUNICIPALITY
0104001	CRANBERRY RUN MOBILE HOME PARK	BUENA BORO
0108013	TOWER 1999 MOBILE HOME PARK	EGG HARBOR TWP
0111004	POMONA MOBILE HOME PARK	GALLOWAY TWP
0113001	HAMMONTON WATER DEPARTMENT	HAMMONTON TOWN
0119001	DELILAH TERRACE MHP	PLEASANTVILLE CITY
0119002	NJAWC - ATLANTIC	PLEASANTVILLE CITY
0303001	BORDENTOWN WATER DEPARTMENT	BORDENTOWN CITY
0306001	BURLINGTON TOWNSHIP WATER DEAPRTMENT	BURLINGTON TWP
0314001	FIELDSBORO WATER DEPARTMENT	FIELDSBORO BORO
0315001	FLORENCE WATER DEPARTMENT	FLORENCE TOWNSHIP
0327001	NJAWC - WESTERN	PALMYRA BORO
0338001	WILLINGBORO MUA	WILLINGBORO TWP
0339001	NEW LISBON STATE SCHOOL	WOODLAND TWP
0405001	BERLIN WATER DEPARTMENT	BERLIN BORO
0424001	MERCHANTVILLE-PENNSAUKEN WATER COMMISSION	MERCHANTVILLE BORO
0428002	PINE HILL MUA	PINE HILL BORO
0436006	STRAWBERRY VILLAGE	WINSLOW TOWNSHIP
0436007	WINSLOW TOWNSHIP MUA-SICKLERVILLE	WINSLOW TOWNSHIP
0601001	BRIDGETON WATER DEPARTMENT	BRIDGETON CITY
0605002	TIPS TRAILER PARK	FAIRFIELD TOWNSHIP
0605004	FAIRTON FEDERAL CORRECTIONAL FACILITY	FAIRFIELD TOWNSHIP
0607001	HOPEWELL PLACE	HOPEWELL TOWNSHIP
0612001	J & J COMMUNITY PARK	STOWE CREEK TWP
0613001	SEABROOK WATER COMPANY	UPPER DEERFIELD TWP
0614003	VINELAND WATER AND SEWER UTILITY	VINELAND CITY
0704002	ESSEX COUNTY UTLITIES	CEDAR GROVE TWP
0801001	CLAYTON WATER DEPARTMENT	CLAYTON BORO
0802001	DEPTFORD TOWNSHIP MUA	DEPTFORD TWP
0805003	MALAGA VILLA APARTMENTS	FRANKLIN TWP
0807001	GREENWICH TOWNSHIP WATER DEPARTMENT	GREENWICH TOWNSHIP

APPENDIX IV-B (cont.)

Community Water Systems with Potential Gross Alpha or Radium MCL Exceedences

(1996 - 2000 Compliance Period)

PWSID	SYSTEM NAME	MUNICIPALITY
0809001	PENNS GROVE WATER SUPPLY CO - BRIDGEPORT	LOGAN TOWNSHIP
0811003	NATIONWIDE MOBILE HOME PARK	MONROE TOWNSHIP
0818004	WASHINGTON TOWNSHIP MUA	WASHINGTON TWP
1011001	NJAWC - FRENCHTOWN	FRENCHTOWN BORO
1103001	CONSUMERS NJ WATER CO. - HAMILTON SQUARE	HAMILTON TOWNSHIP
1105001	HOPEWELL BOROUGH WATER DEPARTMENT	HOPEWELL BORO
1208001	NJAWC - JAMESBURG	JAMESBURG BORO
1223002	MONROE TOWNSHIP MUA	MONROE TOWNSHIP
1216001	PERTH AMBOY DEPARTMENT OF PUBLIC UTILTIIES	PERTH AMBOY CITY
1219001	SAYREVILLE WATER DEPARTMENT	SAYREVILLE BORO
122104	SOUTH BRUNSWICK TOWNSHIP WATER DIVISION	SOUTH BRUNSWICK TWP
1224001	SPOTSWOOD WATER DEPARTMENT	SPOTSWOOD BORO
1319007	PARKWAY WATER COMPANY	HOWELL TOWNSHIP
1352004	GARDEN STATE MOBILE HOME PARK	WALL TOWNSHIP
1507999	REICHS FARM MONITORING WELL	DOVER TOWNSHIP
1511009	PLEASANT GARDENS WATER SYSTEM	JACKSON TOWNSHIP
1511010	NAVAL AIR ENGINEERING STATION LAKEHURST	JACKSON TOWNSHIP
1511014	CONCORD VILLAGE ASSOCIATION	JACKSON TOWNSHIP
1518004	CRESTWOOD VILLAGE WATER COMPANY	MANCHESTER TOWNSHIP
1518005	MANCHESTER TOWNSHIP WATER UTILITY	MANCHESTER TOWNSHIP
1518007	RIDGEWAY PARK #1	MANCHESTER TOWNSHIP
1518009	RIDGEWAY PARK #2	MANCHESTER TOWNSHIP
1615020	UNITED WATER - WEST MILFORD	WEST MILFORD TWP
1707001	PENNS GROVE WATER SUPPLY CO - BRIDGEPORT	PENNS GROVE BORO
1710002	HOLLY TREE ACRES MHP - SYSTEM #1	PITTSGROVE TOWNSHIP
1710006	HARRISON MOBILE HOME PARK	PITTSGROVE TOWNSHIP
1710007	HOLLY TREE ACRES MHP - SYSTEM #2	PITTSGROVE TOWNSHIP
1903001	BRANCHVILLE WATER DEPARTMENT	BRANCHVILLE BORO
1904008	WILLOR MANOR WATER COMPANY	BYRAM TOWNSHIP
1904009	BYRAM HOMEOWNERS ASSOCIATION	BYRAM TOWNSHIP

APPENDIX IV-B (cont.)

Community Water Systems with Potential Gross Alpha or Radium MCL Exceedences

(1996 - 2000 Compliance Period)

PWSID	SYSTEM NAME	MUNICIPALITY
1906001	HILLSIDE ESTATES AT FRANKLIN	FRANKLIN BORO
1918011	SPARTA TOWNSHIP WATER UTILITY - GREENTREE	SPARTA TOWNSHIP
1918016	SPARTA TOWNSHIP WATER UTITLIY - SENECA LAKE	SPARTA TOWNSHIP
1920001	STILLWATER WATER DISTRICT #1	STILLWATER TOWNSHIP
1922003	UNITED WATER VERNON HILLS - ASPEN WOODS	VERNON TOWNSHIP
1922006	UNITED WATER VERNON HILLS - SUSSEX HILLS #1	VERNON TOWNSHIP
1922007	UNITED WATER VERNON HILLS - SUSSEX HILLS #2	VERNON TOWNSHIP
1922008	VERNON WATER COMPANY	VERNON TOWNSHIP
1922009	VERNON WATER COMPANY - OAK HILLS	VERNON TOWNSHIP
1922011	SUNSET RIDGE WATER COMPANY	VERNON TOWNSHIP
1922013	DC WATER COMPANY	VERNON TOWNSHIP
1922014	GREAT GORGE TERRACE ASSOCIATION	VERNON TOWNSHIP
1922018	UNITED WATER VERNON HILLS - STAMEN/MOTT	VERNON TOWNSHIP
1922022	UNITED WATER VERNON HILLS - SAMMIS ROAD	VERNON TOWNSHIP
1922028	VALLEY VIEW APARTMENTS	VERNON TOWNSHIP
2004002	ELIZABETHTOWN WATER COMPANY	ELIZABETH CITY
2110002	HAPPY HILL MOBILE HOME PARK	MANSFIELD TOWNSHIP

Appendix IV-C: List of Public Community Water Systems with Confirmed MCL Exceedences

PWID	Facility Name	Municipality	Deadline	Gross a 226/228 Status	Proposed Remedial Action	Comments
0104001	Cranberry Run MHP	Buena Boro	12/31/99	66.8/13.3	Tie into Buena Boro WD	Connected to Buena Boro during spring 2000
0108013	Tower 1999	Egg Harbor Twp	12/31/99	29.0/5.0	Install new well	New well is installed – awaiting approval for emergency use by BSDW. Well is on line-needs full permitting
0113001	Hammonton WD	Hammonton	12/31/99	15.5/2.5		Affected well taken out of service-applied for replacement well. Follow-up monitoring-shows compliance.
0303001	Bordentown WD	Bordentown Twp	10/21/01			Public notification posted, quarterly monitoring, POE being evaluated.
0314001	Fieldsboro WD	Fieldsboro	10/21/01	18.4		Bulk purchaser from Bordentown WD
0315001	Florence Twp WD	Florence	10/21/01	16.25		Quarterly monitoring < MCL, PN discontinued.
0436006	Strawberry Village	Winslow	10/31/00		Connect to Winslow Twp WD	Conduct quarterly monitoring. Requested to provide bottled water to residents until tie in can be accomplished
0601001	Bridgeton WD	Bridgeton	12/31/99	22.5/5.5	New Piney Point wells.	Will install Piney Point wells to blend with existing Cohansey wells. ACO with extension until 6/1/2001.
0607001	Hopewell Place	Hopewell	7/31/01	43/10.9	Ion exchange (already installed).	Facility has installed ion exchange without BSDW or SIU permits-follow-up sampling. Enforcement issued NOV for lack of permits and will follow-up.
0612001	J&J Community Park	Stowe Creek Twp	12/31/99	110/20.4	Bottled water (interim)	Provided bottled water 12/31/99. Exploring Piney Point wells.
0613001	Seabrook WD	Upper Deerfield	12/31/99	28/7.4	Piney Point wells.	Proposing Piney Point wells-applied for SRF loan.

PWID	Facility Name	Municipality	Deadline	Gross a 226/228 Status	Proposed Remedial Action	Comments
0614003	Vineland City WD	Vineland	12/31/99	16.3/3.6	Ion exchange.	Wells off/installing ion exchange-SIU & Waterworks Permit issued and constructed. SIU permit issued-will need deadline extension-requested 11/18/99. Ion exchange unit on-line 6/1/01 for Well 13.
0807001	Greenwich Twp WD	Greenwich	3/1/01			On quarterly monitoring.
0809001	Pennsgrove WD	Logan	9/27/01	19.75		Additional monitoring by BSDW conducted 1/16/01.
1103001	Consumers Water Hamilton	Hamilton Twp	8/19/00			Well off-BSDW sampling other wells that meet limit. Follow-up monitoring show compliance with the MCL.
1208001	NJAWCo-Jamesburg	Jamesburg	9/27/00		Ion exchange	Ion exchange installed. IPP permit issued from MCUA-Compliance issues to be discussed.
1213002	Monroe Twp MUA	Monroe	9/12/00			2 wells with the highest levels off. Will be replaced Exploring replacement wells
1219001	Sayreville WD	Sayreville	6/17/00			Wells with highest levels off. ACO with 6/01 deadline req. Not over MCL—Alternatives being explored
2004002 .	Elizabethtown Water Company	Cranbury	12/31/99		Affected wells off-line.	Wells taken off-line permanently. Water being supplied by other sources.
1511009	Pleasant Gardens	Jackson Twp	11/22/00			Required to submit proposal by 11/22/00. BSDW considering proposal to do 6 months of additional.
1710006	Harrison MHP	Pittsgrove	12/31/99		Affected well off-line.	Request to be reclassified as nonpublic denied-Using Well #1, which is clean. Well #2 and replacement well exceed Ra MCL.
1922028	Valley View Apts.	Vernon	12/16/99	46.5/0.0	Follow up monitoring shows compliance with	

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PWID	Facility Name	Municipality	Deadline	Gross a 226/228 Status	Proposed Remedial Action	Comments
					MCL. Sealed ion exchange unit. Reported that treatment containers changed yearly-retained by supplier	

BSDW=Bureau of Safe Drinking Water; PN=Public notification; ACO=Administrative Consent Order; SIU=Significant Industrial User; NOV=Notice of Violations; MCUA= Middlesex County Utilities Authority;

Appendix IV-D: USGS Cohansey Radium Studies

USGS
science for a changing world

Radium-226 and Radium-228 in Shallow Ground Water, Southern New Jersey

Concentrations of total radium (the sum of radium-226 and radium-228) and gross alpha-particle activities in drinking water that exceed the U.S. Environmental Protection Agency (USEPA) Maximum Contaminant Levels (MCLs) are known to cause cancer. Results of investigations by the U.S. Geological Survey (USGS) in cooperation with the New Jersey Department of Environmental Protection (NJDEP) indicate that concentrations of total radium in water samples from 33 percent of 170 wells in the Kirkwood-Cohansey aquifer system in southern New Jersey exceeded the MCL of 5 pCi/L (picocuries per liter) (fig. 1). Wells containing water in which concentrations of total radium were greater than the MCL typically are found where the Bridgeton Formation crops out, in or near an agricultural area, where ground water is acidic (pH less than 5), and where nitrate concentrations generally exceed 5 mg/L (milligrams per liter). Leaching of nitrogen, calcium, and magnesium from agricultural chemicals (fertilizer, lime) applied to cropland may increase the mobility of radium in ground water. Gross alpha-particle activities exceeded the USEPA MCL of 15 pCi/L in water from 14 percent of 127 wells. A statistically significant 2:1 ratio between gross alpha-particle activity and concentration of total radium indicates that gross alpha-particle activity can be used as a screening tool to predict the presence of water that may have a high total-radium concentration.

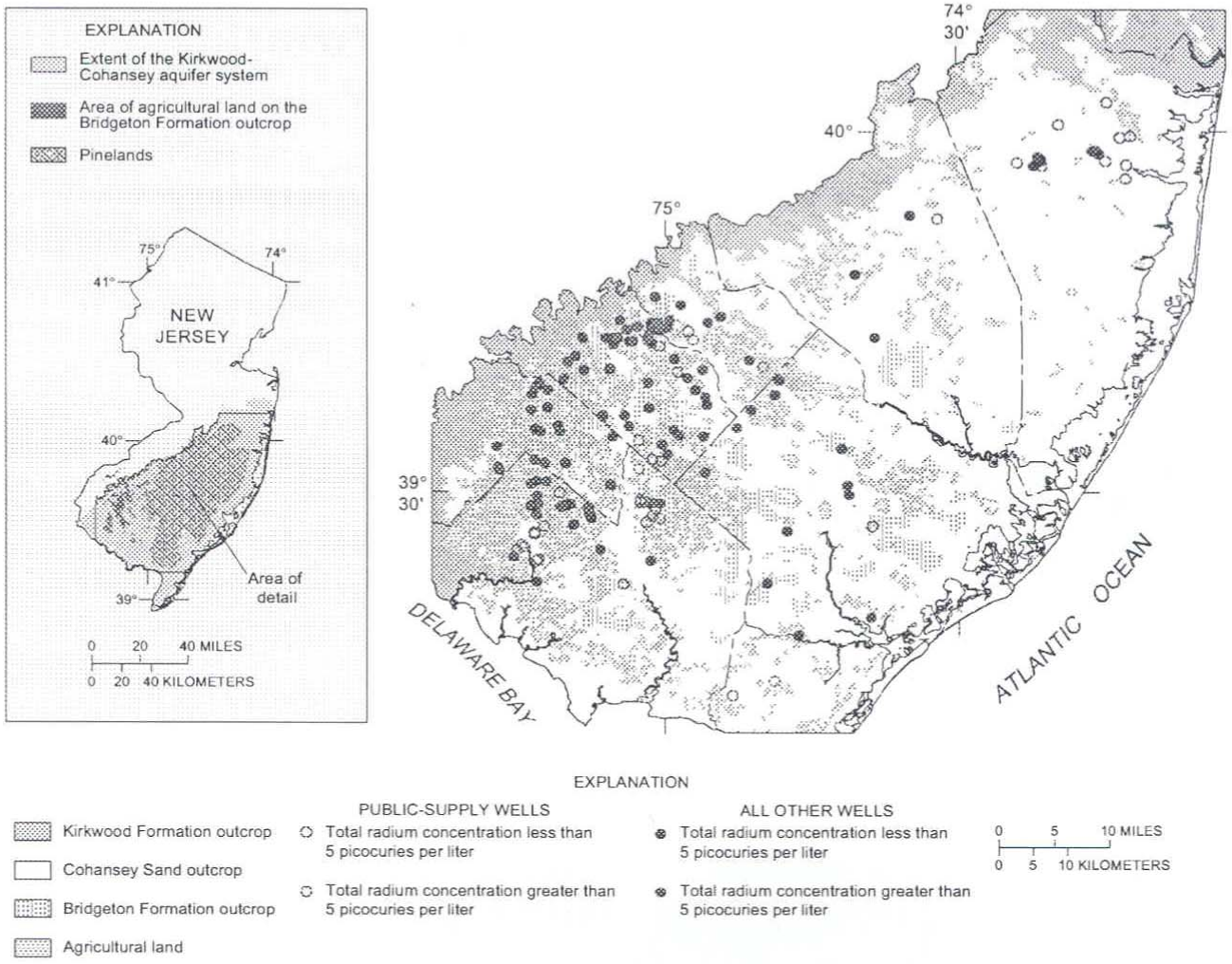

Figure 1. Extent of the Kirkwood-Cohansey aquifer system in New Jersey, areas of agricultural land use, and locations of wells sampled for analysis of radium concentrations, 1988-96.

U.S. Department of the Interior
U.S. Geological Survey

Fact Sheet FS-062-98
June 1998

What is radium and why is it present in water?

Unstable radioactive elements are found in a wide range of concentrations in all rocks, soil, and water. The most common radioactive elements, uranium and thorium, decay slowly and produce other radioactive elements, such as radium, which in turn undergo still further radioactive decay. These radioactive product elements have different chemical properties, decay at different rates, and emit different levels of radiation energy than either uranium or thorium.

The two most common isotopes of radium are radium-226 and radium-228. Radium-226 has a long half-life (1,600 years) compared to that of radium-228 (5.75 years). A half-life is the time required for half of the initial amount of the radionuclide to decay. Radium-226 decays by emitting the nucleus of a helium atom (alpha particle), whereas radium-228 emits an electron (beta particle).

Radium is only moderately soluble in water and only under certain geochemical conditions (Zapecza and Szabo, 1988); radium-226 and radium-228 are equally soluble. Radium can enter ground water by dissolution of aquifer materials, by desorption from rock or sediment surfaces, and by ejection from minerals during radioactive decay.

Why is radium in drinking water of concern?

Radium in drinking water is known to increase cancer risk, primarily for bone and sinus cancers (Mays and others, 1985). As radium decays, the radiation that is emitted can strip electrons from the atoms with which it collides, causing the atoms to become charged or "ionized." The ionizing alpha and beta radiation emitted by radium consists of particles that move slowly and cannot penetrate skin. If radium is ingested, however, especially dissolved in water, the emitted alpha- and beta-particle radiation can ionize and damage cell tissue. Human bone tissue accumulates radium rather than allowing it to be removed from the body, thereby exposing the bones to tissue-damaging alpha or beta radiation. Damage from continuous exposure can potentially cause cancer. Because it accumulates in the body, radium is considered to pose a greater cancer risk than most other radioactive elements.

What level of radium or gross alpha-particle activity in drinking water is a significant health risk?

The USEPA MCL for radioactivity in drinking water is set at the level of a 1 in 10,000 risk of a fatal cancer if 2 liters of water per day is consumed for 70 years. The MCL for the concentration of total dissolved radium, which is defined as the sum of radium-226 and radium-228 concentrations, is 5 pCi/L (U.S. Environmental Protection Agency, 1976). For gross alpha-particle activity, the USEPA MCL is 15 pCi/L (U.S. Environmental Protection Agency, 1976). Activity is the number of radioactive disintegrations in a given quantity of material per unit time. Gross alpha-particle activity is a measure of the total amount of radioactivity in a water sample attributable to the radioactive decay of alpha-emitting radioactive elements. Activity in water is expressed in units of picocuries per liter, where 1 pCi/L is equal to 2.2 radioactive disintegrations per minute per liter of water. Because radium-226 emits an alpha particle, gross alpha-particle activity can be used as a screening tool to predict the presence of radium in a water sample, if large amounts of other alpha-emitting radioactive elements are absent.

Radium in ground water in southern New Jersey

During routine regulatory monitoring conducted by the NJDEP, naturally occurring radium was detected at concentrations greater than the MCL in water from public supply wells screened in the Kirkwood-Cohansey aquifer system. From 1988 to 1996, the USGS, in cooperation with the NJDEP, conducted several sampling programs to determine the distribution of total dissolved radium in the aquifer system and to identify factors that contribute to the presence of high concentrations of total dissolved radium.

The Kirkwood-Cohansey aquifer system is a regionally extensive unconfined (water-table) aquifer that underlies about two-thirds of the New Jersey Coastal Plain (fig. 1). It is a major source of drinking water in much of southern New Jersey. In most areas, the aquifer consists of two geologic formations, the Cohansey Sand and the Kirkwood Formation. The Cohansey Sand is mainly a light-colored, medium- to coarse-grained quartz sand with some gravel and silt (Zapecza, 1989). The Kirkwood Formation is a fine- to medium-grained quartz and silty sand in inland areas and grades to clay in coastal areas. A surficial deposit of feldspathic gravel known as the Bridgeton Formation discontinuously overlies the Cohansey Sand and, in places, the Kirkwood Formation on topographic highs, especially in southwestern New Jersey. These three hydraulically connected units form the aquifer system, although the Bridgeton Formation is present primarily in recharge areas. The Bridgeton Formation contains a greater concentration of natural radioactive elements than the other two formations because it was deposited by the ancestral Hudson River (Martino, 1981), which drained rocks to the north that were enriched in radioactive minerals relative to the source material for the Kirkwood Formation and the Cohansey Sand.

Table 1. Summary statistics for radium concentrations and gross alpha-particle activity in water from wells in the Kirkwood-Cohansey aquifer system, southern New Jersey, 1988-96 [USEPA, U.S. Environmental Protection Agency; MCL, Maximum Contaminant Level]

Dissolved constituent	USEPA MCL (picocuries per liter)	Potential health effects from ingestion of water (Mays and others, 1985)	Number of wells sampled	Concentration or activity (picocuries per liter)			Percentage of samples with concentration or activity above the MCL
				Minimum	Maximum	Median	
Total radium (radium-226 plus radium-228)	5	Bone cancer	170	<1	30.3	3.8	33
Gross alpha-particle activity	15	Cancer	127	<0.6	43.3	5.4	14

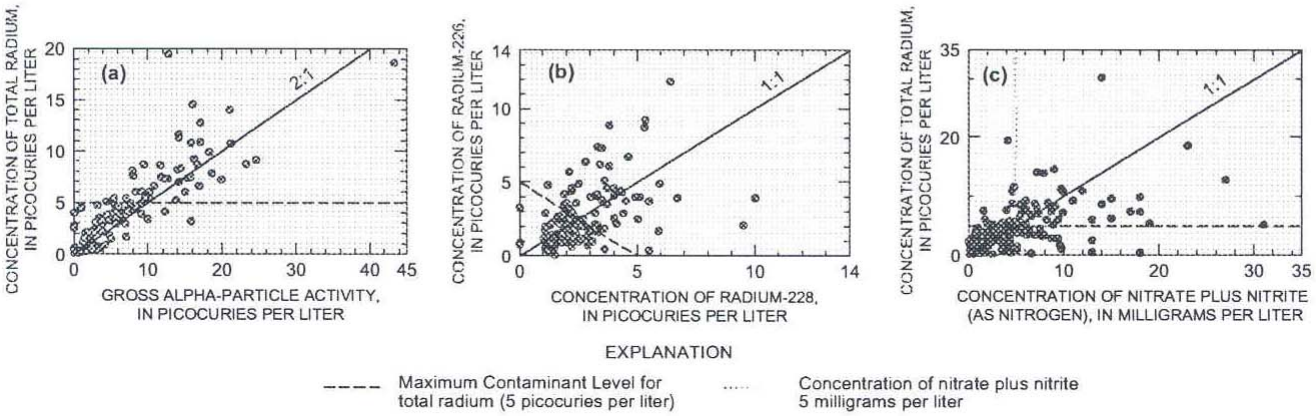

Figure 2. (a) Concentration of total radium as a function of gross alpha-particle activity; (b) concentration of radium-226 as a function of concentration of radium-228; and (c) concentration of total radium as a function of nitrate plus nitrite concentration in water from wells in the Kirkwood-Cohansey aquifer system, southern New Jersey, 1988-96.

Sampling Program

The USGS sampled a regional network of 170 wells, including public-supply, domestic, and observation wells, to characterize the distribution of total dissolved radium in the Kirkwood-Cohansey aquifer system in southern New Jersey (Kozinski and others, 1995; Szabo and others, 1997). Samples were analyzed for radium concentration and for gross alpha-particle activity by using USEPA-approved techniques (Krieger and Whitaker, 1980) about 1 month after collection. Sampling density was greatest in the southwestern part of the study area (fig. 1) because of the large rural and suburban population that depends solely on water from the Kirkwood-Cohansey aquifer system for water supply, and because concentrations of total dissolved radium were highest in this area. Sampling density was lowest in the central part of the study area (the Pinelands; fig. 1) because of the absence of residences (and wells) in this area. Because sampled wells were not distributed evenly throughout the study area, the data set of measured total dissolved radium concentrations may be biased.

Radium concentrations in ground water

The concentration of total radium in water from 56 (33 percent) of the 170 wells sampled was greater than the 5-pCi/L MCL (table 1). Concentrations of total dissolved radium ranged from <1.1 to 30.3 pCi/L, with a median (midpoint value) of 3.8 pCi/L. Gross alpha-particle activities in 18 (14 percent) of the 127 samples for which data were available were greater than the 15-pCi/L MCL. Gross alpha-particle activities ranged from <0.6 to 43.3 pCi/L, with a median of 5.4 pCi/L. Gross alpha-particle activity and total radium concentration were significantly (95-percent or greater statistical confidence interval) correlated (Spearman rank correlation coefficient, $r_s = +0.90$); the ratio typically was about 2:1 (fig. 2a). Concentrations of radium-226 and radium-228 also were significantly correlated ($r_s = +0.70$). The median ratio of the concentrations of radium-228 to radium-226 was 1.06 (fig. 2b). This ratio indicates that radioactive minerals in the sands that make up the aquifer system are the likely source of the dissolved radium because they also contain both radioisotopes in nearly equal proportions (Szabo and others, 1997), whereas likely anthropogenic sources of radium, such as phosphate-bearing fertilizers, tend to contain much more radium-226 than radium-228.

Relation of radium to other chemical constituents

Results of a rank-order-regression statistical model indicate that water from the Kirkwood-Cohansey aquifer system in which the nitrate concentration was greater than 5 mg/L typically contained total radium in concentrations greater than 5 pCi/L (fig. 2c). Of 63 samples with a nitrate concentration greater than 5.0 mg/L, 41 (65 percent) had total radium concentrations greater than 5.0 pCi/L. In contrast, of 92 samples with a nitrate concentration less than 5.0 mg/L, only 14 (15 percent) had total radium concentrations greater than 5.0 pCi/L. Of 75 samples with a dissolved-magnesium concentration greater than or equal

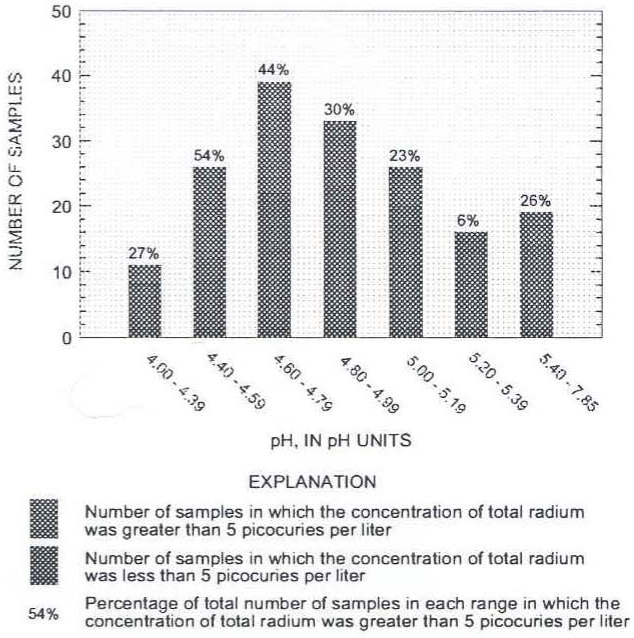

Figure 3. Number of water samples in which the concentration of total radium exceeded 5 picocuries per liter as a function of pH, Kirkwood-Cohansey aquifer system, southern New Jersey, 1988-96.