Source Water Assessment Report

For

Ringwood Water Department

State of New Jersey

Bradley M. Campbell, Commissioner
Department of Environmental Protection

Ernest Hahn, Assistant Commissioner
Land Use Management

Michele Mateo Putnam, Administrator
Water Supply Administration

Barker Hamill, Bureau Chief
Bureau of Safe Drinking Water
401 E. State Street
PO Box 426
Trenton, New Jersey 08625-0426
(609) 292-5550

December 2004

HOW TO USE THIS SOURCE WATER ASSESSMENT REPORT

The following outlines the source water assessment report and directs you to general and/or water system specific information.

Source Water Assessment Executive Summary
A summary of the Source Water Assessment Program and the susceptibility results statewide. This summary also provides the susceptibility ratings for the water system's source(s).

The first three sections of the report contain general information; the remaining four sections are exclusive to the water system and its susceptibility results.

Section I: Background Information on Drinking Water Systems page 1
General information on types of public drinking water systems (community and noncommunity), entry point to the distribution system (EPTDS), and sources of drinking water. The number of public water systems, wells, and surface water intakes in New Jersey is provided.

Section II: Source Water Assessment Program Overview page 7
An introduction to the Source Water Assessment Program and its goals.

Section III: Source Water Assessment Program Steps page 10
A description of the steps the Department of Environmental Protection (DEP) conducted to assess drinking water source(s) susceptibility to potential contamination. The contaminant categories of concern and the potential contaminant sources found to be significant in determining susceptibility (reffered to as explanatory variables) for the Source Water Assessment Program are included in this section. Table 5 provides the percentage of public community water system sources in New Jersey that rated high, medium, and low for each of the contaminant categories.

Section IV: General Description of Water System page 25
General information for the specific water system described in this report such as the system's address, number of entry points to the distribution system, number of wells, number of surface water intakes, and the municipalities and population the system serves. **This is the first section of the report that is specific to the water system.**

Section V: Inventory of Treatment Plants and Drinking Water Sources page 27
An inventory of the specific water system's sources (wells and surface water intakes) and entry points to the distribution system. Additional source information such as source capacity and status is also provided. **The water system data used for the development of the original drinking water source inventory was compiled in the summer of 2003.**

Section VI: Susceptibility Ratings for Drinking Water Source(s) page 30
The susceptibility ratings (high, medium, or low) for each of the specific water system's sources for each contaminant category.

Section VII: Susceptibility Ratings for the Entry Point(s) to the Distribution System (EPTDS) page 33

The susceptibility ratings (high, medium, or low) for each of the water system's EPTDS for each contaminant category. The susceptibility ratings were calculated using the susceptibility ratings for the sources. This section explains the process DEP followed to determine the EPTDS's susceptibility ratings.

Appendix A contains additional specific information for the system, immediately follows the report. Appendix A consists of tables and information relating to the susceptibility rating determination for the system's sources. These items include:

Individual Explanatory Variable Inventory

A series of tables show each water source's inventory for each of the explanatory variables for the contaminant categories. For example, agricultural land use in 1995 was found to be one of the significant variables in determining susceptibility to nutrients for a well. The percentage of agricultural land use in 1995 is provided as well as the source's rating for nutrients. The data populating these tables was used to determine susceptibility to the contaminant categories for the drinking water sources.

Specific Potential Contaminant Source Inventory

A table providing a list of potential contaminant sources located within the source water assessment area for each unconfined well and/or intake. This table provides more specific information concerning the source's potential contaminant source inventory. All of the potential contaminant sources are listed individually. The site's name, address, identification number, and county, when available, is provided.

Contaminant Category Scoring System

A series of tables illustrating how the rating score is determined for a source. This document is divided into surface water and ground water sections and provides a table(s) for each of the contaminant categories. Using these rating score tables and the Individual Explanatory Variable Inventory, the numerical susceptibility rating score can be determined. This rating score was then converted into a high, medium, or low susceptibility rating. (The susceptibility rating score conversions are also provided.)

Entry Point to the Distribution System (EPTDS) Rating Calculations

A table illustrating DEP's calculations of the susceptibility ratings for the system's EPTDS. This rating was determined using the susceptibility ratings for the sources and the sources' contributions. The monitoring and treatment takes place at the EPTDS level. Therefore, to assist in developing monitoring strategies, a susceptibility score and rating was developed.

Public Water Treatment

Almost all community water systems in New Jersey treat source water prior to distributing it to their customers. This portion of the appendices contains a list of the treatment processes the water system was using at the time the source water assessment was conducted. This information is important consider when reviewing the susceptibility ratings; treatment may already be operating to remove contaminants associated with systems with high susceptibility ratings.

Source Water Assessment Maps

A collection of maps illustrating the source water assessment areas for the water system's sources (wells and surface water intakes). A separate map has been created for each ground water and surface water susceptibility model. In the case of ground water, there are seven source water assessment maps, one for each of the contaminant categories of concern. These categories include pathogens, nutrients, pesticides, volatile organic compounds, inorganics, radionuclides/radon, and disinfection byproduct precursors. For surface water intakes, five source water assessment area maps were generated: nutrients, pesticides, volatile organic compounds, inorganics, and disinfection byproduct precursors. In addition to illustrating the source water assessment areas, these maps show the potential contaminant sources used in determining susceptibility ratings for the source(s).

Appendix B contains documents that further explain the procedures taken to determine susceptibility of public drinking water sources. These documents contain information addressing the three steps of a source water assessment: develop a source water assessment area, inventory the potential contaminant sources, and determine susceptibility to potential contaminant sources.

Appendix C contains materials to assist in understanding the source water assessment report and contact information for further questions.

SOURCE WATER ASSESSMENT

Executive Summary

Ringwood Water Department

As a requirement of the 1996 Amendments to the Safe Drinking Water Act, New Jersey Department of Environmental Protection (DEP) performed a source water assessment of each source of public drinking water and determined each source's susceptibility to contamination. Susceptibility is a measure of the potential exposure of a drinking water source to contamination.

Approximately 85 to 90 percent of New Jersey's population receive their drinking water from public water systems. These public water systems are highly regulated and perform routine monitoring for the presence of contaminants. The remaining population obtains their drinking water from private wells. In 2003, 606 public community water systems consisting of 2237 wells and 64 surface water sources served approximately 7.5 million New Jersey residents.

DEP, in conjunction with the United States Geological Survey (USGS), performed the following steps to determine the drinking water sources' susceptibility.

- Identified the area that supplies water to a public drinking water system well or surface water intake (known as the source water assessment area). For ground water sources, this area is also known as the well head protection area. Approximately 10 percent of New Jersey is contained within a community water system well's source water assessment area. For surface water, approximately 53 percent of the state falls within a source water assessment area.
- Inventoried the significant potential sources of contamination within the source water assessment area.
- Determined how susceptible each drinking water source is to contamination.

Susceptibility to the following categories of contamination was determined:

- Pathogens
- Nutrients (nitrates)
- Pesticides
- Volatile Organic Compounds (VOCs)
- Inorganics
- Radionuclides
- Radon
- Disinfection Byproduct Precursors (DBPs)

To determine susceptibility to these contaminants, the USGS, with DEP assistance, developed statistical models based on extensive analysis of existing well sample data and surface water intake data. The statistical models determined the relationship between environmental factors and the probability for contamination to occur. These models identified factors, such as land use or geology, found to be significantly "linked" to a public water system source's potential to become contaminated by one or more categories of

contaminants. DEP and USGS looked at factors that might affect the quality of drinking water sources and separated them into two categories.

The first category consists of *sensitivity factors*, which includes items related to the construction of a well (such as whether the well is in a confined or unconfined aquifer) and naturally occurring factors (such as the geology of the unit in which a well is drawing water from or over which water flows to the surface water intake).

Significant Sensitivity Factors

- Confinement status: For ground water, the confinement status of the well was by far the most frequently occurring sensitivity factor in predicting susceptibility to contamination and in fact was a factor in all the models. Confined wells are protected from activities at the land surface by relatively thick, laterally extensive units of low permeability (clay layers) and are a sufficient distance from the outcrop area of the geologic unit so that the source water is less likely to be affected by contamination at the land surface. Confined wells were determined to be of low susceptibility to contamination occurring at the land surface. Some confined wells, however, are susceptible to contaminants of natural subsurface origin.
- Depth to the top of the open interval: For unconfined wells, depth to the top of the open interval of the well was the most common sensitivity factor to affect the potential for contamination of a well. Depth to top of open interval was found to be a factor in the following five models: pathogens, nutrients, pesticides, inorganics, and radon. The shorter the distance to the land surface, the more likely for the well to be affected by contamination originating at the surface from point sources and certain land uses.
- Percent soil organic matter: For surface water and ground water, percent soil organic matter was found to be a frequently occurring sensitivity factor. Percent soil organic matter was a factor in the VOC, inorganic, and disinfectant byproduct precursor models for both the surface water and ground water susceptibility models.

The second category of factors affecting a source's potential to become contaminated consists of *intensity of use factors*. This category addresses the susceptibility to contamination resulting from human activities at the land surface. Intensity of use factors include those coming from a specific point source, such as a landfill or leaking underground storage tank, and nonpoint sources of contamination grouped by land-use characteristics, such as agriculture or urban land use.

Significant Intensity of Use Factors

Nonpoint Sources

Overall, the results of the modeling performed by USGS show that of the nonpoint sources, factors related to urban land use and agricultural land use, were most often linked to susceptibility of drinking water sources to contamination.

- Surface water: factors related to urban land use from the 1995 coverage (including percentage of commercial/industrial land use, percentage of developed land, percentage of residential land) were important in predicting a source's susceptibility for four contaminant groups, specifically nutrients, pesticides, VOCs, and inorganics. Agricultural land use was found to be a significant factor in three of the surface water models - nutrients, pesticides, and inorganics.

- Ground water: factors related to urban land use from both 1970 and 1995 were important in predicting the susceptibility of source water for five of the models - nutrients, pesticides, VOCs, inorganics and radionuclides. Agricultural land use in 1970 and 1995 coverages were factors in six of the ground water models: pathogens, nutrients, pesticides, radionuclides, radon, and inorganics.

Point Sources

- Surface water: factors related to New Jersey Pollutant Discharge Elimination System /Discharge to Surface Water (NJPDES/DSW) permits and sewage treatment plant density were found most often to be important factors, specifically for the nutrients, VOCs, and inorganics susceptibility models. NJPDES stormwater permitted locations, compost facilities, sites on DEP's Known Contaminated Site List (KCSL) and solid waste landfills were found to be factors in two of the models: VOCs and inorganics.
- Ground water: point sources were found to be significant only in the models for VOC, inorganics, and disinfection byproduct precursors. No point sources were found to be important in the models for pathogens, nutrients, pesticides, radionuclides, and radon.

The specific sensitivity and intensity of use factors for each drinking water source are provided in the Source Water Assessment Report in Tables 2, 3, and 4.

Using the susceptibility factors, the statistical models provided numerical ratings for each source of drinking water for each contaminant category, which were then converted into high (H), medium (M), or low (L) susceptibility ratings.

The Safe Drinking Water Standards or Maximum Contaminant Levels (MCLs) were used to define the three susceptibility ratings (H, M, and L). These standards are developed based health effects, analytical and treatment factors on either acute or long-term impacts related to drinking water exposure. A low susceptibility rating means a potential contaminant level was predicted to be less than 10 percent of the MCL for that contaminant category. A medium rating was given to drinking water sources where the potential contaminant level was predicted to be equal to or greater than 10 percent and less than 50 percent of the MCL. A high rating was assigned to those sources that were predicted to have potential contaminant levels equal to or greater than 50 percent of the MCL. Sources with high susceptibility ratings are still likely to have contaminant concentrations below the MCL. For the list of New Jersey primary and secondary drinking water standards, containing the MCLs, please refer to http://www.state.nj.us/dep/watersupply/standard.htm.

In some cases, insufficient data for particular supplies were available for all variables used in susceptibility models. In such cases, a default value for missing data was assumed. Use of default values could result in a different susceptibility rating than that which would result if the source-specific data were available.

Statewide Summary

Table E1 illustrates the percentage of community water system sources in New Jersey that rated high, medium, and low for each of the contaminant categories. The table is separated by source type: ground water (confined and unconfined) and surface water.

Table E1: Summary of Statewide Susceptibility Ratings for Community Water System Sources (Percent %)

	Pathogens	Nutrients	Pesticides	VOCs	Inorganics	Radionuclides	Radon	DBPs
Ground Water-Confined[1]								
High	0	0	0	0	0	0	0	27
Medium	0	0	0	0	47	39	19	70
Low	100	100	100	100	53	61	81	3
Ground Water-Unconfined[2]								
High	6	67	0	61	39	50	50	26
Medium	56	30	34	1	33	47	46	74
Low	38	3	66	38	28	3	4	0
Surface Water[3]								
High	100[4]	47	13	5	81	0	0	98
Medium	0	42	34	81	19	0	0	2
Low	0	11	53	14	0	100[4]	100[4]	0

[1] Community water systems confined wells in New Jersey in 2003 = 640
[2] Community water systems unconfined wells in New Jersey in 2003 = 1597
[3] Community water system surface water sources in New Jersey in 2003 = 64
[4] All surface water intakes received high susceptibility ratings for pathogens and low susceptibility rating for radionuclides and radon

For the purpose of the source water assessments, the drinking water derived from all surface water intakes was assumed to be highly susceptible to contamination by pathogens. Therefore, all surface water intakes received a high rating for pathogens (100 percent). Surface water sources are subject to various sources of microbial contamination runoff containing fecal matter. Secondly, radionuclide and radon models for surface water were not developed. Radionuclides are primarily a concern of ground water, therefore, all surface water intakes received a low susceptibility rating for radionuclides and radon (0 percent).

Statewide, 77 percent of the sources rated high for at least one of the contaminant categories. Disinfection byproduct precursors were the contaminant category for which surface water sources most commonly received a high susceptibility rating (excluding pathogens). The factors deemed important for the surface water disinfectant byproduct precursor susceptibility model were average percent soil organic matter and distance to wetlands. To address this important category of contaminants, the United States Environmental Protection Agency (USEPA) and DEP adopted the new Stage 1 Disinfectants and Disinfection Byproduct Rule, that requires all community water systems that add a disinfectant to the drinking water during any part of the treatment process to perform routine monitoring for trihalomethanes and haloacetic acids and meet new MCLs of 80 parts per billion and 60 parts per billion, respectively. For more information on the Stage 1 Disinfectants and Disinfection Byproduct Rule please refer to USEPA's web site at http://www.epa.gov/OGWDW/mdbp/dbp1.html.

In addition, disinfection byproduct precursors were the contaminant category for which confined wells (ground water source) most commonly received a high susceptibility rating. The source water assessments resulted in an unexpected number of medium and high susceptibility ratings for the disinfectant precursor model for ground water. The medium and high ratings were unexpected because the reported levels of disinfection byproduct precursors by ground water systems for compliance in New Jersey are generally low. This model is being reviewed with data collected by DEP and may be further refined in the future.

An important distinction exists between the ground water disinfectant precursor model and the other models. The disinfectant byproduct precursors, for which the model was developed, in combination with the disinfection process, form the actual disinfectant byproducts. The disinfectant byproducts are regulated, not the precursors. The precursors themselves are not considered to have adverse health effects, but instead the chemicals that are formed during the disinfection process have the potential health impacts. The other susceptibility models were developed using the regulated contaminant rather than a constituent that reacts to form the regulated contaminant.

For unconfined wells (ground water sources), nutrients and VOCs, were the contaminant categories in which the most sources received a high susceptibility rating. On the other hand, all confined wells obtained a low susceptibility rating for nutrients and VOCs. Both of these contaminant categories are caused by human activity at the land surface, and confined wells are relatively protected from the activity-related contamination by a layer of less permeable material. (The contaminant categories most related to by human activities are nutrients, pesticides, VOCs, and inorganic compounds.)

Drinking Water System: Summary of Sources for Ringwood Water Department

Ringwood Water Department consists of 6 wells, 0 wells under the influence of surface water, 0 surface water intake(s), 1 purchased ground water source(s), and 1 purchased surface water source(s) of drinking water. **(The water system data used for the development of the original drinking water source inventory was compiled in the summer of 2003.)**

Table E2 provides a summary of the susceptibility ratings for the Ringwood Water Department drinking water source(s). The “sources” column of the table provides the number of ground water and surface water sources and the number of wells under the direct influence of surface water in the system. Ground water under the direct influence of surface water (GUDI) is a well found to be influenced by surrounding surface water bodies, and is classified according to site specific water quality measurements, according to the Surface Water Treatment Rule. The other columns provide the number of each of the source(s) that rated high (H), medium (M), and low (L) for each of the contaminant categories.

Table E2: Summary of Susceptibility Ratings for Drinking Water Source(s) for Ringwood Water Department

	Pathogens			Nutrients			Pesticides			VOCs			Inorganics			Radionuclides			Radon			DBPs		
Sources	H	M	L	H	M	L	H	M	L	H	M	L	H	M	L	H	M	L	H	M	L	H	M	L
Wells - 6		3	1	2	1	1			4	2		2			4		3	1	1	3			4	
GUDI - 0																								
Surface water intakes - 0																								

If a drinking water source's susceptibility is high, it does not necessarily mean the drinking water is contaminated. The rating reflects the potential for contamination of source water, not the existence of contamination.

Under the State's Safe Drinking Water Regulations, all public water systems must routinely monitor for contamination. If MCLs (drinking water standards) are exceeded, the water system must perform additional monitoring and treat the water before it is served to the consumer. The water system is also required to notify its customers when MCL violations occur. The process for notification depends on the severity of the violation, which can include public service announcements and publication in a local newspaper. Information about violations must also be included in the Consumer Confidence Reports that community water systems must mail to all their customers annually.

Drinking Water System: Entry Point to the Distribution System

Each entry point to the distribution system (EPTDS) also received a susceptibility rating by combining the weighted average of all the sources contributing to the EPTDS, after the water has been treated (if the drinking water is treated). The susceptibility rating for each EPTDS is available in the Source Water Assessment Report, Section VII, Table 11.

Since the EPTDS is the point at which monitoring and treatment occurs, the DEP determined the EPTDS susceptibility ratings because the assessment will help determine if the existing monitoring requirements for each public water system need to be revised. The assessment will help determine if the routine monitoring frequencies required of a community water system should be increased or decreased (support monitoring waivers). Secondly, the results of the Source Water Assessments will help DEP protect public health by targeting wells and surface water sources that are highly susceptible to contamination for additional water quality monitoring.

The Source Water Assessment Program was designed to encourage protection of drinking water sources by providing information to state and local regulatory agencies and the public to assist in watershed assessment and planning and to enhance the public's role as "water stewards." The results provide information to allow state and local agencies to determine if increased regulatory controls, including local land use ordinances, are warranted. In addition, the basic data gathered through the Source Water Assessment Program, including the locations of the public water system wells and surface water sources, will be available for

DEP program use in efforts to improve environment regulatory actions, such as cleanup decisions in the hazardous and solid waste programs. For more information on DEP's Source Water Protection Strategy please see the Statewide Summary Document available at www.state.nj/us/dep/swap.

For further information please refer to the detailed information in the Source Water Assessment Report or go to www.state.nj/us/dep/swap.

Acknowledgements

The New Jersey Department of Environmental Protection would like to take this opportunity to acknowledge and thank the individuals who contributed to the Source Water Assessment Program.

The Department of Environmental Protection's Water Supply Administration, New Jersey Geological Survey, and Division of Science, Research and Technology prepared the source water assessments in cooperation with the United States Geological Survey.

Water Supply Administration
Edward Apalinski
Patricia Bono
Karen Fell
Barker Hamill
Sandra Krietzman
Myongsun Kong
Mike Matthews
Diane Pupa
Michele Putnam
Linda Walsh
Kristin Zams

New Jersey Geological Survey
Steve Johnson
Bill Mennel
Ted Pallis
Steve Spayd

Division of Science, Research and Technology
Gail Carter
Branden Johnson
Judy Louis

Watershed Management
Robert Kecskes
Tom McKee
Elizabeth Semple

United States Geological Survey
Debra Buxton
Jessica Hopple
Robert Nicholson
Steven Nieswand
Donald Storck
Eric Vowinkel

Source Water Assessment Advisory Committee
Tom Atherholt, NJDEP, DSRT
Jim Blando, NJ Department of Health and Senior Services
Paul Britt, NJ Water Association
Dave Brogle, Middlesex Water Company
Perry Cohn, NJ Department of Health and Senior Services
Ray Cywinski, United Water
Joe Deckelmick, NJ Environmental Federation
Kevin Dixon, NJ American Water Company
Ron Farr, North Jersey District Water Supply Commission
Amy Goldsmith, NJ Environmental Federation
Robert Hordon, Rutgers University
Rick Howlett, NJ Water Association
William Hutchinson, Southeast Morris County MUA
Mark Impomeni, Bergen County Health
Lendel Jones, NJ American Water Company
Robert Karl, Brick Township MUA
Haig Kasabach, Hamilton Township
Geoff Knapp, Morris County
Anne Kruger, Passaic River Coalition
Leo Kruger, Passaic River Coalition
Louisa Lubiak, Passaic River Coalition
Frank Marascia, Elizabethtown Water Company
Peder Nesse, NJ Water Association
John Paschal, Morris County Board of Agriculture
Dave Pringle, NJ Environmental Federation
David Sayers, Delaware River Basin Commission
Paul Scelsi, NJ Department of Transportation
Carol Storms, NJ American Water Company
Louise Usechak, League of Women Voters of NJ
Dan Van Abs, NJ Water Supply Authority
Peter Weppler, North Jersey District Water Supply Commission
Rick Westergard, Gloucester County Planning Department
Ronald Williams, Middlesex Water Company

CONTENTS

SECTION I – BACKGROUND INFORMATION ON DRINKING WATER SYSTEMS 1

SOURCES OF DRINKING WATER 2
TYPES OF PUBLIC WATER SYSTEMS 3
DRINKING WATER TREATMENT 5

SECTION II – SOURCE WATER ASSESSMENT PROGRAM OVERVIEW 7

INTRODUCTION 8
SOURCE WATER ASSESSMENT PROGRAM GOALS 8
SOURCE WATER ASSESSMENT REPORTS 9

SECTION III – SOURCE WATER ASSESSMENT PROGRAM STEPS 10

STEP 1: DELINEATION 12
STEP 2: POTENTIAL CONTAMINANT SOURCE INVENTORY 14
STEP 3: SUSCEPTIBILITY DETERMINATION 15
STEP 4: PUBLIC PARTICIPATION AND OUTREACH 24

SECTION IV - GENERAL DESCRIPTION OF YOUR WATER SYSTEM 25

SECTION V - INVENTORY OF TREATMENT PLANTS AND DRINKING WATER SOURCES 27

SECTION VI - SUSCEPTIBILITY RATINGS FOR YOUR DRINKING WATER SOURCE(S) 30

SECTION VII - SUSCEPTIBILITY RATINGS FOR YOUR ENTRY POINT TO THE DISTRIBUTION SYSTEM (EPTDS) 33

APPENDICES

APPENDIX A – SOURCE WATER ASSESSMENT SUSCEPTIBILITY RATING INFORMATION FOR YOUR WATER SYSTEM

Attachment 1: Individual Explanatory Variable Inventory
Attachment 2: Specific Potential Contaminant Sources Inventory
Attachment 3: Contaminant Category Scoring System
Attachment 4: Entry Point to the Distribution System Rating Calculations
Attachment 5: Public Water Treatment
Attachment 6: Source Water Assessment Maps

APPENDIX B – RESOURCE MATERIALS FOR COMPLETEING SOURCE WATER ASSESSMENTS FOR PUBLIC DRINKING WATER SOURCES

Attachment 1: Guidelines for Delineation of Well Head Protection Areas in New Jersey
Attachment 2: Surface Water Delineation Methodology
Attachment 3: New Jersey Source Water Assessment Program Potential Contaminant Source Inventory Methodology
Attachment 4: Methods to Determine the Susceptibility of Source Water to Community and Noncommunity Water Supplies in New Jersey to Contamination
Attachment 5: Contaminant Group Reports for Ground Water
Attachment 6: Contaminant Group Reports for Surface Water

APPENDIX C – SOURCE WATER ASSESSMENT REPORT MATERIALS

Attachment 1: Source Water Assessment Contact List
Attachment 2: List of Acronyms
Attachment 3: Glossary

FIGURES

FIGURE 1: HYDROLOGIC CYCLE AND SOURCES OF DRINKING WATER **3**

FIGURE 2: TYPES OF PUBLIC WATER SYSTEMS **4**

FIGURE 3: EXAMPLE OF DRINKING WATER TREATMENT **6**

FIGURE 4: FLOWCHART OF SOURCE WATER ASSESSMENT PROGRAM PROCESS **11**

TABLES

TABLE 1: PUBLIC WATER SYSTEMS IN NEW JERSEY IN 2003 5

TABLE 2: SURFACE WATER EXPLANATORY VARIABLES 19

TABLE 3: GROUND WATER UNCONFINED EXPLANATORY VARIABLES 20

TABLE 4: GROUND WATER CONFINED EXPLANATORY VARIABLES 22

TABLE 5: SUMMARY OF STATEWIDE SUSCEPTIBILITY RATINGS FOR COMMUNITY WATER SYSTEM SOURCES (PERCENT %) 23

TABLE 6: MUNICIPALITIES AND POPULATION SERVED 26

TABLE 7: DRINKING WATER SOURCE AND EPTDS INVENTORY 28

TABLE 8: SUMMARY OF SUSCEPTIBILITY RATINGS FOR DRINKING WATER SOURCE(S) 31

TABLE 9: SUSCEPTIBILITY RATING FOR DRINKING WATER SOURCE(S) 32

TABLE 10: EXAMPLE OF AN EPTDS SUSCEPTIBILITY RATING CALCULATION 35

TABLE 11: SUSCEPTIBILITY RATING FOR EPTDS 36

SECTION I – BACKGROUND INFORMATION ON DRINKING WATER SYSTEMS

SECTION I – BACKGROUND INFORMATION ON DRINKING WATER SYSTEMS

This background information is provided to describe how public drinking water systems are regulated and the relationship of these water systems with the Source Water Assessment Program. The following section describes sources of drinking water (groundwater and surface water), types of drinking water systems according to the Department of Environmental Protection (DEP) and Environmental Protection Agency (EPA) definitions, and drinking water treatment.

Sources of Drinking Water

1. Ground Water
Ground water infiltrates the ground and is stored in aquifers, soil and rock below the surface. Aquifers typically consist of gravel, sandstone, sand, or fractured rock. An aquifer can be confined or unconfined. A confined aquifer is ground water bounded between impermeable layers, such as clay. An unconfined aquifer is not bounded by impermeable layers and is more directly linked to surface activities and resources.

Ground water is obtained from a spring or by pumping water from an aquifer through a well. A well is a hole or excavation that is drilled, bored, core driven, jetted, dug, driven or otherwise constructed for the purpose of removal of water from the subsurface for potable water supply. Public wells in New Jersey range from 15 to 1,984 feet deep (in 2002).

2. Surface Water
Surface water, is the water at or above the land's surface, which is neither ground water nor contained within the unsaturated zone, including, but not limited to, the ocean and its tributaries, all springs, streams, rivers, lakes, ponds, wetlands, and artificial waterbodies.

An important link exists between ground water and surface water. Surface water can infiltrate the ground and recharge aquifers. Conversely, ground water slowly moves to the surface and discharges into lakes, rivers, or streams and is known as baseflow. New Jersey's natural stream flow, especially during periods of low precipitation, is largely baseflow from ground water.

Figure 1 illustrates the water cycle, ground water and surface water, and potential sources of contamination to drinking water sources.

Figure 1: Hydrologic Cycle and Sources of Drinking Water

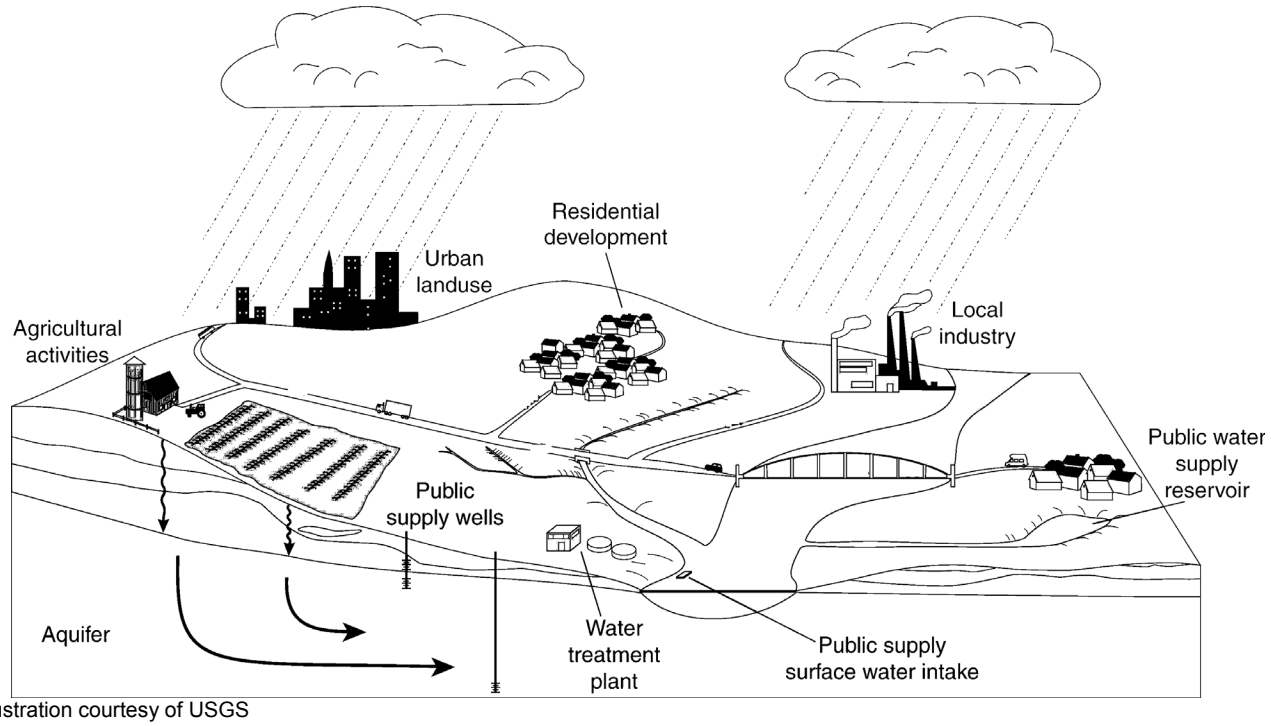


Illustration courtesy of USGS

Types of Public Water Systems

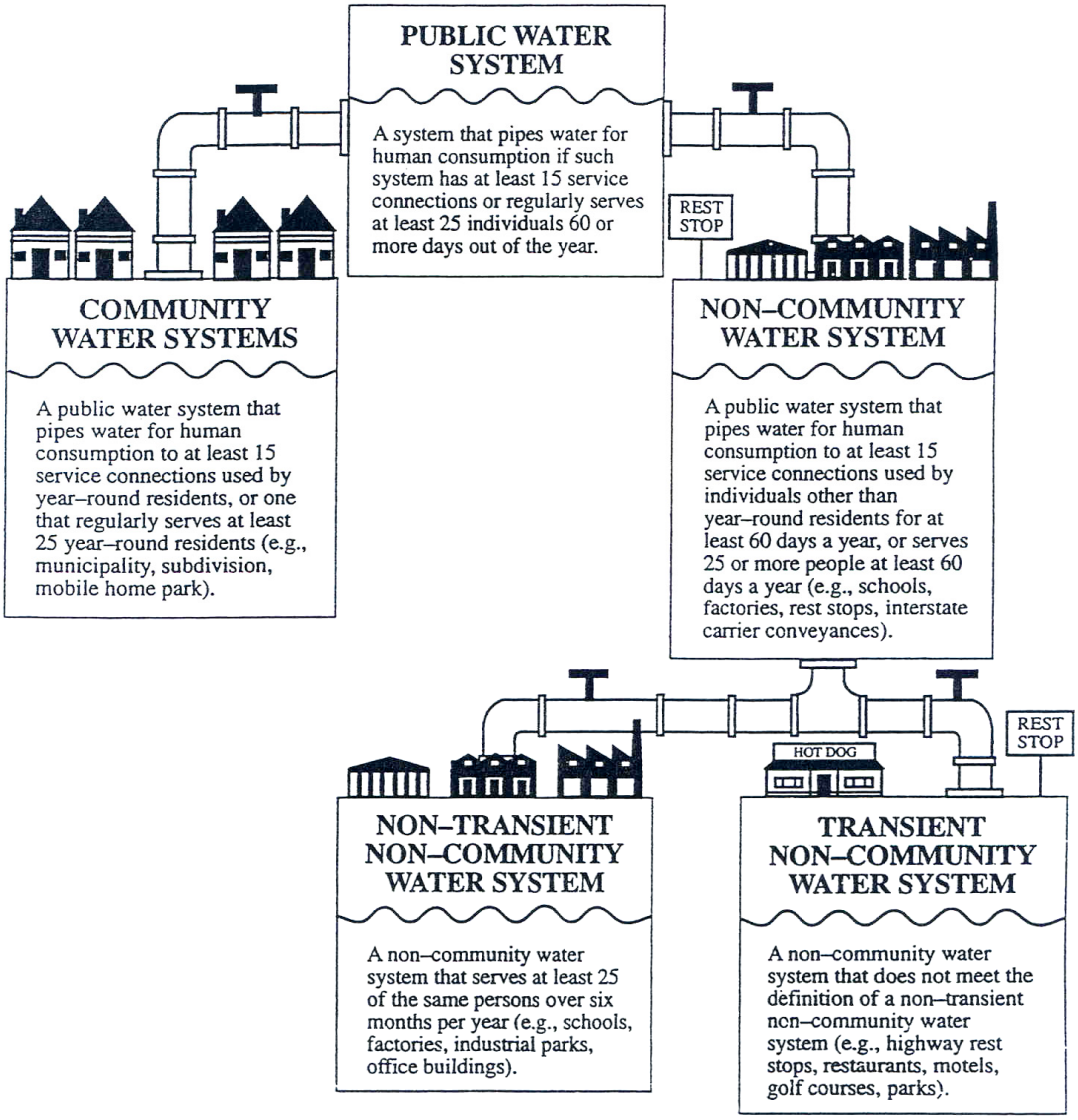
A public water system is defined as a system for the provision to the public of water for human consumption through pipes or other constructed conveyances, if such system has at least 15 service connections or regularly serves at least 25 individuals. Ground water and/or surface water sources can be used for public water systems.

1. **Community Water System**: has at least 15 service connections used by year round residents, or regularly serves at least 25 year round residents. Examples of a community water system are mobile home communities, municipally owned water systems and privately owned water systems that have their own well(s) or surface water intake(s).

2. **Noncommunity Water System**: used by individuals other than year round residents for at least 60 days of the year. A noncommunity water system can be either transient or nontransient. A nontransient noncommunity water system serves at least 25 of the same persons over six months per year, such as schools, factories, and office buildings which have their own well(s) or surface water intake(s). Transient noncommunity water systems are systems that do not fall within the definition of a nontransient water system. Transient noncommunity water systems include rest stop areas, restaurants, and motels that have their own well(s).

A flow chart describing these definitions appears in Figure 2.

Figure 2: Types of Public Water Systems



From: Public Notification Handbook for Public Water Systems, USEPA Office of Water, USEPA Publication 570/9–89–002 September 1989

Approximately 85 to 90 percent of New Jersey's population is served by public water systems. Table 1 summarizes the number of public water systems, wells, and surface water sources in the State of New Jersey in 2003.

Table 1: Public Water Systems in New Jersey in 2003

Type of Public Water System	# of Public Water Systems*	# of Ground Water Sources	# of Surface Water Sources
Community	606	2237	64
Nontransient Noncommunity	876	1083	3
Transient Noncommunity	2654	2779	0
Total	4136	6099	67

* DEP, Bureau of Safe Drinking Water, NJ Public Water System Database.

The remaining New Jersey population is served by private wells (i.e. wells serving individual homes, small businesses, etc.) Private wells are not included in the SWAP. For more information on private wells please visit the Water Supply Administration web site at www.state.nj.us/dep/watersupply or refer to the EPA web site at www.epa.gov/safewater/pwells1.html.

Drinking Water Treatment

A public water system consists of interconnected pipes that lead from the source of drinking water to the consumer. Almost all community water system sources and some noncommunity water system sources are treated to remove microorganisms or dissolved chemicals or minerals. An entry point to the distribution system (EPTDS) is a location in the public water system where treated water from a treatment plant enters into the water distribution system. A public water system may contain one or more EPTDS. If the water is not treated, as some ground water systems are not, then the place where the untreated water source enters the network of pipes is the EPTDS.

Figure 3 illustrates general treatment schemes for both a surface water system and a ground water system. The means of acquiring water (well or surface water intake), the treatment process, and storage are shown. An individual water system may contain only part or even none (do not treat) of these pieces. Individual water treatment may vary according to source water quality.

Figure 3: Example of Drinking Water Treatment

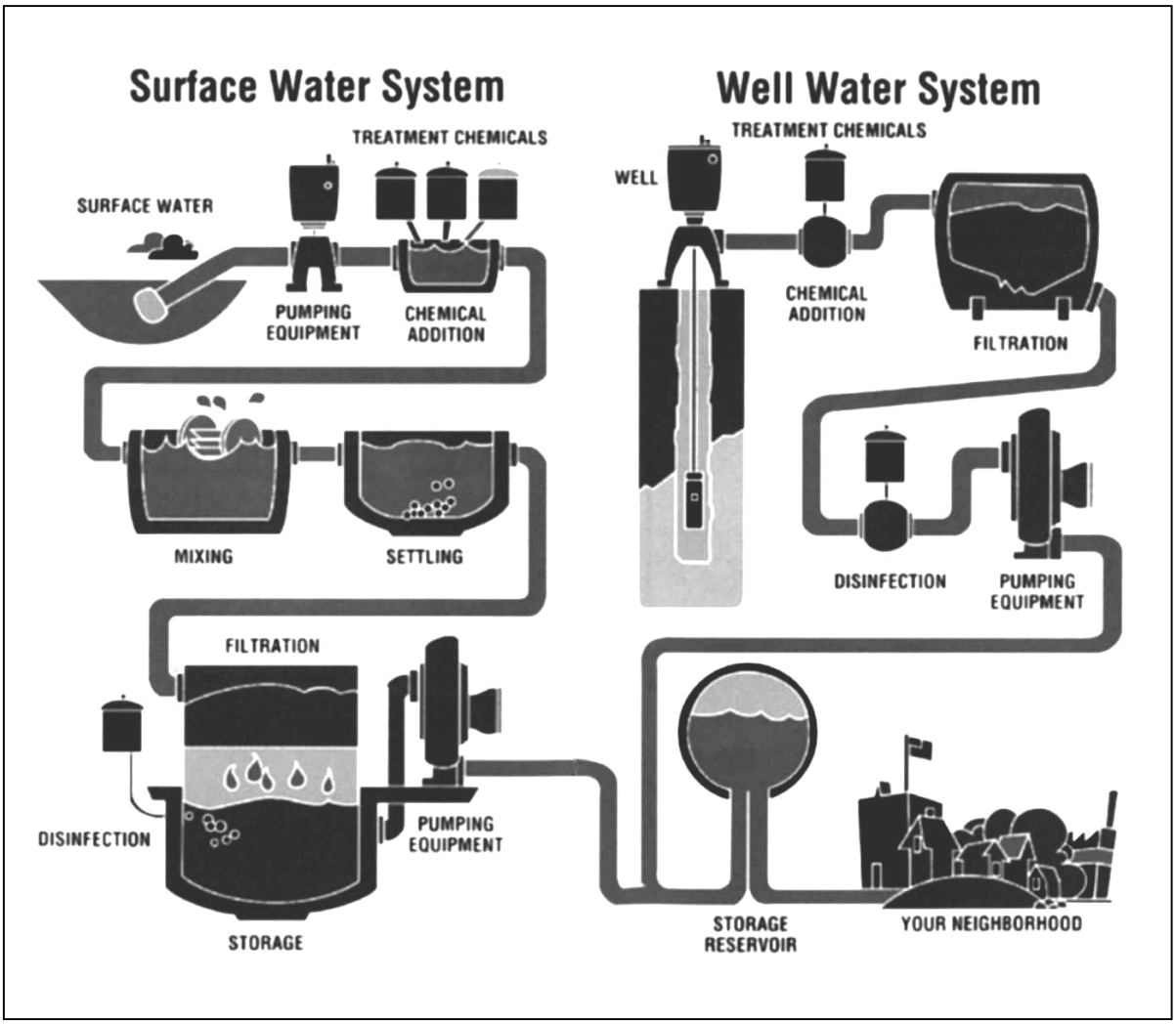


Illustration from “Safeguarding the Quality of Your Drinking Water”, prepared by the Public Information Committee of the New Jersey Section of the American Water Works Association.

SECTION II – SOURCE WATER ASSESSMENT PROGRAM OVERVIEW

SECTION II – SOURCE WATER ASSESSMENT PROGRAM OVERVIEW

Introduction

The 1996 Amendments to the Federal Safe Drinking Water Act place a strong emphasis on public awareness and the information provided to the public concerning the quality of drinking water. As part of the 1996 Amendments, all states were required to establish a Source Water Assessment Program (SWAP).

Through the SWAP, the DEP evaluated the susceptibility of public water systems to several categories of contamination. **If a system rates highly susceptible for a contaminant category, it does not mean a customer is or will be consuming contaminated drinking water.** The rating reflects the potential for contamination of source water, not the existence of contamination. Susceptibility to contamination is a function of several factors, including contaminant use near the water source and the characteristics of the water source.

New Jersey's SWAP Plan, which provides the framework for how DEP performed the assessments, can be found at www.state.nj.us/dep/watersupply/swap1.pdf.

The New Jersey SWAP incorporates four steps:

1. **Delineate the source water assessment area of each public drinking water source.**
2. **Inventory the potential contaminant sources within the source water assessment area.**
3. **Determine the water system's susceptibility to contaminants.**
4. **Incorporate public participation and education.**

Source Water Assessment Program Goals

The information obtained from the completed source water assessments may be used to achieve the goals listed below.

1. Protect sources of drinking water.

The source water assessments provide a susceptibility rating for each source of drinking water, which supplies information on how vulnerable the source is to contamination.

Source water protection focuses on preserving and protecting the public drinking water source. The information obtained from the SWAP will provide communities and decision-makers with the information to protect their drinking water source(s). The source water assessment results can also be used by DEP, purveyors, and local planning officals to lay the groundwork for advancing the State's drinking water protection efforts. Based on the potential of a drinking water source to become contaminated, DEP can initiate a variety of activities to protect the drinking water source through existing DEP programs. For more information regarding DEP's Source Water Protection Strategy please refer to the Source Water Assessment Program Statewide Summary available on the Division of Water Supply's web site at http://www.state.nj.us/dep/watersupply//.

2. Public education of SWAP information.

DEP incorporated public education throughout the development and implementation of the Source Water Assessment Program. During the source water assessment process, DEP

spoke to interested parties, beginning with the development of the SWAP Plan, published articles, wrote two newsletters, and developed a SWAP web site. Upon completion of the source water assessments, DEP generated a source water assessment report and/or summary for each public water system to report the susceptibility ratings.

The goal of the public education efforts is to make the public more aware of the source of their drinking water and the potential contaminants that could impair the water's quality. To continue fulfilling the education requirement, DEP will conduct training sessions following the release of the Source Water Assessment Reports.

3. Establish a customized monitoring schedule for each public water system.
The source water assessments will assist DEP in improving current monitoring requirements for individual public water systems. Currently, the EPA and the DEP have mandatory monitoring schedules that depend on a variety of factors that can include the source of the water (ground water or surface water) and the surrounding land use. These schedules can be customized based on the susceptibility of the sources of drinking water. The SWAP will provide better information for making these determinations.

Source Water Assessment Reports
DEP will issue the following reports to public water systems.

1. **Community Water System Source Water Assessment Report**: primarily intended for the public water system's reference and use, although the report is also available to the public. Individuals, environmental organizations, and municipalities interested in source water protection may also utilize the Community Water System Source Water Assessment Report for protection activities.

2. **Community Water System Source Water Assessment Summary**: a short (4-6 page) informative document created for distribution by the water system to the general public. In addition, DEP will post the summary document on the SWAP web site at http://www.state.nj.us/dep/swap/. The Community Water System Source Water Assessment Summary is a synopsis of the Source Water Assessment Report and provides the source susceptibility ratings for the community water system's sources.

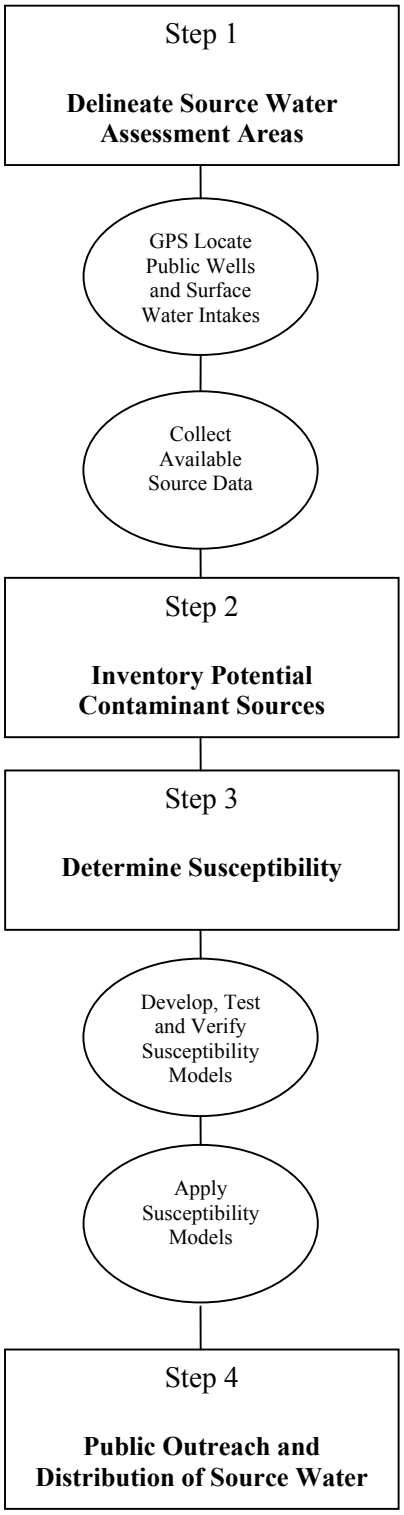
3. **Noncommunity Water System Source Water Assessment Report**: developed for the respective noncommunity water system. The report provides the susceptibility ratings of the system's sources. The general public may request the report from the noncommunity water system or the DEP.

SECTION III – SOURCE WATER ASSESSMENT PROGRAM STEPS

SECTION III – SOURCE WATER ASSESSMENT PROGRAM STEPS

The SWAP consists of four fundamental steps that are illustrated in Figure 4.

Figure 4: Flowchart of Source Water Assessment Program Process



Step 1: Delineation

The first step of the SWAP process is to delineate the source water assessment area for each public water system well and surface water intake. For ground water sources, a source water assessment area in New Jersey is the area from which water is reasonably likely to flow to a well within a 12 year period. This area is also known as a wellhead protection area, or WHPA. For surface water sources, the source water assessment area is the area upstream of a surface water intake, including land that drains to the upstream areas.

Before the source water assessment area was delineated for a public well, attribute data was gathered. Since 1947, a property owner or well driller has been required to obtain a well permit from New Jersey's well permitting program to drill a well in New Jersey. After a licensed well driller drills the well, a well record must be submitted to the Water Supply Administration, DEP. The well record is an "as-built" description of the well construction, and usually contains important attribute data such as well depth, screened interval or length of open hole, and pumping rate/capacity. This information is needed to delineate the source water assessment area around the well. DEP used the well record to determine attribute data. In situations where DEP was unable to obtain attribute data, such as for a well drilled prior to 1947 or when a well record was not available, default values were generated using New Jersey Geological Survey's (NJGS) "Guidelines for Delineation of Well Head Protection Areas in New Jersey," Appendix B- Attachment 1. The guidance document is available on the internet at www.state.nj.us/dep/njgs/whpaguide.pdf, by contacting the DEP, New Jersey Geological Survey at (609) 292-1185, or from the DEP Maps and Publications Sales Office at (609) 777-1038.

For surface water intakes, source water assessment areas were developed based on the location of the intake and the entire drainage area upstream of the intake including headwaters and tributaries. These factors influence the shape and size of the delineations.

Next, the well or intake was located using Global Positioning System (GPS). All wells and intakes were GPS-located according to the "DEP GPS Data Collection Standards for GIS Data Development" available at www.state.nj.us/dep/gis/gpstrim.html. The DEP GPS-located the community water system wells and surface water intakes. The noncommunity water system wells were GPS-located by DEP, County Environmental Health Act (CEHA) Agencies, and the New Jersey Water Association.

After collecting the attribute data and GPS location, the source water assessment areas for wells and intakes were delineated. DEP performed the ground water source water assessment area delineations using the Combined Model/Calculated Fixed Radius Method for all public community water system wells and the Calculated Fixed Radius method for the noncommunity water system wells. For a detailed description of the delineation methods please refer to New Jersey's "Guidelines for Delineation of Well Head Protection Areas in New Jersey," Appendix B- Attachment 1.

For each ground water source, three tiers were calculated and labeled as Tier 1 (two year time of travel), Tier 2 (five year time of travel), and Tier 3 (12 year time of travel). Time of travel was established for determining the risk of contamination to a well. The two year time of travel was developed based on the potential for microbiological contamination. Studies show on average, bacteria can survive in ground water for approximately 170 days and

viruses can survive in ground water for approximately 270 days. The two year time of travel indicates the limits of concern for potential viable microbiological contamination of the water system through the source water.

The five year time of travel was established to address contamination from accidental discharges. This time of travel provides a reasonable amount of time to investigate, monitor, and/or remediate a spill within the source water assessment area. The third time of travel portion of the source water assessment area, 12 year, was designed in consideration of the known contaminant sources. Studies show that 10 to 15 years of time of travel generally covers the full length of a contaminant plume. The 12 year time of travel will permit enough time for responses to be made.

Ground water delineations are available as New Jersey Geological Survey publication DGS02-2, Geographic Information System Coverages of Public Community Water Supply Well Head Protection Areas for New Jersey (1:24,000 scale) at www.state.nj.us/dep/njgs/geodata/dgs02-2.htm.

The DEP delineated the source water assessment areas for surface water intakes using the United States Geological Survey's (USGS) hydrologic unit code 14 (HUC14) as the base data-set for the delineations. Hydrologic unit codes identify drainage basins in a nested group from large to small. The larger the HUC number the smaller the drainage basin. For example a HUC4 will be made up of several smaller HUC8s, and the HUC8s will be made up of several smaller HUC14s. The source water assessment areas for the surface water intakes include the entire drainage area that flows past the intake, including headwaters and tributaries. For more information on the methodology used for surface water delineations, refer to Appendix B- Attachment 2, Surface Water Delineation Methodology.

The DEP has classified approximately 50 wells as "ground water under the direct influence of surface water" (GUDI). GUDI wells are classified according to site specific water quality measurements and provide additional treatment of the source water. For GUDI wells, the DEP performed a conjunctive delineation, an integrated delineation combining the ground water contribution and the surface water contribution to the well. The groundwater and surface water contribution were delineated using the same procedure described above, except the 2 year time of travel for the ground water delineation demarcated the downstream boundary.

A few GUDI wells do not have an obvious surface water body influencing the well. In these instances only the ground water delineated source water assessment area was available. Therefore, the 12 year time of travel boundary for the ground water delineation was used to define the surface water contribution area. An example of this scenario would be the Newton Water and Sewer Utility, Facility number 03, SFID number 010.

The ground water susceptibility models were applied to the GUDI wells ground water contribution area and the surface water susceptibility models were applied to the surface water contribution area. The final susceptibility rating for the GUDI well was determined by taking the higher susceptibility rating of the two (ground water and surface water). Using the pathogen contaminant category as an example, all surface water automatically received a high susceptibility rating for pathogens. Therefore, all GUDI wells received a high susceptibility rating for pathogens. Even if the GUDI well rated low to pathogens for the

ground water contribution area, the high rating for the surface water contribution area was used as the final susceptibility rating (the highest rating of the two).

Step 2: Potential Contaminant Source Inventory

The second step of the SWAP is to identify the potential contaminant sources within the source water assessment area. These potential sources of contamination include point and nonpoint sources. Point source contaminants may be traced to a single source, such as known contaminated sites, industrial and commercial surface and ground water discharges, and sewage treatment discharges. Nonpoint source contaminants may not be traced to one single source because they come from several individual sources within a large area. Land use activities such as salting and runoff from roads and the application of pesticides and herbicides are examples of nonpoint sources. Nonpoint and point sources can have a significant impact on both surface water and ground water quality.

Potential contaminant source inventory information was primarily collected from existing DEP GIS databases. For nonpoint sources, digital GIS land use and land cover data for the years 1970, 1986, and 1995 were used. Several datasets of land coverage were used to account for the changes in land use over the years. The New Jersey Source Water Assessment Program Potential Contaminant Source Inventory (PCSI) Methodology, Appendix B-Attachment 3, describes how the potential contaminant source inventory was developed, the datasets used, the sites and activities included in the inventory, and the preliminary list of explanatory variables used in the susceptibility models.

For the purpose of the SWAP, the DEP, in conjunction with a Source Water Assessment Advisory Committee that met regularly during the development of the SWAP Plan, developed eight conceptual contaminant categories that represent microbiological and chemical contaminants of concern. These categories include pathogens, nutrients, volatile organic compounds, synthetic organic compounds, pesticides, inorganics, radionuclides and disinfection byproduct precursors. This list was further refined during the susceptibility model development process. Tables 2, 3, and 4 contain the final list of contaminant categories and explanatory variables. Each drinking water source was evaluated for susceptibility to each of the following contaminant categories.

Conceptual Contaminant Categories

Pathogens

Disease-causing organisms such as bacteria, protozoa, and viruses. Sources of pathogens include both point and nonpoint activities. An example of a point source of pathogens is a sewer system overflow. An example of a nonpoint source is runoff from areas where livestock are kept.

Nutrients

Common types of nutrients include nitrogen and phosphorous. Nutrients can harm environmental quality, human health, and the efficiency of the drinking water treatment plant by encouraging growth of photosynthetic microorganisms in surface water sources, which alter water characteristics (eutrophic conditions). Sources of nutrients are point and nonpoint sources. Effluents from a sewage treatment plant are a point source of nutrients. Nonpoint sources of nutrients include discharge from septic fields, areas where animal waste is stored, and runoff from agricultural and residential land where fertilizers were used.

Pesticides
Common sources of pesticides include land applications (nonpoint source) and manufacturing/distribution centers of pesticides (point source). Pesticides are manmade chemicals used to control bacteria, fungi, weeds, rodents, and insects. Examples include herbicides such as atrazine and insecticides such as chlordane.

Synthetic Organic Compounds (SOCs)
Sources of SOCs can be point and nonpoint. Common sources include chemical manufacturing plants, pharmaceutical plants, sewage treatment plants, and discharges from contaminated sites. Synthetic organic compounds are manmade.

Volatile Organic Compounds (VOCs)
Common types of VOCs include chemicals that are used as solvents, degreasers, and gasoline components. VOCs are manmade compounds and are the most common organic contaminants in ground water in New Jersey. Sources of VOCs can be point and nonpoint. Examples of VOCs are methyl tertiary butyl ether (MTBE), benzene and vinyl chloride.

Inorganics
Mineral-based compounds that are both naturally occurring and manmade. Sources of inorganics can be point and nonpoint; common sources include discharges from manufacturing plants, releases from contaminated sites, past land uses, and naturally occurring sources. Inorganics include arsenic, cadmium, copper, lead, mercury, and asbestos.

Radionuclides
Sources of radionuclides can be point and nonpoint; common sources include the decay of naturally occurring minerals, leaching of subsurface material (for example rocks and sedimentary materials) into ground water, and improper disposal of radioactive waste. Radionuclides are a category of contaminant that is both naturally occurring and manmade. Radionuclides are radioactive substances such as radium and radon.

Disinfection Byproduct (DBP) Precursors
Disinfection byproducts are formed when the disinfectants used to kill pathogens during treatment react with dissolved organic material present in the water. A common source of DBP precursors is naturally occurring organic material such as leaves in surface water. The amount of organic matter, the type of disinfectant, the concentration of disinfectant, time of contact, pH, and temperature all have an effect on the concentration of disinfection byproducts produced. Chlorine is the most common disinfectant used in New Jersey.

Step 3: Susceptibility Determination
The third step of the SWAP is to determine the public water system's susceptibility to contamination. Susceptibility is a function of source sensitivity (for example soil type and well construction characteristics) and the intensity of surrounding use factors (for example the density of contamination sites or the type of land use).

SUSCEPTIBILITY = Sensitivity + Intensity

DEP contracted with the USGS to develop susceptibility assessment models, with DEP guidance, to determine susceptibility ratings for public supply wells and surface water intakes for the contaminant categories of concern described in Step 2. Some states have determined susceptibility using relatively simple approaches that account for factors such as distance to contaminant sources, but the more thorough modeling approach employed for New Jersey provides a more accurate estimate of susceptibility. The models were based on results from an extensive analysis of ground water and surface water quality data from the DEP-USGS statewide cooperative monitoring networks for a select set of sites in New Jersey. Please refer to the documentation Methods to Determine the Susceptibility of Source Water to Community and Noncommunity Water Supplies in New Jersey to Contamination, Appendix B- Attachment 4 for more information.

USGS developed susceptibility models for seven contaminant categories and radon for both ground water and surface water. DEP had originally intended to develop a susceptibility model for "synthetic organic compounds" (SOCs), but did not do so for two reasons. First, SOCs under the Federal and State Safe Drinking Water Acts consist primarily of pesticides and as part of SWAP, USGS developed a pesticide susceptibility model. Secondly, as USGS investigated whether it could construct a SOCs model, USGS and DEP jointly determined that there was insufficient SOC data that was neither pesticide nor volatile organic compound (VOC) related. (USGS also developed a separate VOC model.) However, it is DEP's experience that the presence of non-pesticide, non-volatile SOCs will typically co-occur with VOCs. Specifically, recent work by DEP and others at community water systems using ground water as a source and known to be contaminated by volatile organic contamination from hazardous waste sites determined that "tentatively identified compounds" (TICs) were present. In this study, although DEP and others were primarily looking for non-volatile organic compounds, TICs were found at some frequency at these sites. As part of the study, a "control" water system with no hazardous waste site nearby and with no volatile contamination was tested and contained no TICs. Qualitative evaluation of the data show systems with the higher levels of volatile organic chemicals and with more than one VOC present contained the highest number of TICs. For these reasons, DEP has determined the SOC rating for a water system would be the same as the public water system's VOC rating, and that a separate SOC susceptibility model was unnecessary.

Separate susceptibility models were developed for radon and other radionuclides for two reasons. First, radon, a gas, is chemically and physically different from other radionuclide constituents. Second, radon most often occurs in areas where other radionuclides are not present. The remedy for radon is different from the remedy for other radionuclides. DEP was concerned that if both radon and other radionuclides were combined, the susceptibility rating would not show the difference in susceptibility of water systems' sources to the different radionuclides.

For the purpose of the source water assessments, all surface water was assumed to be highly susceptible to pathogens, therefore a pathogen model was not developed for surface water. Surface water sources are subject to various sources of microbial contamination runoff containing fecal matter. All surface water intakes received a high rating for pathogens. Secondly, a radionuclide model was not developed for surface water. Radionuclides are primarily a concern of ground water, therefore, all surface water intakes received a low susceptibility rating for radionuclides.

The susceptibility models determined source water susceptibility based on the well or intake's location and explanatory variables. An explanatory variable is a variable that can be used to predict the presence of a contaminant or the potential presence of a contaminant in ground water or surface water. Tables 2, 3, and 4 illustrate the final explanatory variables used in determining sensitivity and intensity ratings for surface water intakes, unconfined wells, and confined wells. These tables also contain the conceptual variables used in the susceptibility rating determinations. A conceptual variable is one that has been shown in a previous scientific investigation to be related to, or is expected to have an effect on, the concentrations of a constituent. Conceptual variables that did not produce significant univariate statistical relations may however, produce a significant relation when used with other variables in multivariate statistical tests.

A list of all contaminant variables reviewed can be found in the documentation Methods to Determine the Susceptibility of Source Water to Community and Noncommunity Water Supplies in New Jersey to Contamination, Appendix B- Attachment 4. For further information, Appendix B- Attachment 5 and 6, Contaminant Group Reports, provide detailed descriptions of the models used for SWAP.

In addition to evaluating the contaminant variables separately, groupings of several point source variables together as a single explanatory variable were investigated to determine if a certain subset of point sources produced meaningful results. USGS determined that although several types of point sources are not statistically significant individually, grouping them as a unit could produce meaningful results. These combinations are known as "Point Source Groupings."

Point Source Grouping 1: consists of sites on the Known Contaminated Site List and on the Solid Waste Landfill Site list. In general, these point sources are existing contamination sources.

Point Source Grouping 2: consists of New Jersey Pollutant Discharge Elimination System for permitted discharges to surface water, New Jersey Pollutant Discharge Elimination System storm water discharges, and Compost Facilities. These point sources are potential surface water contamination problems.

Point Source Grouping 3: consists of New Jersey Pollutant Discharge Elimination System discharges for ground water (NJPDES/DGW), Solid Waste Resource Recovery Facilities (RRF), Solid Waste Transfer Facilities (SWTF), and Class B Recycling Facilities. These point sources are potential ground water contamination problems. The last three activities (RRF, SWTF, and Class B) are designed not to discharge contamination and degrade ground water. They do handle pollutants, and there is a potential to cause contamination. Thus, they are included in the inventory. Facilities that discharge via a NJPDES/DGW permit are given strict permit limits. The discharge standards are typically at or below the ground water quality standards. While these activities are grouped for modeling purposes, the RRF, SWTF, and Class B Recycling Facilities do not appreciably affect the model, based on analysis by USGS.

Point Source Grouping 4: consists of sites regulated by the DEP Discharge Prevention and Countermeasures Plan regulations and Discharge Cleanup and Removal Plan regulations. These facilities store, transfer, process, or use hazardous substances and must specify and

submit information regarding prevention, containment and countermeasure plans and discharge cleanup and removal plans.

Point Source Grouping 5: consists of regulated Underground Storage Tanks (USTs). USTs were treated as a separate point source grouping due to the large number of USTs in New Jersey, relative to the number of other types of potential point sources. There are approximately 19,454 underground storage tank registrations in New Jersey, consisting of active and inactive tanks. USTs were treated separately so that the number of USTs would not obscure possible statistical relations between susceptibility and other potential contaminant sources.

Point Source Grouping 6: consists of the entire Potential Contaminant Source Inventory of point sources.

Several point source groupings were combined to determine whether or not these point source groupings had an effect on a source's susceptibility. If a point source grouping combination was found to be significant it was used as an explanatory variable in the susceptibility models. The explanatory variables can be found in Tables 2, 3, and 4 dependent on the type of drinking water source.

Table 2: Surface Water Explanatory Variables

Illustrates the explanatory variables USGS used in their SWAP surface water modeling.

Constituent/Variable	Pathogens [1]	Nutrients	Pesticides	VOCs	Inorganics	Radionuclides [1]	Radon [1]	DBPs - conceptual [2]
Sensitivity								
% Soil Clay			X					
% Soil Organic Matter				X [2]	X [2]			X [2]
PH of water-quality sample					X			
Physiographic Province					X [2]			
Water Region					X			
Intensity								
% Agricultural Land Use, 1995		X						
% Commercial/Industrial Land Use, 1995					X [2]			
% Developed Land, 1995					X [2]			
% Residential Land Use, 1995			X					
% Urban Land Use, 1995		X		X	X			
Distance to Agricultural Land, 1995			X		X [2]			
Distance to Wetlands, 1995								X [2]
Density of NJPDES SW/Storm, Compost Facilities (Point Source Grouping 2)					X			
Density of KCSL, SWL, NJPDES SW/Storm, Compost Facilities (Point Source Groupings 1,2)				X				
Density of KCSL, SWL, NJPDES GW, SWRRF, SWTF200011, Class B Recycling, DPCC, UST (Point Source Groupings 1, 3, 4, 5)					X			
Sewage Treatment Plant Density		X						
Total Pesticide Application			X					

[1] For the purpose of developing susceptibility models, a pathogen model was not developed because all surface water sources are considered highly susceptible to pathogens; a radionuclide model was not developed because radionuclides are not a concern in surface water.

[2] This conceptual variable shows a graphical relation to water-quality, improves the model, and is supported by scientific investigations.

Table 3: Ground Water Unconfined Explanatory Variables

Illustrates the explanatory variables USGS used in their SWAP ground water unconfined modeling.

Constituent/Variable	Pathogens	Nutrients	Pesticides	VOCs	Inorganics	Radionuclides	Radon	DBPs
Sensitivity								
% Soil Clay					X[4]		X[2]	
% Soil Organic Matter				X	X[2]			X[1]
Conceptual - GWUDI	X[3]							
Depth to Top of Open Interval	X	X[2]	X[2]		X[4]		X	
Depth of Well						X[2]		
Dissolved Oxygen of water-quality sample					X			
Length of Open Interval		X[2]	X[2]					
NJGS Hydrologic Unit (Aquifer)								X[1]
pH of water-quality sample					X	X		
Physiographic Province					X[4]	X	X	
Soil Available Water Capacity	X[1]							
Soil Hydraulic Conductivity					X	X[2]		
Intensity								
% Agricultural Land Use, 1970						X		
% Agricultural Land Use, 1986		X	X					
% Agricultural Land Use, 1995							X	
% Barren Land Use, 1995					X			
% Commercial/Industrial Land Use, 1995				X				
% Urban Land Use, 1970					X			
% Urban Land Use, 1995		X	X[2]					
Area of Urban Land Use, 1995 (square miles)				X				
% Urban Land Use, Tier 1, 1995						X		
% Developed Land, Tier 1, 1995						X		
% Impervious Surface, 1995				X				
Distance to Agricultural Land, 1995	X		X		X	X[1]		
Distance to Golf Course			X[2]					
Distance to DOT Roads					X			
Distance to Sewage Treatment Plant					X			
Distance to Wetlands, 1995							X[2]	
Square Miles of Wetlands, 1995								X[2]
Number of NJPDES SW/GW/Storm, Compost, SWWRF, SWTF200011, Class B Recycling, and DPCC (Point Source Groupings 2, 3, 4)								X

Table 3 continued

Constituent/Variable	**Pathogens**	**Nutrients**	**Pesticides - conceptual[3]**	**SOCs[1]**	**VOCs**	**Inorganics**	**Radionuclides**	**Radon**	**DBPs**
Density of KCSL, SWL, NJPDES GW/SW/Storm, Compost Facility, SWRRF, SWTF200011, Class B Recycling, DPCC, UST (Point Source Groupings 1, 2, 3, 4, 5)						X			
Density of SWL, UST, KCSL (Point Source Groupings 1, 5)					X				
Population Density						X			
Population Density, Tier 1						X			
Septic Tank Density	X[1]								
Septic Tank Density in Piedmont							X		
Sewage Treatment Plant Density						X			
Conceptual - Presence of Streams, Tier 1	X[3]								
Length of Railroads						X			

[1] This conceptual variable shows a graphical relation, improves the model, and is supported by scientific investigations.
[2] This conceptual variable shows a graphical relation to water quality and improves the model.
[3] Statistical tests could not be used because the variable was unavailable for the data set used to develop the model.
[4] This factor is a conceptual variable and an explanatory variable for the contaminant category. As a result of the contaminant category consisting of several inorganics (arsenic, barium, beryllium, fluoride, lead, and mercury), the factor is used as a conceptual and statistically significant variable. Percent soil clay is a conceptual variable (X^2) for lead and mercury, but a statistically significant explanatory variable for beryllium. For depth to top of open interval, the factor is conceptual (X^2) for fluoride and lead, and a statistically significant explanatory variable for beryllium. Thirdly, physiographic province is a conceptual variable (X^3) for mercury and a statistically significant explanatory variable for the arsenic, barium, beryllium, and fluoride models.

Table 4: Ground Water Confined Explanatory Variables

Illustrates the explanatory variables USGS used in their SWAP ground water modeling.

Constituent/Variable	**Pathogens**	**Nutrients**	**Pesticides**	**VOCs**	**Inorganics**	**Radionuclides**	**Radon**	**DBPs**
Sensitivity								
% Soil Organic Matter								
NJGS Hydrologic Unit (Aquifer)								X
Geologic Unit					X	X	X	
pH of water-quality sample								X
Intensity [1]								

[1] Confined wells are not susceptible to intensity variables.

Susceptibility is the measurement of potential for a public water system to become contaminated. The susceptibility models developed by the USGS were applied to all community water system sources and resulted in a high, medium, or low susceptibility rating for each source of water.

If a drinking water source's susceptibility is high, it does not mean the water is contaminated. High susceptibility is a vulnerability rating, not a factor determining whether or not the water is or is not safe to drink. The rating reflects the potential for contamination of source water, not the existence of contamination. Public water systems are required to monitor for regulated contaminants and to install treatment if any contaminants are detected at frequencies and concentrations above allowable levels. Customers can refer to the water company's Consumer Confidence Report (CCR) to determine if the drinking water is meeting all of the Safe Drinking Water Act regulatory requirements. The water utility may be contacted for additional water quality information.

DEP calculated the percentage of community water system sources in New Jersey that rated high, medium, and low for each of the contaminant categories. Table 5 summarizes the susceptibility rating information.

Table 5: Summary of Statewide Susceptibility Ratings for Community Water System Sources (Percent %)

	Pathogens	Nutrients	Pesticides	VOCs	Inorganics	Radionuclides	Radon	DBPs
Ground Water[1]								
High	4	48	0	44	27	35	36	22
Medium	40	22	23	0	38	45	38	76
Low	56	31	77	56	35	20	26	2
Surface Water[2]								
High	100	47	13	5	81	0	0	98
Medium	0	42	34	81	19	0	0	2
Low	0	11	53	14	0	100	100	0

[1] Community water systems wells in New Jersey in 2003 = 2237
[2] Community water system surface water sources in New Jersey in 2003 = 64

USGS developed a rating scoring system for each susceptibility model. When each model was applied to a well or intake, a rating score was generated. This score was then converted into a susceptibility rating of high, medium, or low. For further information on the susceptibility rating score scheme please refer to Appendix A- Attachment 3. The Safe Drinking Water Maximum Contaminant Levels (MCLs) were used to guide the division between the three susceptibility ratings. A low susceptibility rating means a potential contaminant level was predicted to be less than 10 percent of the MCL for that contaminant. A medium susceptibility rating was assigned where the potential contaminant level was predicted to be equal to or greater than 10 percent and less than 50 percent of the MCL. A high susceptibility rating was assigned where the potential contaminant level was equal to or greater than 50 percent of the MCL. For the list of New Jersey primary and secondary drinking water standards, containing the MCLs, please refer to http://www.state.nj.us/dep/watersupply/standard.htm.

In many cases, a public water system may have more than one well or intake, or a combination of wells and intakes. In cases of ground water or surface water only systems, the well or intake ratings were grouped together to represent the EPTDS rating. Each EPTDS received a susceptibility rating for radon and each of the seven contaminant categories. The EPTDS rating was determined by weighing each source's rating score according to the rate of withdrawal. Each weighted score was added, the sum was divided by the number of drinking water sources, and the EPTDS score was classified as low, medium or high susceptibility. Appendix A- Attachment 4 provides an explanation of the EPTDS calculation.

Step 4: Public Participation and Outreach

The fourth step, public participation and outreach, is an essential component of the SWAP. The 1996 Amendments to the Federal Safe Drinking Water Act place a strong emphasis on public participation. To ensure the source water assessments are used for source water protection efforts, the public was involved from the beginning of the program.

The DEP used a variety of techniques to include the public in the program.

1. **Created a Source Water Assessment Advisory Committee to provide input on the draft and final SWAP Plan**. The Source Water Assessment Advisory Committee continued to meet with the DEP regularly to discuss the status of the assessments and provide suggestions during the development of the program. In addition, the Source Water Assessment Advisory Committee provided advice concerning the source water assessment summaries and reports.

2. **Developed a SWAP newsletter, the "New Jersey Source Water Assessment News."** Issues of the "New Jersey Source Water Assessment News" may be found at www.state.nj.us/dep/swap. The newsletter was sent to committee members, public water systems, county health agencies, environmental organizations, municipalities, drinking water laboratories, and other interested parties. The New Jersey Source Water Assessment News informed readers of the status of the SWAP, contact information, source water protection issues, and other related topics.

3. **Published SWAP articles in several organizations' newsletters.** For example, articles were published in the New Jersey Section of American Water Works Association newsletter "Pipeline" and the DEP Division of Watershed Management newsletter "Focus."

4. **Provided speakers for numerous SWAP presentations throughout the State.** The presentations were regularly presented to water purveyors at New Jersey Water Association training courses and other interested organizations such as the watershed management area committees.

The DEP will continue its public outreach following the release of the source water assessments. Public outreach activities will include training sessions for water purveyors, published SWAP articles, and correspondence with interested parties such as purveyors, municipalities, planning boards, and environmental commissions.

SECTION IV - GENERAL DESCRIPTION OF YOUR WATER SYSTEM

SECTION IV – DESCRIPTION OF WATER SYSTEM

Ringwood Water Department
PWID # 1611002

60 Margaret King Avenue
Ringwood, NJ 07456
(973)962-7037

Ringwood Water Department is a public community water system consisting of

6 Entry Points to the Distribution System (EPTDS)
- 6 wells
- 0 wells under the influence of surface water
- 0 surface water intake(s)
- 1 purchased ground water
- 1 purchased surface water

Table 6 below contains the municipalities and the population within each of these municipalities served by Ringwood Water Department.

Table 6: Municipalities and Population Served

Municipality	County	Population Served - 2003
Ringwood Boro	Passaic	8634

SECTION V - INVENTORY OF TREATMENT PLANTS AND DRINKING WATER SOURCES

SECTION V - SYSTEM INVENTORY FOR: Ringwood Water Department

Table 7 provides the Ringwood Water Department's treatment plant(s); source(s); the sources' location(s); whether the source(s) are ground water, surface water, or a purchased supply; and the sources' capacity(s). The first column contains the EPTDS ID and sources contributing to the same EPTDS are identified by the same number. An EPTDS is the entry point to the distribution system, and for most community water systems this location is after the water is treated at a treatment plant.

In the case of a ground water source, the well's confinement status and well permit number are provided.

Table 7: Drinking Water Source and EPTDS Inventory

EPTDS ID	Source ID	Source Name	Water System Component *	Source Status *	Source *	Source Capacity (MGD)	Well Permit #	Confinement Status *
01	001	TREATMENT PLANT #1	T	P				
01	002	WELL 8 SKYLINE DRIVE/SAND PIT	G	P	glacial sand and gravel	0.1512	23-05201	U
01	008	WELL 3/BROOKSYDE AVE.	G	P	igneous and metamorphic rocks	0.0835	43-00035	U
02	003	BEATTIE LANE TP	T	P				
02	032	WELL 9R/BEATTIE LANE	G	P	glacial sand and gravel	0.7343	23-13354	U
03	015	WELL 2/VALLEY ROAD	G	P	igneous and metamorphic rocks	0.0907	23-04903	U
03	022	VALLEY ROAD	T	P				
04	023	SPRING	T	U				
05	019	WELL 5/KOZY COURT	G	U		0		
05	024	KOZY COURT	T	U				
06	021	WELL 6/SKYLINE DR.	G	U	igneous and metamorphic rocks	0.0446	23-05282	U
06	025	SKYLINE DR.	T	U				
07	026	WANAQUE WATER DEPARTMENT	W	E				
13	028	PVWC	P	P				

*KEY

Water System Component

G = Ground Water, P = Purchased Surface Water, S = Surface Water, T = Treatment Plant (EPTDS), U = Ground Water Under The Direct Influence of Surface Water, W = Purchased Ground Water. For a complete definition of each source of drinking water, please refer to the Glossary at the end of this report.

Confinement Status

C = Confined, U = Unconfined. For a definition of a confined and an unconfined aquifer please refer to the Glossary at the end of this report. K = Unknown, S = Semi-confined. For the purposes of SWAP both K and S were treated as unconfined wells.

Source Status

C = Recharge, E = Emergency, I= Interim, O = Other, P= Permanent, R= Reserve, S= Seasonal, U = Not in Use/Capped, V = Abandoned/Not Capped, W = Not in Use/Unspecified, X = Not in Use/Mechanical, Y = Not in Use/Contaminated. For a complete definition of each well status category, please refer to the Glossary at the end of this report.

Source

For ground water sources, the name of the aquifer is provided. For surface water sources, the name of the surface water body on which the intake is located is given.

The Ringwood Water Department contains 6 EPTDS as illustrated in Table 7 (identified by a "T" in the water system component column). Often public water systems treat source water at the EPTDS to ensure the drinking water provided to the public meets Federal and State Drinking Water Standards. Please refer to Appendix A- Attachment 5 for information on the public water system's treatment process.

SECTION VI - SUSCEPTIBILITY RATINGS FOR YOUR DRINKING WATER SOURCE(S)

SECTION VI – SUSCEPTIBILITY RATINGS FOR DRINKING WATER SOURCE(S)

Table 8 provides a summary of the susceptibility ratings for the system's source(s). The source column of the table provides the number of ground water and surface water sources and the number of ground water under the direct influence of surface water (GUDI) wells in the system. The other columns provide the total number of source(s) that rated high (H), medium (M), and low (L) for each of the contaminant categories.

Table 8: Summary of Susceptibility Ratings for Drinking Water Source(s)

	Pathogens			**Nutrients**			**Pesticides**			**VOCs**			**Inorganics**			**Radionuclides**			**Radon**			**DBPs**		
Sources	H	M	L	H	M	L	H	M	L	H	M	L	H	M	L	H	M	L	H	M	L	H	M	L
Wells - 6		3	1	2	1	1			4	2		2			4		3	1	1	3			4	
GUDI - 0																								
Surface water intakes - 0																								

To review a summary of how the other public water systems in the State of New Jersey rated, please refer to Table 5, "Summary of Statewide Susceptibility Ratings for Community Water System Sources (Percent %)" in Section III of the Source Water Assessment Report.

If a drinking water source's susceptibility is high, it does not necessarily mean the water is contaminated. High susceptibility is a vulnerability rating, not a factor determining whether or not the water is or is not meeting State and Federal Safe Drinking Water Standards. The rating reflects the potential for contamination of source water, not the existence of contamination. Public water systems are required to monitor for regulated contaminants and to install treatment if any contaminants are detected at frequencies and concentrations above allowable levels. Please refer to the Consumer Confidence Report (CCR) to determine if the drinking water is meeting all of the Safe Drinking Water Act regulatory requirements.

Table 9 illustrates the susceptibility rating for each individual source for each of the contaminant categories.

Table 9: Susceptibility Rating for Drinking Water Source(s)

EPTDS ID	Source ID	Source Name	Contaminant Category							
			Pathogens	Nutrients	Pesticides	VOCs	Inorganics	Radionuclides	Radon	DBPs
			Rating	Rating	Rating	Rating	Rating	Rating		Rating
01	002	WELL 8 SKYLINE DRIVE/SAND PIT	L	H	L	H	L	M	H	M
01	008	WELL 3/BROOKSYDE AVE.	M	L	L	L	L	L	M	M
02	032	WELL 9R/BEATTIE LANE	M	H	L	L	L	M	M	M
03	015	WELL 2/VALLEY ROAD	M	M	L	H	L	M	M	M
05	019	WELL 5/KOZY COURT								
06	021	WELL 6/SKYLINE DR.								

At the time the source inventory was developed for this report, the status of Wells 5 and 6 was not in use/capped; therefore these sources were not assessed. If these wells become active in the future, a source water assessment will be performed.

The potential contaminant source inventory and sensitivity variables were used to determine the susceptibility ratings for the sources. For specific information on the water system's potential contaminant source inventory and sensitivity variables, please refer to the Individual Explanatory Variable Inventory and the Specific Potential Contaminant Sources Inventory, Appendix A- Attachment 1 and 2.

SECTION VII - SUSCEPTIBILITY RATINGS FOR YOUR ENTRY POINT TO THE DISTRIBUTION SYSTEM (EPTDS)

SECTION VII – SUSCEPTIBILITY RATINGS FOR ENTRY POINT TO THE DISTRIBUTION SYSTEM (EPTDS)

The Ringwood Water Department contains 6 EPTDS. The EPTDS and the susceptibility rating for radon and each of the seven-contaminant categories are provided in Table 11. A susceptibility rating was developed for each EPTDS because this rating represents the water that is treated and delivered to the consumer. A majority of the monitoring regulations are established for the point at which the water exits the water treatment facility, therefore the EPTDS susceptibility rating is important in determining the monitoring requirements.

The EPTDS rating was calculated by the following method. The source contribution resulted from multiplying the pumping rate for each water source by each source's susceptibility score (a point value based on the contaminant category scoring system found in Appendix A – Attachment 3). In cases where the pumping rate was not available, the pumping capacity was used. Next, all source contributions were summed and divided by the total capacity (sum of all the pumping rates and/or capacities) for the EPTDS.

$$\frac{\sum \text{Source Contributions (Source Capacity x Source Susceptibility Score Rating)}}{\text{Total Capacity } (\sum \text{ of all source capacities to the EPTDS})} = \textbf{EPTDS Susceptibility Score}$$

Key

Source Capacity: the source capacity used for determining EPTDS ratings was the same as the pumping rate used by New Jersey Geological Survey to create the source water assessment areas. If the pumping rate was not available, the pumping capacity or a default value was used. The pumping rate selection is described in the New Jersey Geological Survey's "Guidance for Well Head Protection Area Delineations in New Jersey", Appendix B- Attachment 1.

Source Contribution: the value calculated by multiplying the source's pumping rate by the source's susceptibility score rating. The susceptibility score rating is the point value based on the contaminant category scoring system, which can be found in Appendix A – Attachment 3.

Source Susceptibility Score Rating: to obtain a high, medium, or low susceptibility rating, USGS developed a susceptibility scoring system for each contaminant category (pathogens, VOCs, inorganics, nutrients, radionuclides, disinfection byproduct precursors, and pesticides). Each contaminant category has its own point system based on the susceptibility model. For example a susceptibility score range for a contaminant could be 0-5 = low susceptibility, 6-10 = medium susceptibility, and 11-20 = high susceptibility. See Appendices A- Attachment 3 for the susceptibility scoring system USGS used to determine the susceptibility ratings.

Total Capacity: is the full amount of water the sources are contributing to the EPTDS. The pumping rates/capacities are summed to determine the total capacity for the EPTDS.

For groundwater sources, only permanent, seasonal, and interim wells were used in the EPTDS rating calculation. Other wells such as emergency, reserve, and not-in-use, were not included in the source to EPTDS "roll-up", but these wells were rated on a source basis.

For public water systems that consist of a combination of well(s) and intake(s), the EPTDS received a ground water EPTDS rating and a surface water EPTDS rating. Even in circumstances where the surface water is blended with ground water, the EPTDS received two separate susceptibility ratings. A separate ETPDS rating is provided for the ground water and the surface water because separate susceptibility models were developed for ground and surface water. Ground water and surface water susceptibility models differ in susceptibility rating score, therefore, the rating results are not on the same scale.

If a facility has only one well or intake contributing to the EPTDS, that EPTDS received the same rating as the well or intake. DEP used the equation below to determine an EPTDS susceptibility rating.

Table 10 provides an example of how the EPTDS ratings were calculated. To review how the EPTDS ratings were calculated for the Ringwood Water Department, please refer to Appendix A- Attachment 4.

Table 10: Example of an EPTDS Susceptibility Rating Calculation

EPTDS 01

Source	**Capacity (MGD)**	**Source Susceptibility Score Rating (0-20, low to high)**	**Total = Source Contribution**
Well 1	1.09	20	(1.09*20) = 21.8
Well 2	1.72	10	17.2
Well 3	0.72	5	3.6
Well 4	1.48	10	14.8
Well 5	0.75	20	15.0
Total Capacity	5.76		72.4
EPTDS Susceptibility Score is 72.4 / 5.76 = 12.6			

For the above example, the sum of the source contributions for EPTDS 01 (72.4) is divided by the total capacity from all sources (5.76) giving a susceptibility score for the EPTDS of 12.6. The original range for rating sources was 0-5 low, 6-10 medium, 11-20 high. EPTDS 01 susceptibility rating was 12.6; therefore the EPTDS would receive a high rating.

Table 11 lists the susceptibility ratings for each EPTDS for the Ringwood Water Department.

Table 11: Susceptibility Rating for EPTDS

EPTDS ID	EPTDS Name	Contaminant Category							
		Pathogens	Nutrients	Pesticides	VOCs	Inorganics	Radionuclides	Radon	DBPs
		Rating	Rating	Rating	Rating	Rating	Rating		Rating
01	TREATMENT PLANT #1	L	M	L	L	L	M	H	M
02	BEATTIE LANE TP	M	H	L	L	L	M	M	M
03	VALLEY ROAD	M	M	L	H	L	M	M	M