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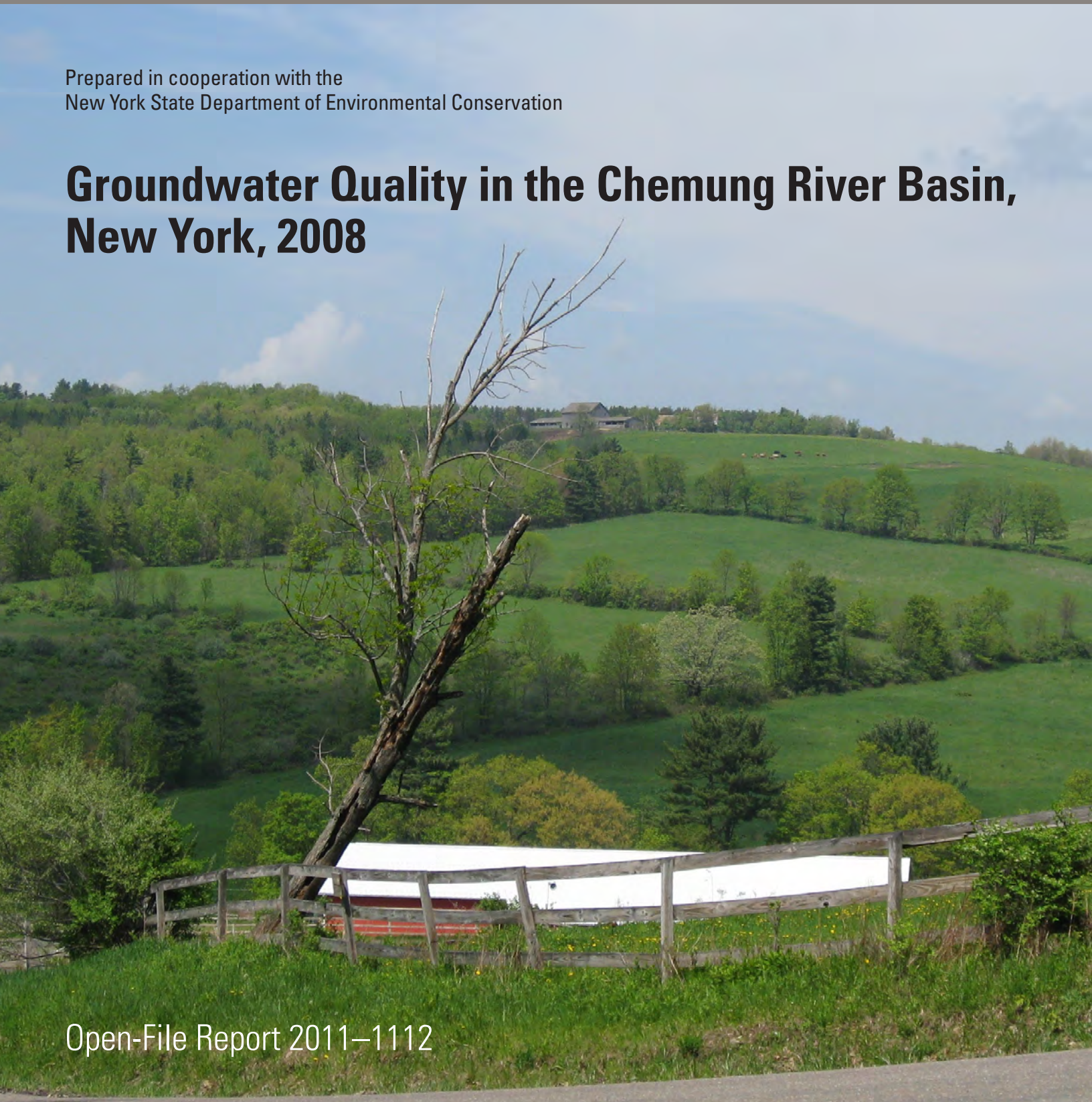
Groundwater Quality in the Chemung River Basin, New York, 2008



Open-File Report 2011–1112

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

Cover. Coleman Avenue, near Harris Hill, Town of Big Flats, Chemung County.

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By Amy J. Risen and James E. Reddy

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U.S. Department of the Interior
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U.S. Department of the Interior
KEN SALAZAR, Secretary

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Conversion Factors, Datum, and Acronyms

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Flow rate	
million gallons per day (Mgal/d)	0.04381	cubic meter per second (m^3/s)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$°F = (1.8 \times °C) + 32$$

Vertical coordinate information is referenced to North American Vertical Datum of 1929 (NAVD 29).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

List of Acronyms

AL	Action Level
AMCL	Alternative maximum contaminant level
CFU/mL	Colony forming units per milliliter
CIAT	2-Chloro-4-isopropylamino-6-amino-s-triazine (also called deethylatrazine)
DWA	Drinking Water Advisory
ESA	Ethanesulfonic acid
HPC	Heterotrophic plate count
LRL	Laboratory Reporting Level
MCL	Maximum Contaminant Level
MTBE	Methyl-*tert*-butyl ether
µg/L	micrograms per liter
µm	micrometer
µS/cm	microsiemens per centimeter at 25 degrees Celsius
mg/L	milligrams per liter
NWQL	USGS National Water Quality Laboratory
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OA	Oxanilic acid
OGRL	USGS Organic Geochemistry Research Laboratory
OIET	2-Hydroxy-4-isopropylamino-6-ethylamino-s-triazine (also called hydroxyatrazine)
pCi/L	picocuries per liter
Pt-Co units	Platinum-cobalt units
SMCL	Secondary Maximum Contaminant Level
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
VOC	Volatile organic compound

Groundwater Quality in the Chemung River Basin, New York, 2008

By Amy J. Risen and James E. Reddy

Abstract

The second groundwater quality study of the Chemung River Basin in south-central New York was conducted as part of the U.S. Geological Survey 305(b) water-quality-monitoring program. Water samples were collected from five production wells and five private residential wells from October through December 2008. The samples were analyzed to characterize the chemical quality of the groundwater. Five of the wells are screened in sand and gravel aquifers, and five are finished in bedrock aquifers. Two of these wells were also sampled for the first Chemung River Basin study of 2003. Samples were analyzed for 6 physical properties and 217 constituents, including nutrients, major inorganic ions, trace elements, radionuclides, pesticides, volatile organic compounds, phenolic compounds, organic carbon, and four types of bacterial analyses. Results of the water-quality analyses for individual wells are presented in tables, and summary statistics for specific constituents are presented by aquifer type. The results are compared with Federal and New York State drinking-water standards, which typically are identical.

Water quality in the study area is generally good, but concentrations of some constituents equaled or exceeded current or proposed Federal or New York State drinking-water standards; these were: sodium (one sample), total dissolved solids (one sample), aluminum (one sample), iron (one sample), manganese (four samples), radon-222 (eight samples), trichloroethene (one sample), and bacteria (four samples). The pH of all samples was typically neutral or slightly basic (median 7.5); the median water temperature was 11.0 degrees Celsius (°C). The ions with the highest median concentrations were bicarbonate (median 202 milligrams per liter [mg/L]) and calcium (median 59.0 mg/L). Groundwater in the study area is moderately hard to very hard, but more samples were hard or very hard (121 mg/L as calcium carbonate ($CaCO_3$) or greater) than were moderately hard (61-120 mg/L as $CaCO_3$); the median hardness was 205 mg/L as $CaCO_3$. The maximum concentration of nitrate plus nitrite was 3.67 mg/L as nitrogen, which did not exceed established drinking-water standards for nitrate plus nitrite (10 mg/L as nitrogen). The trace elements with the highest median concentrations were strontium (median 196.5 micrograms per liter [µg/L]), barium (median 186 µg/L), and iron (median 72.5 µg/L in unfiltered water). Five pesticides and pesticide degradates were detected among four samples at concentrations of 0.11 µg/L or less; they included herbicides and herbicide degradates. Six volatile organic compounds (VOCs) were detected among four samples; these included four solvents, methyl tert-butyl ether, and one trihalomethane. Trichloroethene, a solvent, was detected in one production well at 5.5 µg/L; the Federal and New York State Maximum Contaminant Level (MCL) (5 µg/L) was exceeded. The highest radon-222 activities were in samples from bedrock wells [maximum 1,740 picocuries per liter (pCi/L)]; eight of the wells sampled exceeded a proposed U.S. Environmental Protection Agency (USEPA) drinking-water standard of 300 pCi/L. Any detection of coliform bacteria indicates a potential violation of New York State health regulations; total coliform bacteria were detected in four samples, and fecal coliform bacteria were detected in one sample.

Introduction

Section 305(b) of the Federal Clean Water Act Amendments of 1977 requires that states monitor and report biennially on the chemical quality of surface water and groundwater within their boundaries (U.S. Environmental Protection Agency, 1997). In 2002, the U.S. Geological Survey (USGS), in cooperation with the New York State Department of Environmental Conservation (NYSDEC), developed a program to evaluate groundwater quality throughout the major river basins in New York on a rotating basis. The work parallels the NYSDEC Rotating Intensive Basin Study program, which evaluates surface-water quality in 2 or 3 of the 14 major river basins in the State each year. The groundwater-quality program began in 2002 with a pilot study in the Mohawk River Basin (Butch and others, 2003). Groundwater-quality sampling was completed in the Chemung River Basin in 2003 (Hetcher-Aguila, 2004); the Lake Champlain (Nystrom, 2006) and Susquehanna River Basins in 2004 (Hetcher-Aguila and Eckhardt, 2006); the St. Lawrence (Nystrom, 2007b), Delaware (Nystrom, 2007a), and

Genesee River Basins (Eckhardt and others, 2007) in 2005; the Mohawk River Basin (Nystrom, 2008) and western New York (Niagara and Allegheny River Basins, and tributaries to Lake Erie and western Lake Ontario) (Eckhardt and others, 2008) in 2006; and the Upper Hudson River Basin (Nystrom, 2009) and Central New York (Oswego, Seneca, and Oneida River Basins) (Eckhardt and others, 2009) in 2007. Sampling in the Eastern Lake Ontario Basin, the Chemung River Basin, and the Lower Hudson River Basin (Nystrom, 2010) was completed in 2008.

Purpose and Scope

This report presents the results of the 2008 groundwater study in the Chemung River Basin in south-central New York. It supplements the water-quality study completed in 2003 in the Chemung River Basin (Hetcher-Aguila, 2004) by re-sampling two of the wells from that study (wells SB 1470 and SB 2326) and provides analytical results for eight new wells (fig. 1). This report briefly describes the study area and the sampling methods, and presents results of the 2008 water-quality analyses. Summary statistics (number of samples exceeding Federal or State drinking-water standards) and the minimum, median, and maximum concentrations of selected analytes in 10 samples from wells in surficial and bedrock aquifers are given in tables 1 to 3. Information on the sampled wells and detailed analytical results for all analytes are given in Appendix tables 1-1 through 1-9 at the end of the report.

Study Area

The Chemung River Basin (1,744-square miles [mi^2]) lies mostly in south-central New York and partly in north-central Pennsylvania (fig. 1). A complete description of the study area is presented in the first Chemung River Basin report (Hetcher-Aguila, 2004). Briefly, the study area includes all or parts of seven counties in south-central New York. It encompasses the Cohocton River Basin and the Canisteo River Basin. The main valley of the Chemung River trends northwest-southeast, is about 1 mile wide in most places, and empties into the Susquehanna River, south of Waverly, New York, in Pennsylvania. The entire study area lies within the Appalachian Plateau physiographic province. The Chemung River valley is filled with as much as 500 feet of glaciofluvial sand and gravel and glaciolacustrine silt and clay (Miller, 1982). Saturated deposits of sand and gravel form aquifers that supply water to the villages and cities throughout the basin, including the cities of Elmira, Corning, and Bath (fig. 1). The main valley intersects northeast-southwest trending glaciated tributary valleys that are also filled with glacial sediments. Bedrock aquifers are used for water supply where sand and gravel aquifers are absent, typically in upland areas. The bedrock uplands rise as high as 900 ft above the valley floor and consist of nearly flat-lying interbedded shales, siltstones, and fine-grained sandstones of Devonian age.

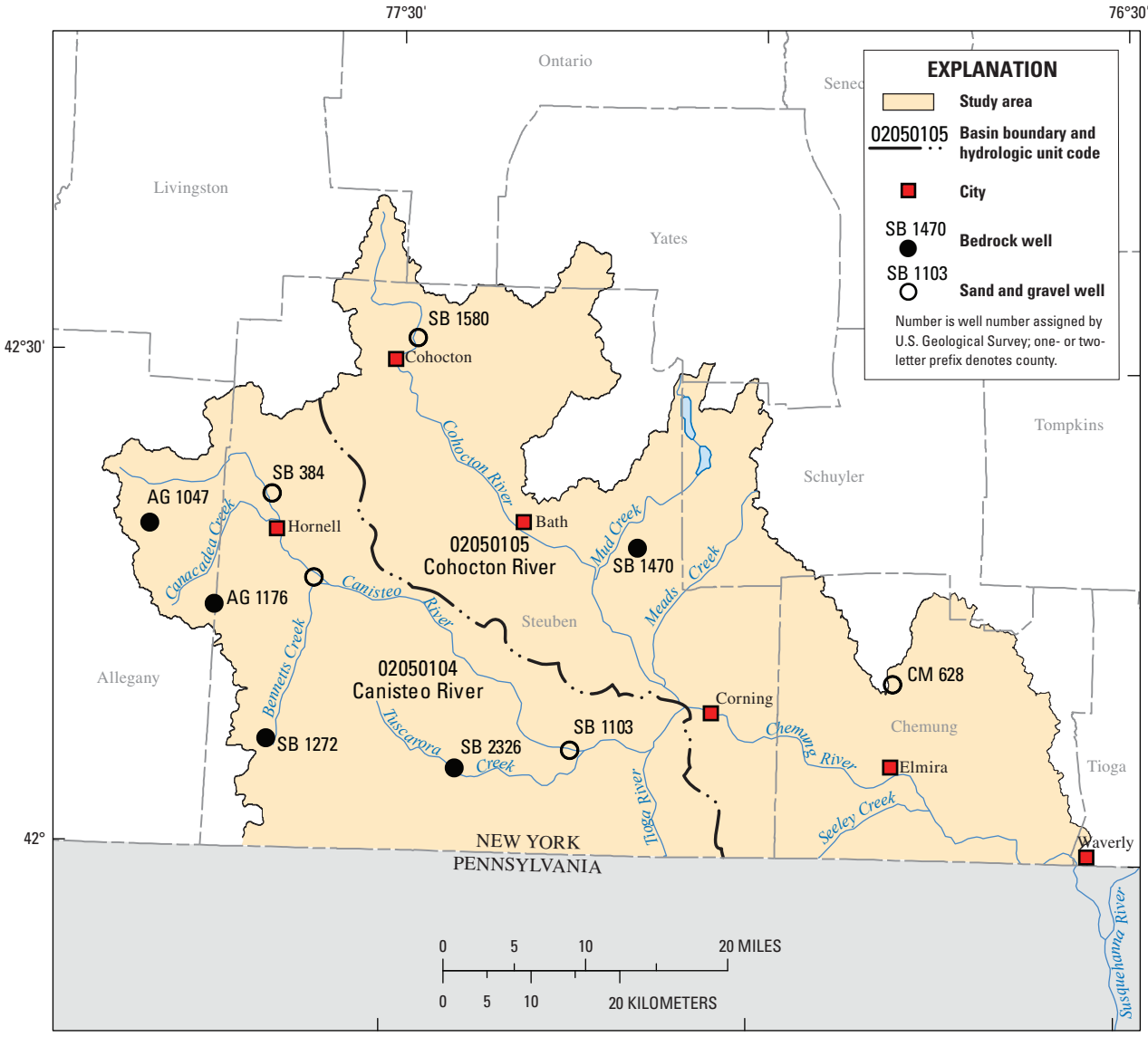
Methods

A total of 10 wells were selected for sample collection as described by Hetcher-Aguila (2004). Five are finished in sand and gravel aquifers, and five are finished in bedrock aquifers. The five wells that tap sand and gravel are production wells, and the five bedrock wells are private residential wells. Sampling was done from October through December 2008. The water samples were analyzed for 6 physical properties and 217 constituents, including 4 types of bacterial analyses. Three samples—two field blanks and one replicate sample—were collected for quality assurance (QA) and quality control (QC), as required for the Federal 305(b) program.

Samples were collected from every well for these analyses and were processed by methods described in USGS manuals for the collection of water-quality data (U.S. Geological Survey, variously dated). A detailed description of the sampling and analytical methods is given by Hetcher-Aguila (2004). Samples collected for pesticide analyses were processed by the methods of Shelton (1994), Sandstrom and others (2001), and Wilde and others (2004). These samples were analyzed for 132 pesticides and pesticide degradates through methods described by Zaugg and others (1995), Furlong and others (2001), Sandstrom and others (2001), Meyer and others (1993), and Lee and Strahan (2003). The analytical method devised by Zaugg and others (1995) was developed in cooperation with the U.S. Environmental Protection Agency (USEPA) and allows detection of the Nation's most commonly used pesticides. Samples for bacterial analyses were processed in accordance with New York State Department of Health (NYSDOH) guidelines.

The analyses for physical properties, most trace elements and metals, acid-neutralizing capacity, organic carbon, radon-222, volatile organic compounds (VOCs), and phenols were done on unfiltered water samples to obtain total whole-water concentrations. Dissolved concentrations of nutrients, major inorganic constituents, three metals, and pesticides were obtained from filtered samples. Concentrations of iron and manganese were measured in both filtered and unfiltered samples to provide the total and dissolved concentrations (table 1-6). Sulfuric acid was added to the samples collected for phenol analysis. Hydrochloric acid was added to samples collected for total organic carbon, VOC, and mercury analyses, and nitric acid was added to some of the samples collected for trace-element analyses to prevent sample degradation. Samples collected for dissolved inorganic-compound analyses were filtered through a 0.45-micrometer (µm) cellulose capsule filter that was attached to the Teflon discharge line inside the sample-collection chamber; samples for pesticide analysis were filtered through a 0.7-µm furnace-baked glass-fiber plate filter using the methods of Wilde and others (2004).

The samples were stored on ice in coolers and delivered directly or shipped by overnight delivery to four laboratories: (1) the USGS National Water Quality Laboratory (NWQL)



Base from U.S. Geological Survey, Seamless Data Distribution System, accessed in 2009 at http://seamless.usgs.gov
Universal Transverse Mercator projection, Zone 18

Figure 1. Pertinent geographic features of study area in the Chemung River Basin, New York, and locations of the 10 wells sampled in 2008. (Well data are given in table 1–1 at end of report.)

in Denver, Colorado, for analysis for inorganic major ions, nutrients, inorganic trace elements and radon-222, VOCs, and some pesticides; (2) the USGS Organic Geochemistry Research Laboratory (OGRL) in Lawrence, Kansas, for additional pesticides; (3) a NYSDOH-certified laboratory in Melville, N.Y., for total organic carbon and phenolic compounds; and (4) a NYSDOH-certified laboratory in Ithaca, N.Y., for bacterial analysis.

Groundwater Quality

Samples from 10 wells were analyzed for 223 constituents and physical properties. More than one-half (163) of these were not detected above the laboratory reporting levels (LRLs) in any sample (table 1-2). Results for the remaining 60 constituents and properties that were detected are presented in the appendix. The categories are as follows: physical properties (table 1-3), inorganic constituents (table 1-4), nutrients and total organic carbon (table 1-5), trace elements and radon-222 (table 1-6), pesticides (table 1-7), VOCs table 1-8), and bacterial water-quality indicators (table 1-9). Some concentrations were reported as "estimated" when the detected value was less than the established LRL, or when recovery of a compound has been shown to be highly variable (Childress and others, 1999).

Analytical results for selected constituents were compared with Federal and New York State drinking-water standards, which typically are identical. The standards include Maximum Contaminant Levels (MCLs), Secondary Maximum Contaminant Levels (SMCLs), Drinking Water Advisories (DWAs), and Action Levels (ALs) established by the USEPA (2002, 2004, and 2009) and the New York State Department. of Health (2007a). MCLs are enforceable standards that specify the highest level of a contaminant that is allowed in public drinking-water supplies; they are not enforceable for private homeowner wells but are presented here as a standard for evaluation of the results. SMCLs are non-enforceable guidelines based on cosmetic and aesthetic criteria, such as taste and odor. DWAs are non-enforceable guidelines for concentrations of contaminants that are not likely to have adverse health or aesthetic effects. ALs require water systems to use treatment techniques for the reduction of contaminants; for example, concentrations of metals could be reduced by controlling corrosiveness. There are several additional compounds for which detections must be reported by public-water systems in their annual report (New York State Department of Health, 2007a;b).

The QA/QC field blank contained no constituent in concentrations greater than the LRLs, except toluene, which was detected at a trace concentration of 0.2 µg/L, and silica, which was detected at 0.14 milligrams per liter (mg/L); this indicates that little to no contamination occurred through the sampling or analytical procedures. The results of analysis of the QA/QC replicate sample indicate that variability in sample results meets the precision requirements of the study. The analytes with the largest percent differences between concentrations in a groundwater sample and that in the replicate sample were acid-neutralizing capacity, residue on evaporation, and low-concentration trace elements (concentrations near the LRL for the trace elements).

The quality of the sampled groundwater was generally acceptable, although at each well the concentrations of some constituents exceeded Federal or New York State drinking-water standards. Exceedances generally involved minerals that occur from natural interactions of water and rock (aluminum, iron, manganese, sodium) but also include the anthropogenic contaminants chloroform and trichloroethene, as well as bacterial contaminants. Eight of the wells tested exceeded the USEPA proposed MCL for radon-222, which is generated from the natural decay of uranium.

Physical Properties

The pH of the samples (table 1-3) ranged from 7.0 to 7.7; the median was pH 7.6 for sand and gravel wells and pH 7.5 for bedrock wells. The temperature of the water ranged from 8.6 to 15.1°C; the median was 11.0°C for sand and gravel wells and 11.6°C for bedrock wells. Specific conductance of the samples ranged from 277 to 1,080 µS/cm at 25°C; the median was 498°µS/cm at 25°C for sand and gravel wells and 538 µS/cm at 25°C for bedrock wells. Dissolved-oxygen concentrations ranged from less than 0.1 mg/L (the LRL) to 5.4 mg/L: the median was 0.6 mg/L for sand and gravel wells and 2.8 mg/L for bedrock wells. The color of the samples ranges from less than 1 platinum-cobalt (Pt-Co) unit to 8 Pt-Co units; the median was 5 Pt-Co units for sand and gravel wells and 5 Pt-Co units for bedrock wells. The odor of hydrogen sulfide gas, which may occur in the absence of oxygen, was noted by field personnel in water from one of the bedrock wells.

Major Ions

The anions that were detected in the highest concentrations were bicarbonate (alkalinity), chloride, and sulfate (tables 1 and 1-4). Bicarbonate concentrations ranged from 129 to 531 mg/L as $CaCO_3$; the median was 187 mg/L for sand and gravel wells and 217 mg/L for bedrock wells. Chloride concentrations ranged from 0.72 to 99.1 mg/L; the median was 49.2 mg/L for sand and gravel wells and 9.27 mg/L for bedrock wells. Sulfate concentrations ranged from 7.81 to 49.5 mg/L; the median was 23.3 mg/L for sand and gravel wells and 28.3 mg/L for bedrock wells.

The cations that were detected in the highest concentrations were calcium, magnesium, and sodium (tables 1 and 1-4). Calcium concentrations ranged from 29.8 to 108 mg/L; the median was 65.3 mg/L for sand and gravel wells and 40.3 mg/L for bedrock wells. Magnesium concentrations ranged from 8.01 to 29.4 mg/L; the median

Table 1. Summary statistics for concentrations of major ions in sand and gravel aquifers and bedrock aquifers in the Chemung River Basin, New York, 2008.

[Concentrations are in milligrams per liter (mg/L). All samples represent filtered water; --, not applicable; E, estimated; $CaCO_3$, calcium carbonate]

	Constituent	Drinking-water standard	Number of samples exceeding standard	Sand and gravel (5 samples)			Bedrock (5 samples)		
				Minimum	Median	Maximum	Minimum	Median	Maximum
Cations	Calcium	--	--	49.5	65.3	99.9	29.8	40.3	108
	Magnesium	--	--	8.97	16.8	18.3	8.01	10.8	29.4
	Potassium	--	--	.77	1.75	4.20	1.46	2.03	3.00
	Sodium	[a]60	1	12.0	26.4	56.2	4.42	13.9	219
Anions	Bicarbonate	--	--	173	187	333	129	217	531
	Chloride	[b]250	0	31.5	49.2	87.8	.72	9.27	99.1
	Fluoride	[c]2.0–[b] 2.2	0	E .06	E .07	E .08	.12	.14	.39
	Sulfate	[b,c]250	0	10.6	23.3	49.5	7.81	28.3	49.3
Hardness, mg/L as $CaCO_3$		--	--	160	230	320	110	140	310
Alkalinity, mg/L as $CaCO_3$		--	--	142	153	273	106	178	435
Residue on evaporation, mg/L		[c]500	1	234	282	460	155	312	640

[a] USEPA Drinking Water Advisory Taste Threshold.

[b] NYSDOH Maximum Contaminant Level.

[c] USEPA Secondary Maximum Contaminant Level.

was 16.8 mg/L for sand and gravel wells and 10.8 mg/L for bedrock wells. Sodium concentrations ranged from 4.42 to 219 mg/L; the median was 26.4 mg/L for sand and gravel wells and 13.9 mg/L for bedrock wells. One bedrock well sample exceeded the USEPA nonregulatory drinking-water advisory taste threshold, which recommends that sodium concentrations in drinking water not exceed the range of 30 to 60 mg/L (U.S. Environmental Protection Agency, 2002; 2009).

Calcium and magnesium contribute to water hardness. Water hardness in the basin ranged from 110 to 320 mg/L as $CaCO_3$; the median was 230 mg/L for sand and gravel wells and 140 mg/L for bedrock wells. One well yielded water that was moderately hard (61-120 mg/L as $CaCO_3$); and five wells yielded water that was very hard (greater than 180 mg/L as $CaCO_3$) (Hem, 1985). Wells finished in bedrock were slightly more alkaline (median 178 mg/L as $CaCO_3$) than those finished in sand and gravel (median 153 mg/L as $CaCO_3$). Residue on evaporation is a measure of total dissolved solids, and ranged from 155 to 640 mg/L. The median residue on evaporation was 282 mg/L for sand and gravel wells and 312 mg/L for bedrock wells; one bedrock sample exceeded the USEPA SMCL of 500 mg/L.

Nutrients and Organic Carbon

Nitrate and ammonia were the predominant nutrients in the ground-water samples (tables 2 and 1-5); nitrite and organic nitrogen concentrations were negligible in most samples. Nitrate plus nitrite concentrations ranged from less than 0.04 (the LRL) to 3.67 mg/L as nitrogen (N); the median concentration was 1.21 mg/L in samples from sand and gravel wells and 0.05 mg/L in samples from bedrock wells. Ammonia concentrations ranged from less than 0.02 (the LRL) to 0.596 mg/L as N. Concentrations of orthophosphate were typically low; the maximum concentration was 0.103 mg/L (as phosphorus). Total organic carbon concentrations ranged from an estimated 0.4 mg/L to 2.2 mg/L.

Trace Elements and Radon-222

The elements detected in the highest concentrations were aluminum, barium, boron, iron, lithium, manganese, and strontium (table 3). Aluminum, boron, lithium, and strontium were generally present at higher concentrations in bedrock wells than at concentrations in sand and gravel wells. Aluminum concentrations ranged from less than 6 (the LRL) to 69 µg/L; the SMCL (50 µg/L) was exceeded in one bedrock well sample. Barium concentrations ranged from 38.8 to 937 µg/L. Boron concentrations ranged from 9.4 to 372 µg/L; MCLs have not been established for boron. Iron concentrations in filtered samples ranged from less than 4 µg/L (the LRL) to 503 µg/L; the Federal SMCL and the New York State MCL for iron (300 µg/L) were exceeded in one sand and gravel well sample. Lithium concentrations ranged from 1.5 to 104 µg/L; MCLs have not been established for lithium. Manganese concentrations in filtered samples ranged from less

Table 2. Summary statistics for concentrations of nutrients and organic carbon in sand and gravel aquifers and bedrock aquifers in the Chemung River Basin, New York, 2008.

[All samples represent filtered water except as noted; mg/L, milligrams per liter; --, not applicable; <, less than; N, nitrogen; P, phosphorus; E, estimated]

Constituent	Drinking-water standard	Number of samples exceeding standard	Sand and gravel (5 samples)			Bedrock (5 samples)		
			Minimum	Median	Maximum	Minimum	Median	Maximum
Ammonia plus organic N, mg/L as N	--	--	E .06	< .10	.18	< .10	.13	.65
Ammonia, mg/L as N	--	--	< .020	< .020	.123	< .020	< .020	.596
Nitrite plus nitrate, mg/L as N	[a,b]10	0	< .04	1.21	2.29	< .04	.05	3.67
Nitrite, mg/L as N	[a,b]1	0	< .002	< .002	.044	< .002	< .002	< .002
Orthophosphate, mg/L as P	--	--	E .005	< .008	.103	E .005	E .006	E .007
Total organic carbon, unfiltered, mg/L	--	--	E .4	1.0	1.1	E .5	1.5	2.2

[a] USEPA Maximum Contaminant Level.

[b] NYSDOH Maximum Contaminant Level.

than 0.2 µg/L (the LRL) to 198° µg/L; the Federal SMCL for manganese (50 µg/L) was exceeded in three sand and gravel well samples. Strontium concentrations ranged from 50.1 to 638 µg/L; MCLs have not been established for strontium.

Radon-222 was detected in every sample (table 1-6), and activity ranged from 153 to 1,740 pCi/L. The median activity was 450 pCi/L in samples from sand and gravel wells and 1,430 pCi/L in samples from bedrock wells. The proposed MCL of 300 pCi/L for radon-222 in drinking water was exceeded in eight samples, but the proposed Alternate Maximum Contaminant Level (ACML) of 4,000 pCi/L was not exceeded. The AMCL is the proposed allowable activity of radon in raw-water samples where the State has implemented mitigation programs to address the health risks of radon in indoor air. The proposed MCL and AMCL for radon are under review and have not been adopted (U.S. Environmental Protection Agency, 2004; 2006).

Some trace elements were detected less frequently or at lower concentrations (table 3) than other constituents. The MCLs for antimony (6 µg/L), arsenic (10µg/L), beryllium (4 µg/L), cadmium (5 µg/L), chromium (100 µg/L), selenium (50 µg/L), silver (100 µg/L), thallium (2 µg/L), zinc (5,000 µg/L), and uranium (30 µg/L), and the SMCL for copper (1,000 µg/L), were not exceeded in any sample. Cobalt and nickel were detected, but no MCLs have been established for them. Antimony, beryllium, cadmium, mercury, silver, and thallium were not detected in any sample (table 1-2).

Pesticides

Five pesticides and related compounds (including four pesticide degradates) were detected in water from four wells (table 1-7). All of the samples containing pesticides were from sand and gravel aquifers. Caffeine is not a pesticide; however, it is measured as part of the pesticide analyses because it can be an indicator of human wastes. Caffeine was not detected in any sample (table 1-2). The herbicide atrazine and two of its degradates—CIAT (2-chloro-4-isopropylamino-6-amino-s-triazine, also called deethylatrazine) and OIET (2-hydroxy-4-isopropylamino-6-ethylamino-s-triazine, also called hydroxytriazine)—were detected. Atrazine was detected in a sample from one production well at an estimated concentration of 0.002 µg/L. CIAT was detected in three samples at estimated concentrations ranging from 0.002 to 0.009 µg/L, and OIET was detected in one sample at an estimated 0.007 µg/L. Alachlor ESA, a degradate of the herbicide alachlor, was detected in samples from two production wells at 0.02 and 0.03 µg/L. Metolachlor ESA, a degradate of the herbicide metolachlor, was detected in three samples at a range of 0.06 to 0.11 µg/L, and these are the highest concentrations measured for any pesticide-related product in this study. No pesticide concentration exceeded Federal or New York State MCLs, and no Federal MCLs currently have been established for these pesticide degradation products. However, NYSDOH requires that any detections of alachlor ESA or atrazine in public water supplies be reported in their annual reports. These trace-level detections of pesticides are similar to those reported by Eckhardt and others (2001), Phillips and others (1999), and Eckhardt and Stackelberg (1995) from studies of pesticides in groundwater throughout New York State.

Volatile Organic Compounds and Phenolic Compounds

Volatile Organic Compounds and Phenolic Compounds

Six VOCs were detected in four samples; two samples were from sand and gravel wells, and two were from

Table 3. Summary statistics for concentrations of trace elements and radon-222 in sand and gravel aquifers and bedrock aquifers in the Chemung River Basin, New York, 2008.

[All concentrations are in micrograms per liter except as noted. All samples unfiltered except as noted. pCi/L, picocuries per liter; --, not applicable; E, estimated; <, less than]

Constituent	Drinking-water standard	Number of samples exceeding standard	Sand and gravel (5 samples)			Bedrock (5 samples)		
			Minimum	Median	Maximum	Minimum	Median	Maximum
Aluminum	[c]50	1	< 6	< 6	< 6	< 6	25	69
Antimony	[a,b]6	0	< .4	< .4	< .4	< .4	< .4	< .4
Arsenic	[a]10	0	E .18	.23	7.5	E .16	.21	.30
Barium	[a,b]2,000	0	89.5	267	937	38.8	146	411
Beryllium	[a,b]4	0	< .02	< .02	< .02	< .02	< .02	< .02
Boron, filtered	--	--	9.4	16	38	18	29	372
Chromium	[a,b]100	0	< .40	< .40	< .40	E .21	< .40	< .40
Cobalt	--	--	E .06	< .10	< .10	E .08	< .10	.16
Copper	[c]1,000	0	E 2.2	< 4.0	4.2	E 2.3	< 4.0	11.8
Iron, filtered	[b,c]300	1	< 4	15	503	E 3	E 4	76
Iron	[b,c]300	1	< 14	16	507	E 9	40	126
Lead	[d]15	0	< .10	.42	1.15	.14	.22	1.36
Lithium	--	--	1.5	6.3	15	10.4	12.3	104
Manganese, filtered	[c]50–[b]300	[c]3–[b]0	< .2	57.5	198	.3	3.2	33.5
Manganese	[c]50–[b]300	[c]4–[b]0	1.1	58.3	230	5.1	10.1	75.1
Molybdenum	--	--	.1	.3	1.0	< .1	.2	.8
Nickel	--	--	E .17	.29	.50	E .11	.26	.48
Selenium	[a,b]50	0	E .07	< .12	.21	< .12	< .12	.15
Silver	[a,b]100	0	< .06	< .06	< .06	< .06	< .06	< .06
Strontium	--	--	110	118	199	50.1	227	63
Thallium	--	--	< .12	< .12	< .12	< .12	< .12	< .12
Zinc	[b,c]5,000	0	E 1.6	2.2	12.4	2.4	5.1	24.6
Radon-222, pCi/L	[e]300	8	290	450	600	153	1,430	1,740
Uranium	[a]30	0	.025	.237	.620	< .020	.456	1.64

[a] USEPA Maximum Contaminant Level.

[b] NYSDOH Maximum Contaminant Level.

[c] USEPA Secondary Maximum Contaminant Level.

[d] USEPA Action Level.

[e] USEPA Proposed Maximum Contaminant Level.

bedrock wells (table 1-8). MTBE, tetrachloroethene, trichloroethene, 1,1,1-trichloroethane, and trichloromethane (also called chloroform) were detected at concentrations ranging from 0.1 to 5.7 µg/L in samples from two production wells. MTBE is a gasoline additive that can infiltrate into groundwater from leaking fuel tanks. Chloroform is a member of a group of compounds called trihalomethanes. Trihalomethanes are typically formed as by-products when chlorine or bromine is used to disinfect water. The State and Federal MCL of 80 µg/L for total trihalomethanes was not exceeded. Trichloroethene was detected in one production well at 5.5 µg/L; the Federal and New York State MCL (5 µg/L) was exceeded. The New York State MCLs for 1,1,1-trichloroethane, tetrachloroethene, and toluene (5 µg/L) were not exceeded. Chloroform and toluene were also detected in two residential wells, each at 0.2 µg/L. Phenolic compounds, which are semivolatile, were not detected in any sample (table 1-2).

Bacteria

All samples were analyzed for total coliform, fecal coliform, Escherichia coli (E. coli), and heterotrophic bacteria. Coliform bacteria were detected in four samples, and fecal coliforms were detected in one sample; E. coli were not detected (table 1-9). Coliform bacteria were detected in one sample from a sand and gravel production well and in three samples from private supply bedrock wells. The NYSDOH and USEPA MCL violation for total coliform bacteria occurs when 5 percent of samples of finished water collected in one month test positive for total coliform (if 40 or more samples are collected per month) or when two samples are positive for total coliform (if fewer than 40 samples are collected per month). Heterotrophic plate counts (HPCs) ranged from less than 1 (absent) to 403 colony-forming units per milliliter (CFU/mL).

Wells sampled in 2003 and 2008

Two of the wells sampled in the fall of 2008 were sampled previously in the summer of 2003 as part of this study; one is bedrock residential well SB 1470, and the other is sand and gravel production well CM 628. Of the 223 constituents and physical properties analyzed for in 2008, 52 were common to the 2003 and 2008 analyses (tables 1-10 through 1-13). Most of the 2008 measurements changed less than 25 percent from the 2003 measurements, and those that changed more than 50 percent are reported below. Water quality was generally good, and the constituents that exceeded State or Federal MCLs or SMCLs at these wells were aluminum and bacteria.

The physical properties changed less than 11 percent, with exception to water color, which increased by at least 100 percent for both wells (table 1-10). The major ions changed less than 20 percent (table 1-10). Concentrations of most major nutrients and organic carbon changed less than 30 percent, although nitrate plus nitrite decreased 60 percent and total organic carbon increased 83 percent for well SB1470 (table 1-10). No MCLs were exceeded for physical properties, major ions, major nutrients, or organic carbon. The trace element and radon-222 concentrations (table 1-11) in 2003 and 2008 were also very similar; however, concentrations of several constituents changed by more than 50 percent—aluminum, cobalt, iron, manganese, nickel, and zinc for well SB 1470 and manganese and nickel for well CM 628. Radon-222 concentrations for both wells and both years exceeded the proposed Federal MCL of 300 pCi/L, but the proposed AMCL of 4,000 pCi/L was not exceeded. Pesticide concentrations (table 1-12) were similar; no pesticides were detected in samples for well SB 1470 in either year, but both atrazine and its degradate CIAT were detected at concentrations in the low nanograms for well CM 628 in both years (OIET was not measured in 2003). Atrazine concentrations were low, and the 2008 concentration for well CM 628 was an estimated 0.008 µg/L, a 27 percent decrease from 2003. No VOCs or phenolics were detected in either well for either year (table 1-13). Bacterial analyses (table 1-10) were positive for coliform for both years at both wells, and the positive results exceed the State MCL. Both wells tested positive for E. coli in 2003, exceeding the State MCL; however, no E. coli were detected in either well in 2008. HPCs increased 168 percent in the sample from well SB 1470 in 2008.

Summary

In 2001, the U.S. Geological Survey, in cooperation with the New York State Department of Environmental Conservation, began an assessment of groundwater quality in bedrock and sand and gravel aquifers throughout New York State. As a part of this assessment, the Chemung River Basin was studied in 2003 and again in 2008. The 2008 study is the subject of this report. For the 2008 study, 10 water samples were collected from five production wells and five private residential wells from October through December 2008. Water samples were analyzed for 223 physical properties and constituents, including inorganic major ions, nutrients, organic carbon, trace elements, radon-222, pesticides, volatile organic compounds (VOCs), phenolic compounds, and bacteria. Two wells, CM 628 and SB 1470, were tested in both studies and a comparison was made of the results. The measurements for most constituents changed little; measurements of only eight constituents changed more than 50 percent from the 2003 value.

The quality of the sampled groundwater was generally acceptable in 2003 and 2008. However, each well sampled in 2008 had at least one constituent that exceeded a Federal or New York State drinking-water standard, or goal, or proposed standard. Maximum Contaminant Levels (MCLs) or Secondary Maximum Contaminant Levels set by the U.S. Environmental Protection Agency (USEPA) and New York State Department of Health for trace elements (manganese, iron, and (or) aluminum) were exceeded in samples from five wells, for the bacterial analyses (total and (or) fecal coliform) at four wells, for the volatile organic compound trichloroethene at one well, and for residue on evaporation at one well. The USEPA drinking-water advisory taste threshold was exceeded for one inorganic ion (sodium) at one well. The USEPA proposed MCL for the radioactive isotope radon-222 was exceeded at eight wells. Five pesticides and related compounds (including four pesticide degradates) were detected in water from four production wells. No pesticide concentration exceeded Federal or New York State MCLs, and no Federal MCLs currently have been established for these pesticide degradation products. Six VOCs were detected in four samples; two samples were from production wells, and two were from private residential wells. Trichloroethene was detected in one production well at 5.5 µg/L; the Federal and New York State MCL (5 µg/L) was exceeded.

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Appendix

Tables 1-1 through 1-13

Table 1–1. Information on wells sampled in the Chemung River Basin, New York, 2008.

[Well locations are shown in figure 1. P, Production; R, Residential; --, information not available]

Well number[1]	U.S. Geological Survey site identifier	Date sampled	Well type	Well depth, feet below land surface	Casing depth, feet below land surface
Sand and gravel wells					
CM 628	421058076483401	11/4/2008	P	72	62
SB 383	421630077362001	11/18/2008	P	65	--
SB 384	422130077400001	11/12/2008	P	67	57
SB 1103	420630077145001	12/16/2008	P	76	41
SB 1580	423118077282001	11/12/2008	P	100	90
Bedrock wells					
AG 1047	421938077495701	10/15/2008	R	105	30
AG 1176	421441077442601	11/4/2008	R	102	41
SB 1272	420634077395101	10/28/2008	R	150	55
SB 1470	421848077094701	11/18/2008	R	278	18
SB 2326	420507077242201	12/16/2008	R	190	40

[1] Prefix denotes county: SB, Steuben; CM, Chemung; AG, Allegany. Number is local well-identification number assigned by U.S. Geological Survey.

Table 1–2. Compounds for which ground-water samples were analyzed but not detected.

USGS parameter code	Constituent	Laboratory reporting level, micrograms per liter (µg/L)
	Trace elements in unfiltered water	
01097	Antimony	0.4
01012	Beryllium	0.02
01027	Cadmium	0.06
71900	Mercury	0.010
01077	Silver	0.06
01059	Thallium	0.12
	Pesticides in filtered water	
04038	2-Chloro-6-ethylamino-4-amino-s-triazine (CEAT)	0.06
62850	2-[(2-Ethyl-6-methylphenyl)amino]-2-oxo ESA	0.02
39732	2,4-D	0.06
50470	2,4-D methyl ester	0.200
66496	2,4-D plus 2,4-D methyl ester	0.02
38746	2,4-DB	0.02
82660	2,6-Diethylaniline	0.006
49308	3-Hydroxy carbofuran	0.040
49260	Acetochlor	0.010–02
61029	Acetochlor ethanesulfonic acid	0.02
61030	Acetochlor oxanilic acid	0.02
63782	Acetochlor second amide	0.02
62847	Acetochlor sulfynilacetic acid	0.02
49315	Acifluorfen	0.040
46342	Alachlor	0.008–0.02
62849	Alachlor ESA 2nd amide	0.02
61031	Alachlor oxanilic acid	0.02
63781	Alachlor second amide	0.02
62848	Alachlor sulfynilacetic acid	0.02
49313	Aldicarb sulfone	0.08
49314	Aldicarb sulfoxide	0.060
49312	Aldicarb	0.12
34253	alpha-HCH	0.008
82686	Azinphos-methyl	0.120
50299	Bendiocarb	0.04
82673	Benfluralin	0.014
50300	Benomyl	0.060
61693	Bensulfuron methyl	0.06
38711	Bentazon	0.06
04029	Bromacil	0.06
49311	Bromoxynil	0.12

Table 1–2. Compounds for which ground-water samples were analyzed but not detected.

USGS parameter code	Constituent	Laboratory reporting level, micrograms per liter (µg/L)
	Pesticides in filtered water—Continued	
04028	Butylate	0.002
50305	Caffeine	0.080
49310	Carbaryl	0.04
49309	Carbofuran	0.040
61188	Chloramben methyl ester	0.10
50306	Chlorimuron	0.080
38933	Chlorpyrifos	0.010
82687	cis-Permethrin	0.014
49305	Clopyralid	0.06
04041	Cyanazine	0.040
04031	Cycloate	0.04
49304	Dacthal monoacid	0.04
82682	DCPA	0.006
63778	Dechloroacetochlor	0.02
63777	Dechloroalachlor	0.02
63779	Dechlorodimethenamid	0.02
63780	Dechlorometolachlor	0.02
62170	Desulfinyl fipronil	0.012
39572	Diazinon	0.005
38442	Dicamba	0.04
49302	Dichlorprop	0.04
39381	Dieldrin	0.009
61951	Dimethenamid ethanesulfonic acid	0.02
62482	Dimethenamid oxanilic acid	0.02
61588	Dimethenamid	0.02
49301	Dinoseb	0.04
04033	Diphenamid	0.04
82677	Disulfoton	0.04
49300	Diuron	0.04
82668	EPTC	0.002
82663	Ethalfluralin	0.009
82672	Ethoprop	0.016
62169	Desulfinylfipronil amide	0.029
49297	Fenuron	0.06
62167	Fipronil sulfide	0.013
62168	Fipronil sulfone	0.024
62166	Fipronil	0.040
61952	Flufenacet ethanesulfonic acid	0.02

Table 1–2. Compounds for which ground-water samples were analyzed but not detected.

USGS parameter code	Constituent	Laboratory reporting level, micrograms per liter (µg/L)
	Pesticides in filtered water—Continued	
62483	Flufenacet oxanilic acid	0.02
62481	Flufenacet	0.02
61694	Flumetsulam	0.06
38811	Fluometuron	0.04
04095	Fonofos	0.010
63784	Hydroxyacetochlor	0.02
63783	Hydroxyalachlor	0.02
63785	Hydroxymetolachlor	0.02
64045	Hydroxydimethenamid	0.02
50356	Imazaquin	0.06
50407	Imazethapyr	0.06
61695	Imidacloprid	0.060
39341	Lindane	0.014
82666	Linuron	0.060
39532	Malathion	0.020
38482	MCPA	0.04
38487	MCPB	0.20
50359	Metalaxyl	0.04
38501	Methiocarb	0.040
49296	Methomyl	0.060–0.120
82667	Methyl parathion	0.008
39415	Metolachlor	0.014–0.02
61044	Metolachlor OA	0.02
82630	Metribuzin	0.016
61697	Metsulfuron	0.14
82671	Molinate	0.002
61692	N-(4-Chlorophenyl)-N’-methylurea	0.06
82684	Napropamide	0.018
49294	Neburon	0.02
50364	Nicosulfuron	0.10
49293	Norflurazon	0.04
49292	Oryzalin	0.04
38866	Oxamyl	0.12
34653	p,p’-DDE	0.003
39542	Parathion	0.020
82669	Pebulate	0.016
82683	Pendimethalin	0.012
82664	Phorate	0.020

Table 1–2. Compounds for which ground-water samples were analyzed but not detected.

USGS parameter code	Constituent	Laboratory reporting level, micrograms per liter (µg/L)
	Pesticides in filtered water—Continued	
49291	Picloram	0.12
04037	Prometon	0.1
82676	Propyzamide	0.004
04024	Propachlor	0.012–0.02
62766	Propachlor ethanesulfonic acid	0.05
62767	Propachlor oxanilic acid	0.02
82679	Propanil	0.014
82685	Propargite	0.02
49236	Propham	0.040
50471	Propiconazole	0.04
38538	Propoxur	0.060
38548	Siduron	0.04
04035	Simazine	0.010
50337	Sulfometuron	0.060
82670	Tebuthiron	0.02
82665	Terbacil	0.040
82675	Terbufos	0.02
82681	Thiobencarb	0.016
82678	Triallate	0.006
49235	Triclopyr	0.08
82661	Trifluralin	0.012
	Volatile organic compounds, in unfiltered water	
77652	1,1,1-Trichloro-1,2,2-trifluoroethane	0.1
34496	1,1-Dichloroethane	0.1
34501	1,1-Dichloroethene	0.1
34536	1,2-Dichlorobenzene	0.1
32103	1,2-Dichloroethane	0.2
34541	1,2-Dichloropropane	0.1
34566	1,3-Dichlorobenzene	0.1
34571	1,4-Dichlorobenzene	0.1
34030	Benzene	0.1
32101	Bromodichloromethane	0.1
34301	Chlorobenzene	0.1
77093	cis-1,2 Dichloroethene	0.1
32105	Dibromochloromethane	0.2
34668	Dichlorodifluoromethane	0.2
34423	Dichloromethane	0.2
81576	Diethyl ether	0.2

Table 1–2. Compounds for which ground-water samples were analyzed but not detected.

USGS parameter code	Constituent	Laboratory reporting level, micrograms per liter (µg/L)
Volatile organic compounds, in unfiltered water—Continued		
81577	Diisopropyl ether	0.2
34371	Ethylbenzene	0.1
50005	Methyl tert-pentyl ether	0.2
85795	m + p Xylene	0.2
77135	o-Xylene	0.1
77128	Styrene	0.1
50004	tert-Butyl ethyl ether	0.1
32102	Tetrachloromethane	0.2
34546	trans-1,2-Dichloroethene	0.1
32104	Tribromomethane	0.2
34488	Trichlorofluoromethane	0.2
39175	Vinyl Choride	0.2
32730	Phenolic Compounds	4

Table 1–3. Physical properties of groundwater samples from the Chemung River Basin, New York, 2008.

[Well locations are shown in figure 1. mg/L, milligrams per liter; <, less than; µS/cm, microsiemens per centimeter at 25 degrees Celsius; (00080), U.S. Geological Survey National Water Information System (NWIS) parameter code; M, detected but not quantified]

Well number[1]	Water color filtered, platinum cobalt units (00080)	Dissolved-oxygen concentration, field, mg/L (00300)	pH, field, standard units (00400)	Specific conductance, field, µS/cm (00095)	Water temperature, degrees Celsius (00010)	Hydrogen sulfide (71875)
Sand and gravel wells						
CM 628	5	5.4	7.7	435	14.0	Absent
SB 383	< 1	.6	7.2	822	11.0	Absent
SB 384	5	2.4	7.4	778	11.0	Absent
SB 1103	5	< .3	7.6	461	10.3	Absent
SB 1580	8	.5	7.7	498	10.2	Absent
Bedrock wells						
AG 1047	5	< .1	7.5	1,080	15.1	M
AG 1176	5	1.1	7.5	277	11.6	Absent
SB 1272	8	2.8	7.4	538	8.6	Absent
SB 1470	2	5.2	7.0	316	11.7	Absent
SB 2326	5	4.2	7.5	737	8.8	Absent

[1] Prefix denotes county: SB, Steuben; CM, Chemung; AG, Allegany. Number is local well-identification number assigned by U.S. Geological Survey.

Table 1–4. Concentrations of inorganic constituents in groundwater samples from the Chemung River Basin, New York, 2008.

[Well locations are shown in figure 1. mg/L, milligrams per liter; (00900), U.S. Geological Survey National Water Information System (NWIS) parameter code; $CaCO_3$, calcium carbonate; E, estimated value—constituent was detected inthe sample but with low or inconsistent recovery. **Bold** values exceed one or more drinking-water standards]

Well number[1]	Hardness, filtered, mg/L as $CaCO_3$ (00900)	Calcium, filtered, mg/L (00915)	Magnesium, filtered, mg/L (00925)	Potassium, filtered, mg/L (00935)	Sodium, filtered, mg/L (00930)	Acid-neutralizing capacity,[2] unfiltered, mg/L as $CaCO_3$ (90410)	Alkalinity,[2] filtered, mg/L as $CaCO_3$ (29801)
Sand and gravel wells							
CM 628	160	49.5	10.0	1.75	22.1	142	142
SB 383	320	99.9	16.8	4.20	46.2	273	273
SB 384	270	78.2	18.3	2.09	56.2	228	228
SB 1103	180	58.1	8.97	0.77	26.4	150	149
SB 1580	230	65.3	16.9	1.31	12.0	153	153
Bedrock wells							
AG 1047	110	29.8	8.01	3.00	**219**	436	435
AG 1176	140	36.7	11.4	1.94	4.42	142	143
SB 1272	270	60.0	29.4	2.42	13.9	251	252
SB 1470	140	40.3	9.18	1.46	6.35	106	106
SB 2326	310	108	10.8	2.03	24.6	178	178

Well number[1]	Bicarbonate,[3] filtered, mg/L as $CaCO_3$ (29805)	Chloride, filtered, mg/L (00940)	Fluoride, filtered, mg/L (00950)	Silica, filtered, mg/L (00955)	Sulfate, filtered, mg/L (00945)	Residue on evaporation, at 180° Celsius, filtered, mg/L (70300)
Sand and gravel wells						
CM 628	173	40.5	E 0.07	5.34	17.8	234
SB 383	333	83.8	E .07	8.29	23.3	460
SB 384	278	87.8	E .06	8.63	33.1	440
SB 1103	182	49.2	E .08	8.91	10.6	264
SB 1580	187	31.5	E .06	8.55	49.5	282
Bedrock wells						
AG 1047	531	65.5	.39	7.93	45.9	**640**
AG 1176	174	.72	.27	9.02	7.81	155
SB 1272	307	.87	.12	8.69	49.3	312
SB 1470	129	9.27	.14	11.6	28.3	184
SB 2326	217	99.1	.12	9.27	26.5	440

[1] Prefix denotes county: SB, Steuben; CM, Chemung; AG, Allegany. Number is local well-identification number assigned by U.S. Geological Survey.

[2] Fixed-endpoint titration at pH 4.5.

[3] Calculated from alkalinity.

Table 1–5. Concentrations of nutrients and total organic carbon in groundwater samples from the Chemung River Basin, New York, 2008.

[Well locations are shown in figure 1. mg/L, milligrams per liter; N, nitrogen; P, phosphorus; <, less than; (00623), U.S. Geological Survey National Water Information System (NWIS) parameter code; E, estimated value—constituent was detected in the sample but with low or inconsistent recovery]

Well number[1]	Ammonia plus organic nitrogen, filtered, mg/L as N (00623)	Ammonia, filtered, mg/L as N (00608)	Nitrate plus nitrite, filtered, mg/L as N (00631)	Nitrite, filtered, mg/L as N (00613)	Orthophosphate, filtered, mg/L as P (00671)	Total organic carbon, unfiltered, mg/L (00680)
Sand and gravel wells						
CM 628	E 0.06	< 0.020	0.25	< 0.002	E 0.006	1.1
SB 383	< .10	< .020	2.29	< .002	< .008	.9
SB 384	< .10	< .020	1.71	.002	E .005	E .4
SB 1103	.18	.123	< .04	< .002	.103	1.1
SB 1580	< .10	< .020	1.21	.044	.008	1.0
Bedrock wells						
AG 1047	.65	.596	< .04	< .002	E .006	2.1
AG 1176	< .10	< .020	< .04	< .002	E .006	< 1.0
SB 1272	.16	< .020	.05	< .002	E .007	1.5
SB 1470	.13	< .020	3.00	< .002	E .006	2.2
SB 2326	< .10	< .020	3.67	< .002	E .005	E .5

[1]Prefix denotes county: SB, Steuben; CM, Chemung; AG, Allegany. Number is local well-identification number assigned by U.S. Geological Survey.

Table 1–6. Concentrations of trace elements and radon-222 in groundwater samples from the Chemung River Basin, New York, 2008.

[Well locations are shown in figure 1. µg/L, micrograms per liter; (01105), U.S. Geological Survey National Water Information System (NWIS) parameter code; <, less than; E, estimated value—constituent was detected in the sample but with low or inconsistent recovery; pCi/L, picocuries per liter. **Bold** values exceed one or more drinking-water standards]

Well number [1]	Aluminum, unfiltered, µg/L (01105)	Arsenic, unfiltered, µg/L (01002)	Barium, unfiltered, µg/L (01007)	Boron, filtered, µg/L (01020)	Chromium, unfiltered, µg/L (01034)	Cobalt, unfiltered, µg/L (01037)	Copper, unfiltered, µg/L (01042)
Sand and gravel wells							
CM 628	< 6	0.22	152	16	< 0.40	< 0.10	< 4.0
SB 383	< 6	E .18	267	38	< .40	E .07	4.2
SB 384	< 6	.23	89.5	13	< .40	E .06	E 2.2
SB 1103	< 6	7.5	937	17	< .40	< .10	< 4.0
SB 1580	< 6	.99	294	9.4	< .40	< .10	< 4.0
Bedrock wells							
AG 1047	27	< .20	411	372	< .40	< .10	< 4.0
AG 1176	< 6	.27	146	18	< .40	< .10	11.8
SB 1272	< 6	E .16	38.8	60	< .40	< .10	E 2.3
SB 1470	25	.21	77.8	29	< .40	E .08	10.4
SB 2326	**69**	.30	220	18	E .21	.16	E 2.4

[1]Prefix denotes county: SB, Steuben; CM, Chemung; AG, Allegany. Number is local well-identification number assigned by U.S. Geological Survey.

Table 1–6. Concentrations of trace elements and radon-222 in groundwater samples from the Chemung River Basin, New York, 2008.—Continued

[Well locations are shown in figure 1. µg/L, micrograms per liter; (01046), U.S. Geological Survey National Water Information System (NWIS) parameter code; <, less than; E, estimated value—constituent was detected in the sample but with low or inconsistent recovery; M, measured but not quantified. **Bold** values exceed one or more drinking-water standards]

Well number[1]	Iron, filtered, µg/L (01046)	Iron, unfiltered, µg/L (01045)	Lead, unfiltered, µg/L (01051)	Lithium, unfiltered, µg/L (01132)	Manganese, filtered, µg/L (01056)	Manganese, unfiltered, µg/L (01055)
Sand and gravel wells						
CM 628	< 4	< 14	0.13	1.5	< 0.2	1.1
SB 383	< 4	< 14	.53	3.6	**198**	**230**
SB 384	18	18	.42	7.6	18.7	21.4
SB 1103	**503**	**507**	< .10	15.0	**141**	**143**
SB 1580	15	16	1.15	6.3	57.5	**58.3**
Bedrock wells						
AG 1047	76	126	.14	104	33.5	36.9
AG 1176	E 4	E 9	.22	12.1	29.5	**75.1**
SB 1272	< 4	< 14	.22	29.0	2.1	5.4
SB 1470	E 3	40	.50	10.4	.3	10.1
SB 2326	10	105	1.36	12.3	3.2	5.1

Table 1–6. Concentrations of trace elements and radon-222 in groundwater samples from the Chemung River Basin, New York, 2008. —Continued

[Well locations are shown in figure 1. µg/L, micrograms per liter; (01046), U.S. Geological Survey National Water Information System (NWIS) parameter code; <, less than; E, estimated value—constituent was detected in the sample but with low or inconsistent recovery; M, measured but not quantified. **Bold** values exceed one or more drinking-water standards]

Well number[1]	Molybdenum, unfiltered, µg/L (01062)	Nickel, unfiltered, µg/L (01067)	Selenium, unfiltered, µg/L (01147)	Strontium, unfiltered, µg/L (01082)	Radon-222, unfiltered, pCi/L (82303)	Uranium, (natural), unfiltered, µg/L (28011)	Zinc, unfiltered, µg/L (01092)
Sand and gravel wells							
CM 628	0.1	E 0.17	< 0.12	110	**450**	0.177	4.6
SB 383	.2	.50	.16	194	**600**	.237	12.4
SB 384	.3	.25	E .07	116	**420**	.620	E 2.0
SB 1103	.5	.33	< .12	199	**520**	.025	E 1.6
SB 1580	1.0	.29	.21	118	290	.427	2.2
Bedrock wells							
AG 1047	< .1	.26	.15	275	153	< .020	5.1
AG 1176	.8	.25	< .12	50.1	**1,740**	.456	3.7
SB 1272	.3	E .11	< .12	638	**1,430**	1.64	24.6
SB 1470	.1	.41	< .12	227	**1,460**	.104	6.9
SB 2326	.2	.48	< .12	226	**1,120**	.809	2.4

Table 1–7. Concentrations of pesticides detected in groundwater samples from the Chemung River Basin, New York, 2008.

[Well locations are shown in figure 1. µg/L, micrograms per liter; <, less than; (04040), U.S. Geological Survey National Water Information System (NWIS) parameter code; CIAT, 2-Chloro-4-isopropylamino-6-amino-s-triazine; OIET, 2-Hydroxy-4-isopropylamino-6-ethylamino-s-triazine; ESA, ethanesulfonic acid; E, estimated value—constituent was detected in the sample but with low or inconsistent recovery]

Well number[1]	CIAT, filtered, µg/L (04040)	OIET filtered, µg/L (50355)	Alachlor ESA, filtered, µg/L (50009)	Atrazine, filtered, µg/L (39632)	Metolachlor ESA, filtered, µg/L (61043)
Sand and gravel wells					
CM 628	E 0.009	E 0.007	< 0.02	E 0.002	< 0.02
SB 383	E .002	< .060	.02	< .007	.09
SB 384	E .003	< .060	.03	< .007	.11
SB 1103	< .014	< .060	< .02	< .007	< .02
SB 1580	< .014	< .060	< .02	< .007	.06
Bedrock wells					
AG 1047	< .014	< .060	< .02	< .007	< .02
AG 1176	< .014	< .060	< .02	< .007	< .02
SB 1272	< .014	< .060	< .02	< .007	< .02
SB 1470	< .014	< .060	< .02	< .007	< .02
SB 2326	< .014	< .060	< .02	< .007	< .02

[1] Prefix denotes county: SB, Steuben; CM, Chemung; AG, Allegany. Number is local well-identification number assigned by U.S. Geological Survey.

Table 1–8. Concentrations of volatile organic compounds in groundwater samples from the Chemung River Basin, New York, 2008.

[Well locations are shown in figure 1. µg/L, micrograms per liter; <, less than; (34506), U.S. Geological Survey National Water Information System parameter code. **Bold** values indicate detections]

Well number[1]	1,1,1-Trichloroethane, unfiltered, µg/L (34506)	Trichloromethane, unfiltered, µg/L (32106)	Toluene, unfiltered, µg/L (34010)	Trichloroethene, unfiltered, µg/L (39180)	Tetrachloroethene, unfiltered, µg/L (34475)	Methyl tert-butyl ether, unfiltered, µg/L (78032)
Sand and gravel wells						
CM 628	<0 .1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.2
SB 383	< .1	< .1	< .1	< .1	**3.3**	**0.4**
SB 384	**0.1**	**5.7**	< .1	**5.5**	< .1	< .2
SB 1103	< .1	< .1	< .1	< .1	< .1	< .2
SB 1580	< .1	< .1	< .1	< .1	< .1	< .2
Bedrock wells						
AG 1047	< .1	< .1	< .1	< .1	< .1	< .2
AG 1176	< .1	< .1	< .1	< .1	< .1	< .2
SB 1272	< .1	< .1	**0.2**	< .1	< .1	< .2
SB 1470	< .1	< .1	< .1	< .1	< .1	< .2
SB 2326	< .1	**0.2**	< .1	< .1	< .1	< .2

[1] Prefix denotes county: SB, Steuben; CM, Chemung; AG, Allegany. Number is local well-identification number assigned by U.S. Geological Survey.

Table 1–9. Concentrations of bacteria in unfiltered groundwater samples from the Chemung River Basin, New York, 2008.

[Well locations are shown in figure 1. mL, milliliter; <, less than; > greater than; CFU, colony-forming unit; (61213), U.S. Geological Survey National Water Information System (NWIS) parameter code. **Bold** values exceed one or more drinking-water standards]

Well number[1]	Total coliform colonies per 100 mL (61213)	Fecal coliform colonies per 100 mL (61215)	*Escherichia coli*, colonies per 100 mL (31691)	Heterotrophic plate count, CFUs per mL (31692)
Sand and gravel wells				
CM 628	**18**	< 1	< 1	6
SB 383	< 1	< 1	< 1	8
SB 384	< 1	< 1	< 1	2
SB 1103	< 1	< 1	< 1	< 1
SB 1580	< 1	< 1	< 1	5
Bedrock wells				
AG 1047	< 1	< 1	< 1	3
AG 1176	**1**	< 1	< 1	6
SB 1272	< 1	< 1	< 1	91
SB 1470	**>200**	< 1	< 1	233
SB 2326	**100**	**1**	< 1	403

[1] Prefix denotes county: SB, Steuben; CM, Chemung; AG, Allegany. Number is local well-identification number assigned by U.S. Geological Survey.

Table 1–10. Physical properties of, and concentrations of major ions, nutrients, total organic carbon, and bacteria in groundwater samples collected in the Chemung River Basin, New York, 2003 and 2008.

[Well locations are shown in figure 1. NWIS, National Water Information System; wu, unfiltered water; wf, filtered water; mg/L, milligrams per liter, µS/cm, microsiemens per centimeter at 25 degrees Celsius; N, nitrogen; P, phosphorus; CFU, colony-forming unit; mL, milliliter; pos, positive result (organism detected); <, less than; >, greater than; E, estimated value—constituent was detected in the sample but with low or inconsistent recovery]

U.S. Geological Survey NWIS parameter code	Constituent	Well SB 1470		Well CM 628	
		2003	2008	2003	2008
	Physical properties				
00080	Color, wf, platinum-cobalt units	< 1	2	2	5
00300	Dissolved oxygen, wu, mg/L	5.4	5.2	6.0	5.4
00400	pH, wu	8.4	7.0	8.0	7.7
00095	Specific conductance, wu, µS/cm	374	316	393	435
00010	Temperature, wu, degrees Celsius	11.2	11.7	14.4	14.0
	Inorganic constituents (major ions)				
00915	Calcium, wf, mg/L	50.3	40.3	43.0	49.5
00925	Magnesium, wf, mg/L	11.4	9.18	8.41	10.0
00935	Potassium, wf, mg/L	1.48	1.46	1.64	1.75
00930	Sodium, wf, mg/L	6.98	6.35	21.2	22.1
00940	Chloride, wf, mg/L	10.1	9.27	41.7	40.5
00950	Fluoride, wf, mg/L	< 0.2	0.14	< 0.2	E 0.07
00955	Silica, wf, mg/L	13.3	11.6	5.54	5.34
00945	Sulfate, wf, mg/L	24.1	28.3	15.0	17.8
	Nutrients and total organic carbon				
00623	Ammonia + organic-N, wf, mg/L as N	.10	.13	E .07	E .06
00608	Ammonia, wf, mg/L as N	< .04	< .020	< .04	< .020
00631	Nitrate plus nitrite, wf, mg/L as N	7.45	3.00	.23	.25
00613	Nitrite, wf, mg/L as N	< .008	< .002	< .008	< .002
00671	Orthophosphate, wf, mg/L as P	< .02	E .006	< .16	< .06
00680	Total organic carbon, wu, mg/L	1.2	2.2	1.4	1.1
	Bacteria				
31691	Escherichia coli, wu, CFU per 100 mL	pos	< 1	pos	< 1
61215	Fecal coliform, wu, CFU per 100 mL	10	< 1	< 5	< 1
31692	Heterotrophic plate count, wu, CFU per mL	87	233	9	6
61213	Total coliform, wu, CFU per 100 mL	pos	> 200	pos	18

Table 1–11. Concentrations of trace elements and radon-222 in groundwater samples collected in the Chemung River Basin, New York, 2003 and 2008.

[Well locations are shown in figure 1. NWIS, National Water Information System; wu, unfiltered water; wf, filtered water; µg/L, micrograms per liter; pCi/L, picocuries per liter; <, less than; m, constituent was detected in the sample but was not quantified; E, estimated value—constituent was detected in the sample but with low or inconsistent recovery]

U.S. Geological Survey NWIS parameter code	Constituent	Well SB 1470		Well CM 628	
		2003	2008	2003	2008
	Trace elements				
01105	Aluminum, wu, µg/L	4	25	4	< 6
01007	Barium, wu, µg/L	77	77.8	129	152
01020	Boron, wf, µg/L	30	29	20	16
01034	Chromium, wu, µg/L	< 0.8	< 0.40	< 0.8	< 0.40
01037	Cobalt, wu, µg/L	m	E .08	m	< .10
01042	Copper, wu, µg/L	18.6	10.4	1.3	< 4.0
01046	Iron, wf, µg/L	< 8	E 3	< 8	< 4
01045	Iron, wu, µg/L	m	40	< 6	< 14
01051	Lead, wu, µg/L	m	.50	m	.13
01132	Lithium, wu, µg/L	11.5	10.4	1.2	1.5
01056	Manganese, wf, µg/L	4.2	.3	< .4	< .2
01055	Manganese, wu, µg/L	5	10.1	< .22	1.1
01062	Molybdenum, wu, µg/L	E .2	.1	E .1	.1
01067	Nickel, wu, µg/L	2	.41	1	E .17
01147	Selenium, wu, µg/L	< .5	< .12	< .5	< .12
01082	Strontium, wu, µg/L	273	227	95	110
28011	Uranium, wu, µg/L	.102	.104	.138	.177
01092	Zinc, wu, µg/L	3	6.9	6	4.6
	Radon-222				
82303	Radon-222, wu, pCi/L	2,580	1,460	570	450

Table 1–12. Concentrations of pesticides in groundwater samples collected in the Chemung River Basin, New York, 2003 and 2008.

[Well locations are shown in figure 1. NWIS, National Water Information System; wf, filtered water; µg/L, micrograms per liter; <, less than; E, estimated value—constituent was detected in the sample but with low or inconsistent recovery]

U.S. Geological Survey NWIS parameter code	Constituent	Well SB 1470		Well CM 628	
		2003	2008	2003	2008
04040	2-Chloro-4-isopropylamino-6-amino-s-triazine (CIAT), wf, µg/L	< 0.006	< 0.014	E 0.007	E 0.009
50009	Alachlor ESA, wf, µg/L	< .05	< .02	< .05	< .02
39632	Atrazine, wf, µg/L	< .007	< .040	.011	E .008
61043	Metolachlor ESA, wf, µg/L	< .05	< .02	< .05	< .02

Table 1–13. Concentrations of volatile organic compounds in groundwater samples collected in the Chemung River Basin, New York, 2003 and 2008.

[Well locations are shown in figure 1. NWIS, National Water Information System; wu, unfiltered water; µg/L, micrograms per liter; <, less than]

U.S. Geological Survey NWIS parameter code	Constituent	Well SB 1470		Well CM 628	
		2003	2008	2003	2008
34506	1,1,1-Trichloroethane, wu, µg/L	< 0.1	< 0.1	< 0.1	< 0.1
32106	Trichloromethane, wu, µg/L	< .1	< .1	< .1	< .1
34010	Toluene, wu, µg/L	< .1	< .1	< .1	< .1
39180	Trichloroethene, wu, µg/L	< .1	< .1	< .1	< .1
34475	Tetrachloroethene, wu, µg/L	< .1	< .1	< .1	< .1
78032	Methyl tert-butyl ether (MTBE), wu, µg/L	< .2	< .2	< .2	< .2

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