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NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Ground-Water Quality in the St. Lawrence River Basin, New York, 2005-06

Open-File Report 2007-1066

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

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By Elizabeth A. Nystrom

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DIRK KEMPTHORNE, Secretary

U.S. Geological Survey
Mark D. Myers, Director

U.S. Geological Survey, Reston, Virginia 2007

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Conversion Factors

Multiply	By	To obtain
Length		
centimeter (cm)	0.3937	inch (in.)
foot (ft)	0.3048	meter (m)
Area		
acre	0.004047	square kilometer (km ²)
square mile (mi ²)	2.590	square kilometer (km ²)
Volume		
liter (L)	0.2642	gallon (gal)
gallon (gal)	3.785	liter (L)
Flow rate		
gallon per minute (gal/min)	0.06309	liter per second (L/s)
Radioactivity		
picocurie per liter (pCi/L)	0.037	becquerel per liter (Bq/L)

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

$$^{\circ}\text{F}=(1.8\times^{\circ}\text{C})+32$$

Vertical coordinate information is referenced to North American Vertical Datum of 1988 (NAVD 88).

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

Abbreviated water-quality units used in this report:

micrometers (µm)

micrograms per liter (µg/L)

milligrams per liter (mg/L)

picoCuries per liter (pCi/L)

microsiemens per centimeter @ 25°C (µS/cm)

Acronyms used in this report:

AMCL Alternative maximum contaminant level

CFU Colony-forming units

cICP-MS Collision/reaction cell inductively coupled plasma-mass spectrometry

ESA Ethanesulfonic acid

GC-MS	Gas chromatography-mass spectrometry
GPS	Global positioning system
GWSI	Ground-Water Site Inventory
HPLC-MS	High-performance liquid chromatography-mass spectrometry
ICP-AES	Inductively coupled plasma-atomic emission spectrometry
ICP-MS	Inductively coupled plasma-mass spectrometry
ICP-OES	Inductively coupled plasma-optical emission spectrometry
LC-MS	Liquid chromatography-mass spectrometry
MCL	Maximum contaminant level
MTBE	Methyl <i>tert</i> -butyl ether
NWQL	USGS National Water Quality Laboratory
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OGRL	USGS Organic Geochemistry Research Laboratory
POC	Principal organic contaminant
PVC	Polyvinyl chloride
SDWS	Secondary drinking water standards
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
VOC	Volatile organic compound

Ground-Water Quality in the St. Lawrence River Basin, New York, 2005-06

By Elizabeth A. Nystrom

Abstract

The Federal Clean Water Act requires that States monitor and report on the quality of ground water and surface water. To satisfy part of these requirements, the U.S. Geological Survey and New York State Department of Environmental Conservation have developed a program in which ground-water quality is assessed in 2 to 3 of New York State's 14 major river basins each year. To characterize the quality of ground water in the St. Lawrence River Basin in northern New York, water samples were collected from 14 domestic and 11 production wells between August 2005 and January 2006. Eight of the wells were finished in sand and gravel and 17 wells were finished in bedrock. Ground-water samples were collected and processed using standard U.S. Geological Survey procedures and were analyzed for 229 constituents and physical properties, including inorganic constituents, nutrients, trace elements, radon-222, pesticides and pesticide degradates, volatile organic compounds, and bacteria.

Sixty-six constituents were detected above laboratory reporting levels. Concentrations of most compounds at most sites were within drinking water standards established by the U.S. Environmental Protection Agency and New York State Department of Health, but a few compounds exceeded drinking water standards at some sites. Water in the basin is generally hard to very hard (hardness equal to 121 mg/L as CaCO_3 or greater); hardness and alkalinity were generally higher in the St. Lawrence Valley than in the Adirondack Mountains. The cation with the highest median concentration was calcium; the anion with the highest median concentration was bicarbonate. The concentration of chloride in one sample exceeded the 250 milligrams per liter U.S. Environmental Protection Agency Secondary Drinking Water Standard; the concentration of sulfate in one sample also exceeded the 250 milligrams per liter U.S. Environmental Protection Agency Secondary Drinking Water Standard. Nitrate was the predominant nutrient detected but no sample exceeded the 10 mg/L U.S. Environmental Protection Agency Maximum Contaminant Level. The trace elements detected with the highest median concentrations were strontium, barium, and iron. Concentration of trace elements in several samples exceeded U.S. Environmental Protection Agency Secondary Drinking Water Standards, including aluminum (50 micrograms per liter, 4 samples), iron (300 micrograms per liter, 5 samples), and manganese (50 micrograms per liter, 4 samples). The concentration of uranium in one sample from a domestic well finished in crystalline bedrock was three times the U.S. Environmental Protection Agency Maximum Contaminant Level of 30 micrograms per liter.

The median concentration of radon-222 was 600 picoCuries per liter, but concentrations as high as 18,800 picoCuries per liter were detected; two wells with high radon concentrations also had high uranium concentrations. Radon-222 is not currently regulated, but the U.S. Environmental Protection Agency has proposed a Maximum Contaminant Level of 300 picoCuries per liter along with an Alternative Maximum Contaminant Level of 4,000 picoCuries per liter, to be in effect in states that have programs to address radon in indoor air. Concentrations of radon-222 exceeded the proposed Maximum Contaminant Level in 60 percent of samples and exceeded the proposed Alternative Maximum Contaminant Level in 8 percent of samples. Six pesticides and pesticide degradates were detected; all were amide or triazine herbicides or degradates. Five volatile organic compounds were detected, including disinfection byproducts such as trichloromethane and gasoline components or additives such as methyl *tert*-butyl ether. No pesticides, pesticide degradates, or volatile organic compounds were detected above established limits. Coliform bacteria, including *Escherichia coli*, were detected in three wells finished in carbonate bedrock.

Introduction

The Federal Clean Water Act Amendments of 1977 require that States monitor and report biennially on the chemical quality of surface water and ground water within their boundaries (U.S. Environmental Protection Agency, 1997, Section 305(b)). 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 ground-water quality throughout the major river basins in New York State on a rotating basis. This program parallels the NYSDEC Rotating Intensive Basin Study program, which evaluates surface-water quality in two or three of 14 river basins in the State each year. Ground-water quality was studied in the Mohawk River Basin in 2002 (Butch and others, 2003), in the Chemung River Basin in 2003 (Hetcher-Aguila, 2005), and in the Lake Champlain and Susquehanna River Basins in 2004 (Nystrom, 2006; Hetcher-Aguila and Eckhardt, 2006). In 2005-2006, ground-water quality in the St. Lawrence, Delaware, and Genesee River Basins was studied.

Purpose and Scope

This report presents the findings from the 2005-2006 ground-water quality study in the St. Lawrence River Basin. To characterize ground-water quality in the St. Lawrence River Basin, 25 samples were collected in the basin between August 2005 and January 2006. This report (1) describes the methods of site selection, sample collection, and chemical analysis used to sample ground water in the St. Lawrence River Basin in 2005-2006, and (2) discusses the results by category—physical properties, major ions, nutrients, trace elements and radionuclides, pesticides, volatile organic compounds, and bacteria. Information about the wells sampled and results are presented in tables 1 through 9.

Hydrogeologic Setting

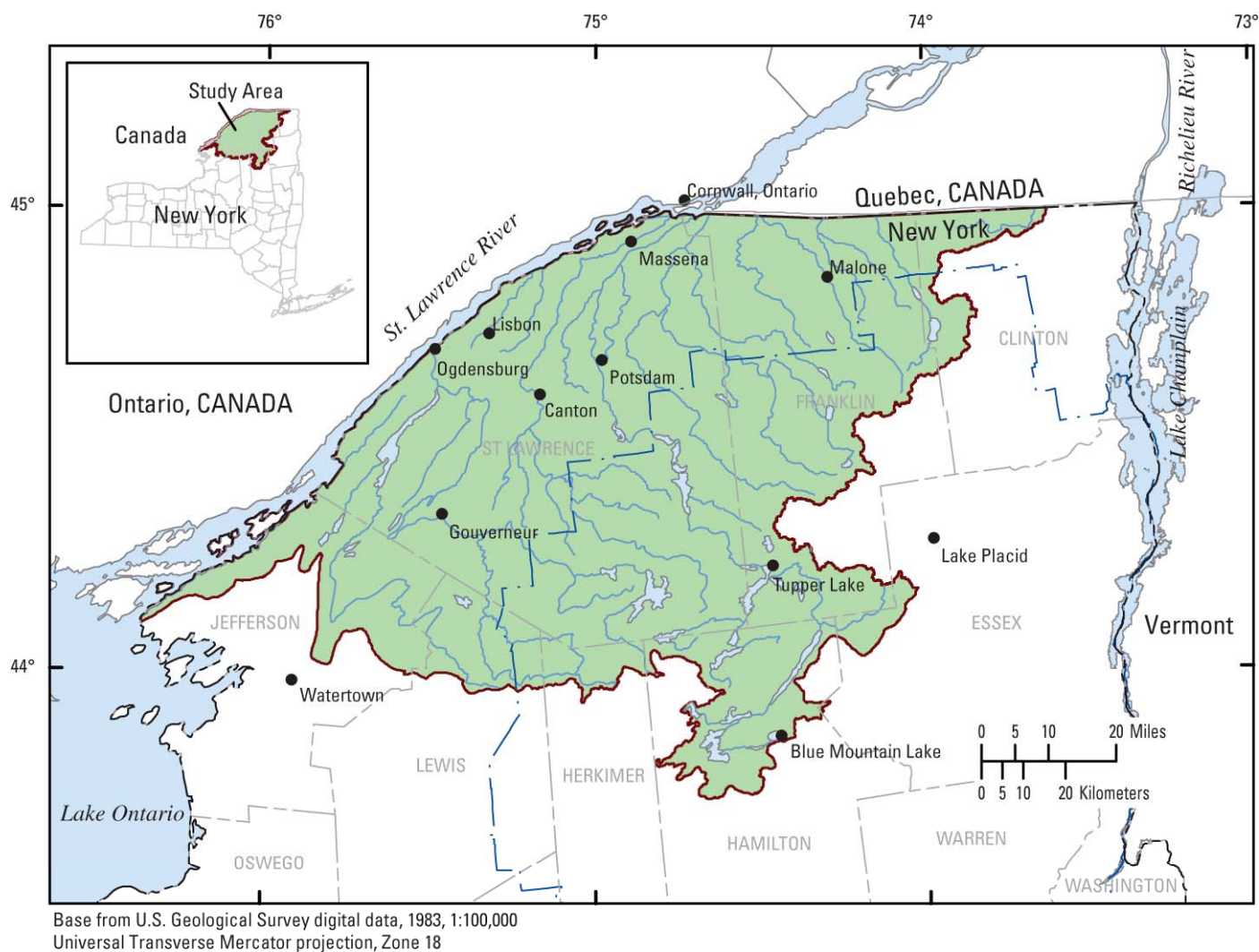
This study addresses the area in New York State that drains into the St. Lawrence River downstream of Lake Ontario, excluding the Lake Champlain/Richelieu River Basin (fig. 1). The St. Lawrence River Basin covers 5,650 mi² (Seaber and others, 1987) in northeastern New York State, including all of St. Lawrence County, most of Franklin County, and portions of Clinton, Essex, Hamilton, Herkimer, Jefferson, and Lewis Counties. The St. Lawrence River forms the

international border between the United States and Canada for 114 mi, between the outlet of Lake Ontario and Cornwall, Ontario (New York State Department of Environmental Conservation, 1994).

The St. Lawrence River flows from the outlet of Lake Ontario and the Great Lakes to the Gulf of St. Lawrence at the Atlantic Ocean. About 296,000 mi² in the United States and Canada drain into the Great Lakes Basin, forming the largest fresh surface-water system in the world (Government of Canada and U.S. Environmental Protection Agency, 1995). The St. Lawrence River Basin in New York contains two main physiographic regions: the Adirondack Mountains and the St. Lawrence Valley (fig. 2). These regions differ in topography, climate, population, and land use. The Adirondack Mountains, with altitudes from about 1,000 ft to over 4,000 ft above sea level, are mostly forested, sparsely populated, and covers about 50 percent of the basin. The border of this physiographic region corresponds closely with the northwestern border of the Adirondack State Park; about 45 percent of the basin is in the park. The Adirondack State Park was created in 1892 and has an area of approximately 6 million acres; nearly half of the land in the Park is owned by the State and is designated by the State Constitution as “forever wild”. Altitudes in the St. Lawrence valley range from about 250 to 1,000 ft above sea level. Approximately 28 percent of the gently rolling terrain in the valley is used for agriculture (fig. 3) as compared to about 2 percent of land in the Adirondack Mountains portion of the basin (land cover calculated from the National Land Cover Dataset, Vogelmann and others, 2001). Although the entire basin is predominantly rural, most of the largest population centers are in the St. Lawrence Valley.

Bedrock geology in the St. Lawrence River Basin consists of metamorphic and sedimentary rock. Most of the bedrock in the Adirondack Mountains is metamorphic; the oldest rock in the region is the crystalline basement rock of Precambrian age, which includes metaplatonic anorthosite in the High Peaks region and granitic gneiss (Isachsen and others, 2000). Bedrock in the St. Lawrence Valley is mostly sedimentary, and includes Potsdam sandstone of Middle to Late Cambrian age, and Beekmantown Group limestone and dolostone of Early to Middle Ordovician age (Isachsen and others, 2000). Surficial deposits throughout the basin are primarily the result of the Wisconsin glaciation during the Pleistocene epoch, when the entire region was glaciated. The Adirondack Mountains and their foothills contain many small lakes, kames, kettles, and eskers as a result of glaciation. Scattered deposits of outwash, beach, and ice-contact sand and gravel are present. Glacial lake deposits and till are widespread in the St. Lawrence Valley. Till is coarser in the Adirondack Mountains than in the St. Lawrence Valley owing to the nature of the bedrock (Great Lakes Basin Commission, 1975).

Ground water is an important drinking-water supply source for domestic and public supplies in the St. Lawrence River Basin. Sand and gravel deposits generally produce the highest yields in the basin, but the sandstone and carbonate aquifers along the northern edge of the basin in the St. Lawrence Valley (fig. 4) also produce moderate yields (Great Lakes Basin Commission, 1975). The crystalline bedrock in the Adirondack Mountains generally produces the lowest yields of the aquifers in the basin. Most domestic wells in the basin are finished in bedrock; production wells typically tap sand and gravel to obtain higher yields. Several small to medium size public-water systems in the basin, however, utilize wells finished in bedrock, especially those in the western part of the basin.



EXPLANATION

- St. Lawrence River Basin boundary
- Adirondack State Park
- Province boundary

Figure 1. Hydrologic and geographic features of the St. Lawrence River Basin in New York.

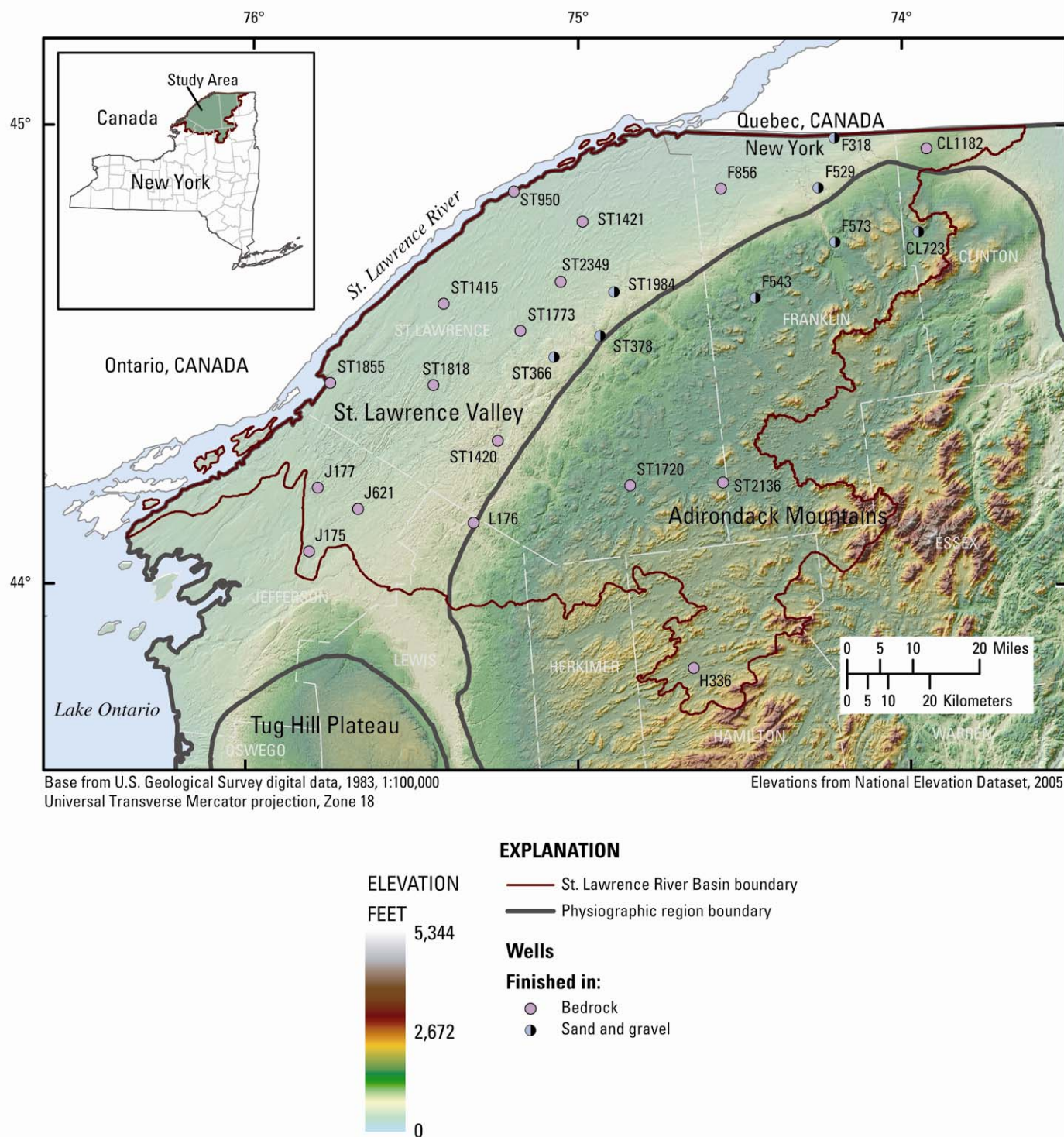
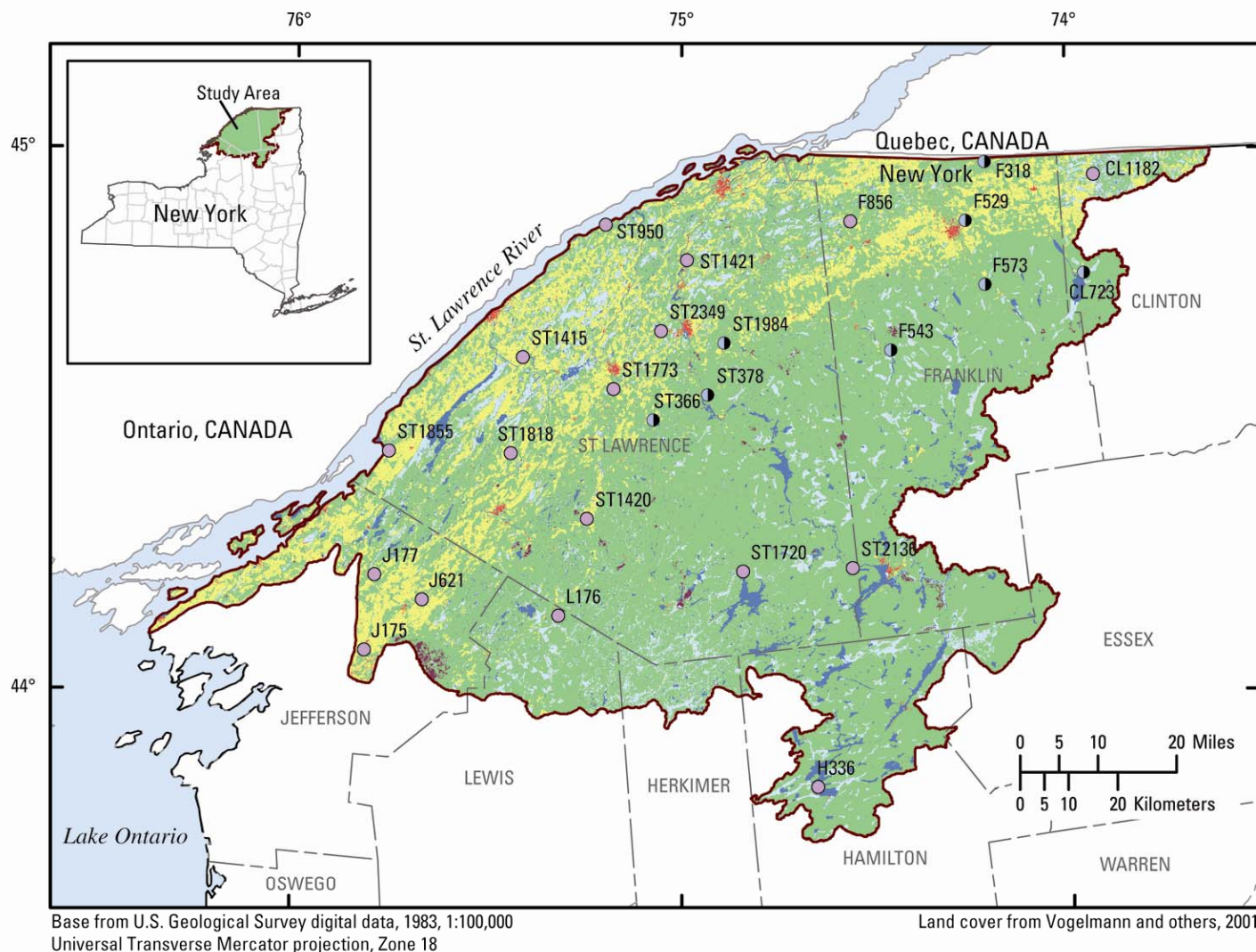


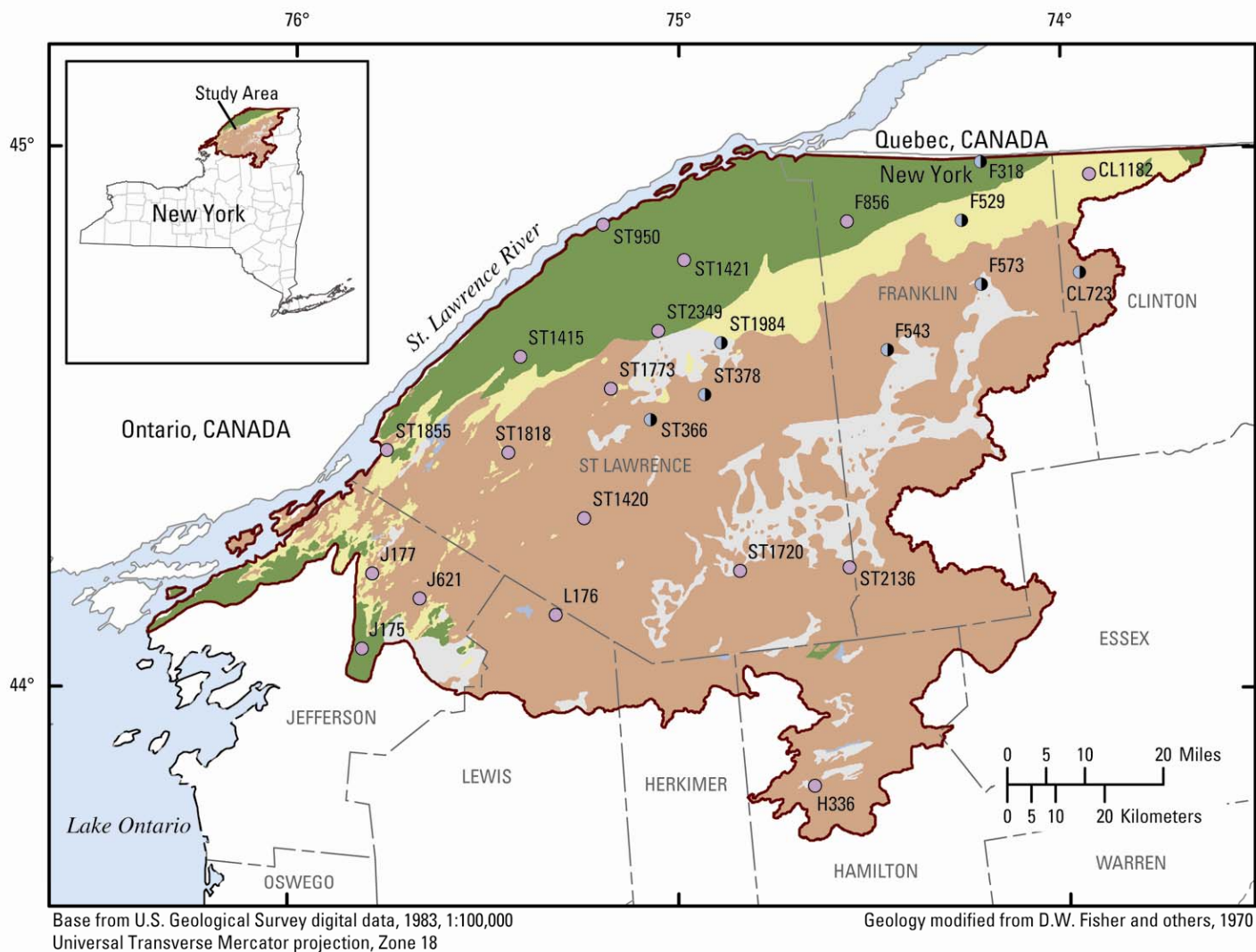
Figure 2. Physiographic regions and locations of wells sampled in the St. Lawrence River Basin in New York.



EXPLANATION

— St. Lawrence River basin boundary	Land Cover
Wells	Open Water
Finished in:	Developed
● Bedrock	Rock
● Sand and gravel	Forest
	Agriculture
	Wetlands

Figure 3. Land cover and locations of wells sampled in the St. Lawrence River Basin in New York.



EXPLANATION

— St. Lawrence River Basin boundary

Wells

Finished in:

- Bedrock
- Sand and gravel

Bedrock Geology

- Carbonate
- Sandstone
- Crystalline
- Glacial deposits
- Water (underlying geology unknown)

Figure 4. Generalized bedrock geology in the St. Lawrence River Basin, New York.

Methods of Investigation

The methods used in this study, including (1) well-selection criteria, (2) sampling procedures, and (3) analytical methods, were designed to maximize data precision, accuracy, and comparability. Ground-water sample collection and processing were conducted in accordance with standard USGS procedures (U.S. Geological Survey, variously dated). Samples were analyzed at four laboratories including the USGS National Water Quality Laboratory (NWQL) in Denver, Colo., the USGS Organic Geochemistry Research Laboratory (OGRL) in Lawrence Kans., and two NYSDOH-certified laboratories using documented methods.

Site Selection

Wells were selected for sampling to provide adequate spatial coverage of the basin, with emphasis on areas of greatest ground-water use; selection was based on the availability of hydrogeologic information about each well and its surrounding area. More wells finished in bedrock were sampled than wells finished in sand and gravel owing to the general predominance of bedrock wells in many areas of the basin. The 25 wells selected for sampling represented forested, rural, residential, and agricultural areas. Locations of the wells are shown in figure 2; the characteristics of the wells sampled and the land cover surrounding each is listed in table 1. The project did not target specific municipal, industrial, or agricultural practices. Water samples were collected from 5 domestic wells and 3 production wells completed in glacial sand and gravel aquifers; and from 9 domestic and 8 production wells completed in bedrock aquifers.

The 14 domestic wells were selected based on information from the NYSDEC Water Well program, which began in 2000. The program requires that licensed well drillers file a report with NYSDEC containing basic information about each well drilled—such as well and casing depth and diameter, yield, as well as a hydrogeologic log. Inspection of well-completion reports identified 100 to 120 wells as potential sampling locations. The well owners were sent a letter that included a request for permission to sample the well, and questionnaire asking the location of the well, the most convenient times for sampling, and other well-related information. Well owners who granted permission were contacted later by phone to clarify well information and arrange a sampling time.

The 11 production wells were identified through the New York State Department of Health (NYSDOH) Public Water Supply databases and the USGS Ground-Water Site Inventory (GWSI) database. Town officials and (or) water managers were sent letters and questionnaires similar to those sent to domestic-well owners. Follow-up phone calls were used in a manner similar to that used for domestic wells. Well information such as well depth and bedrock lithology was provided by water managers. Bedrock geology for production and domestic wells was verified through published bedrock geology maps, such as Fisher and others (1970).

Eight of the 25 wells were finished in sand and gravel and 17 of the wells were finished in bedrock. Five of the 14 domestic wells were finished in sand and gravel, and nine were finished in bedrock (table 1). Three of the 11 production wells were screened in sand and gravel and eight were finished in bedrock. The sand and gravel wells ranged in depth from 27 to 236 feet; the bedrock wells ranged from 71 to 500 feet deep and were finished in fractured sandstone (2 wells), limestone (8 wells), or Precambrian crystalline rock (7 wells). Land use around the wells varied from predominantly agricultural (for example well F529) to residential (ST1421) to forested (F573) (fig. 3).

Sampling Methods

The 25 wells were sampled between August 2005 and January 2006. Ground-water samples were collected and processed using standard USGS protocols (U.S. Geological Survey, variously dated). Water samples were collected from a spigot between the well and pressure tank, where possible, and before any water-treatment system so that they would be most representative of the source water quality of the aquifer. Most production wells were sampled at a spigot or a faucet used for collection of raw-water samples by water managers. Most domestic wells were sampled from a spigot near the pressure tank.

One or two wells were sampled per day. Typically, samples were collected using one or more 10-ft lengths of Teflon tubing attached to a “garden-hose” type spigot located as close to the well as possible. After connecting the tubing, the well was purged by running to waste for at least 20 minutes, or until at least one well-casing volume of water had passed the sampling point. Most of the production wells were pumped for at least 1 hour prior to sampling, typically at pumping rates on the order of 100 gal/min. Domestic wells were purged at pumping rates ranging from about 5 to 10 gal/min; less than three well-casing volumes were purged from recently used wells. During well purging, notes about the well and surrounding land and land use were taken, and a global positioning system (GPS) measurement of latitude and longitude also was made. After purging the well, water was directed at about 1 to 2 gal/min into the flow-through chamber that contained a multi-parameter meter with temperature, pH, specific conductance, and dissolved-oxygen probes. Field values were then recorded at regular intervals; sampling began when the values of temperature, pH, specific conductance, and dissolved oxygen concentration had stabilized (U.S. Geological Survey, variously dated).

For sample collection, the flow rate was adjusted to about 1 gal/min; at domestic wells, another spigot was left open during sampling to keep the submersible pump running. The Teflon sampling tube was then disconnected from the multi-parameter meter and connected to a sampling chamber constructed of a polyvinyl chloride (PVC) frame and a clear plastic chamber bag. The sampling chamber was placed on a plastic-box table with a built-in drain. The Teflon tubing and spigot-attachment equipment were cleaned in the laboratory before each day of sampling with a dilute Liquinox solution, followed by tapwater and deionized-water. Equipment for filtration for pesticide samples was methanol rinsed. A fresh sampling-chamber bag was used at each site. Samples were collected and preserved in the sampling chamber according to standard USGS sampling methods (U.S. Geological Survey, variously dated). Sample bottles for nutrient, major-ion, and some trace-element analyses were filled with water filtered through disposable (one-time use) 0.45- μm -pore-size polyether sulfone capsule filters that were pre-conditioned in the laboratory with deionized water the day of sample collection. Sample bottles for pesticide analysis were filled with water filtered through baked 0.7- μm -pore-size glass fiber filters. Acid preservation was required for trace elements, VOCs, and major cation analyses. Acid preservation was done only after collection of other samples to avoid the possibility of cross contamination by the acid preservative; for example, samples preserved with nitric acid were acidified after the collection of samples for nutrient analysis. Samples for radon analysis were collected through a septum chamber with a glass syringe according to standard USGS procedures (U.S. Geological Survey, variously dated). Water samples analyzed by non-USGS laboratories were collected in bottles provided by the analyzing laboratory.

All samples except those for radiological analysis were chilled to 4° C or less after collection. Samples for bacterial analysis were personally delivered to a NYSDEC-certified

laboratory in Lisbon, N.Y. (fig. 1), within 6 hours of collection; the remainder of the samples were shipped, overnight delivery, to the designated laboratories.

Most sampling sites had easy access to a spigot, however, some production wells did not. Wells L176, ST378, and ST1420 were sampled from faucets and wells J177 and ST950 from taps where water-system personnel routinely collect raw water samples. Physical properties were measured with the multi-parameter meter in a bucket after flow adjustment to avoid air entrainment. The syringe for radon-222 sample collection at these sites was inserted directly into the flowing water in the throat of the faucet or tap to minimize sample exposure to the atmosphere. pH and dissolved oxygen were not measured in the field at sites F543, ST1415, and ST2136 because of probe failure; pH measured in the laboratory is reported for these sites.

Analytical Methods

Samples were analyzed for 229 physical properties and constituents, including inorganic constituents, nutrients, trace elements, radionuclides, pesticides and their degradates, volatile organic compounds (VOCs), and bacteria. Physical properties, such as water temperature, pH, and specific conductance were measured at the sampling site. Analyses for inorganic constituents, nutrients, trace elements, radon-222, pesticides and pesticide degradates, and volatile organic compounds were conducted at the USGS NWQL in Denver, CO; additional pesticide and pesticide degrade analyses were done at the USGS OGRL in Lawrence, Kans. Other analyses were done at NYSDOH-certified laboratories; including total organic carbon and phenolic compound analyses at Friend Laboratory in Waverly, N.Y., and bacterial analyses at Premium Testing Laboratory in Lisbon, N.Y.

Anion concentrations were determined by ion-exchange chromatography, and cation analyses were conducted using inductively coupled plasma-atomic emission spectrometry (ICP-AES), as described in Fishman (1993). Nutrients were analyzed using colorimetry, as described by Fishman (1993), and Kjeldahl digestion with photometric finish, as described by Patton and Truitt (2000). Mercury concentrations were determined using cold vapor-atomic fluorescence spectrometry according to methods described by Garbarino and Damrau (2001). Arsenic, chromium, and nickel analyses were analyzed using collision/reaction cell inductively coupled plasma-mass spectrometry (cICP-MS) as described by Garbarino and others (2006). Remaining trace-element analyses were done by ICP-AES (Struzeski and others, 1996), inductively coupled plasma-optical emission spectrometry (ICP-OES), and inductively coupled plasma-mass spectrometry (ICP-MS) (Garbarino and Struzeski, 1998). In-bottle digestions for trace-element analyses were done as described by Hoffman and others (1996). Radon-222 was measured by liquid-scintillation counting (ASTM International, 2006).

Samples for pesticide analyses were processed as described by Wilde and others (2004). Pesticides and pesticide-degradates were analyzed at the NWQL using gas chromatography-mass spectrometry (GC-MS) and high-performance liquid chromatography-mass spectrometry (HPLC-MS) as described by Zaugg and others (1995), Sandstrom and others (2001), and Furlong and others (2001). Acetamide parent compounds and degradation-product analyses were conducted using liquid chromatography-mass spectrometry (LC-MS) at the USGS OGRL according to methods described by Lee and Strahan (2003). The VOC analyses were done using GC-MS by methods described by Connor and others (1998).

Bacteriological analyses were completed at Premium Testing Laboratory, a NYSDOH-certified laboratory in the St. Lawrence River Basin. The samples were collected and processed in

accordance with NYSDEC and NYSDOH protocols, except that the tap each water sample was collected from was not flame sterilized. Samples were tested for total coliform, fecal coliform, and *Escherichia coli* (*E. coli*) by Standard Methods 9222 B and D (American Public Health Association, 1998). A heterotrophic plate count test (SM 9215 B) also was conducted.

Total organic carbon and total phenols were analyzed by Friend Laboratory, a NYSDOH-certified laboratory. Total organic carbon analyses was determined using EPA Method 9060 (U.S. Environmental Protection Agency, 2004), and total phenols were analyzed using EPA method 420.2 (U.S. Environmental Protection Agency, 1983).

One field blank sample and one sequential replicate sample were collected for quality assurance in addition to the 25 ground-water samples. Nitrogen-purged VOC/pesticide-grade universal blank water and inorganic-grade blank water supplied by the USGS NWQL were used for an equipment blank; the water was run through a portion of the Teflon tubing used for sampling and water for filtered-water constituents was pumped through pre-cleaned filters. Samples were acidified in the same manner as environmental samples. The blank contained no chemical concentrations above the laboratory reporting levels; the color of the blank sample was measured to be 5 platinum-cobalt units. The percent-concentration differences from the sequential replicate sample were less than 5 percent for the 29 of the 32 constituents detected in the replicate sample. The largest percent differences between concentration in the ground-water sample and the replicate sample were in arsenic (0.16 µg/L in the environmental sample and 0.2 µg/L in the quality-assurance sample with a laboratory reporting level of 0.12 µg/L) and chromium (0.36 µg/L in the environmental sample and 0.4 µg/L in the quality-assurance sample with a laboratory reporting level of 0.04 µg/L).

Ground-Water Quality in the St. Lawrence River Basin

Ground-water samples were analyzed for 229 constituents or properties; of these, more than half (164) were not detected in any sample above laboratory reporting levels (table 2). The 66 constituents and properties that were detected are reported in tables 3 through 9. Some concentrations of constituents are reported as estimated concentrations; these semi-quantitative values are preceded by an “E” remark code in the tables. Estimated concentrations are typically reported in cases where the detected value is less than established laboratory reporting levels or when recovery of a compound has been shown to be highly variable (Childress and others, 1999). Concentrations of some constituents exceeded maximum contaminant levels (MCLs) or secondary drinking water standards (SDWS) set by USEPA (U.S. Environmental Protection Agency, 2003) or NYSDOH (New York State Department of Health, 1998). MCLs are enforceable standards for finished water at public-water supplies; they are not enforceable for private homeowner wells but are presented here as a standard for evaluation of the water quality results.

Physical Properties

None of the field physical properties of the samples exceeded established water-quality standards; some physical properties varied by region within the basin. Sample color ranged from <1 to 12 platinum-cobalt units (table 3). No sample exceeded the USEPA SDWS or NYSDOH MCL of 15 platinum-cobalt units. The concentration of dissolved oxygen in the well water ranged from 0.1 mg/L to 11.6 mg/L with a median of 2.6 mg/L. pH ranged from 6.8 to 8, and the median pH was 7.4; no sample exceeded the USEPA SDWS pH range of 6.5 to 8.5. Specific conductance ranged from 99 to 1,830 µS/cm @ 25°C, with a median of 364 µS/cm, and was higher in the St.

Lawrence Valley than in the Adirondack Mountains, especially in wells finished in carbonate bedrock. Water temperature ranged from 7.3 to 12.2°C, with a median of 9.4°C.

Major Ions

The alkalinity and hardness of the water samples is typically influenced by the minerals that comprise the source aquifers. Alkalinity ranged from 33 to 215 mg/L as CaCO₃ with a median of 124 mg/L as CaCO₃ (table 4); alkalinity was generally higher in the St. Lawrence Valley, especially in wells in areas of carbonate bedrock. Water hardness ranged from 42 to 800 mg/L as CaCO₃ with a median of 170 mg/L as CaCO₃; 72 percent (18) of the samples were hard or very hard (121 mg/L as CaCO₃ or higher) (Hem, 1985). Water in the St. Lawrence Valley typically was harder than water in the Adirondack Mountains; 89 percent of samples in the St. Lawrence Valley were hard or very hard, compared to 17 percent of samples from the Adirondack Mountains. The median noncarbonate hardness constituted 24 percent of total hardness in the samples. Silica concentrations ranged from 6.52 mg/L to 24.6 mg/L, with a median concentration of 11.9 mg/L. Residue on evaporation ranged from 73 mg/L to 1,130 mg/L, with a median of 210 mg/L.

The cation with the highest concentrations in the ground-water samples was calcium, which ranged from 11.1 mg/L to 255 mg/L, with a median of 47.6 mg/L. The anion with the highest concentrations in the ground-water samples was bicarbonate (HCO₃⁻, calculated from alkalinity), which ranged from 40 mg/L to 262 mg/L, with a median of 151 mg/L. Concentrations of most ions, with the exception of bicarbonate, were higher in wells finished in bedrock than in sand and gravel. In addition, most ion concentrations, with the exception of fluoride, were higher in wells finished in carbonate bedrock than in crystalline bedrock; ion concentrations were also generally higher in the St. Lawrence Valley than in the Adirondack Mountains. The concentration of chloride in one sample (386 mg/L) exceeded the USEPA SDWS and NYSDOH MCL of 250 mg/L, and the concentration of sulfate in one sample (501 mg/L) exceeded the USEPA SDWS and NYSDOH MCL of 250 mg/L. No sample exceeded the USEPA SDWS or NYSDOH MCLs for fluoride (lowest standard 2 mg/L). The minimum, median, and maximum concentrations of ions (in mg/L) and inorganic properties in the 25 well samples are listed as follows:

		Sand and gravel wells			Carbonate wells			Crystalline & sandstone wells		
		(8 samples)			(8 samples)			(9 samples)		
		Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum
Cations	Calcium	11.1	27.4	47.9	30.7	88.2	255	15.2	47.9	69.7
	Magnesium	3.4	9.9	20.5	15.1	32.1	48.5	2.51	12.3	21.4
	Potassium	0.49	0.74	2.36	1.6	2.9	9.15	0.37	1.00	3.62
	Sodium	1.5	3.6	6.9	10.8	25.2	167	1.71	7.23	27.6
Anions	Bicarbonate	40	121	262	128	202	251	50	143	216
	Chloride	0.47	2.38	8.55	4.21	39.9	386	0.53	10.3	124
	Fluoride	< .1	0.1	0.2	< .1	0.4	1.1	0.1	0.3	1.5
	Sulfate	6.8	12.0	27.9	21	38.8	501	4.5	15.6	33.0

	Sand and gravel wells			Carbonate wells			Crystalline & sandstone wells		
	(8 samples)			(8 samples)			(9 samples)		
	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum
Hardness, mg/L as CaCO ₃	42	110	200	150	325	800	50	170	240
Alkalinity, mg/L as CaCO ₃	33	100	215	105	166	206	41	117	177
Residue on evaporation, mg/L	73	132	221	210	386	1130	85	186	411

Nutrients

The principal nutrient detected was nitrate. Nitrate was detected in 15 samples with a median concentration of 0.12 mg/L. No sample exceeded the USEPA and NYSDOH 10 mg/L MCL for nitrate; the maximum concentration was 3.45 mg/L and more than 90 percent of the samples had nitrate concentrations of less than 1 mg/L. Ammonia plus organic nitrogen was detected in 15 samples, with a maximum concentration of 0.6 mg/L and a median concentration of 0.06 mg/L (table 5). Ammonia was detected in 5 samples with a maximum concentration of 0.51 mg/L. Ammonia and ammonia plus organic nitrogen were detected more frequently in the St. Lawrence Valley than in the Adirondack Mountains. Nitrite, rarely detected in ground water, was detected in only one sample at an estimated concentration of 0.004 mg/L, well below the 1 mg/L MCL. Orthophosphate was detected in 3 samples with a maximum concentration of 0.19 mg/L. Total organic carbon was detected in 12 samples, mostly in bedrock wells in the St. Lawrence Valley, its maximum concentration was 4.2 mg/L.

Trace Elements and Radionuclides

The trace elements with the highest concentrations in the water samples were strontium (median concentration 167 µg/L), barium (63 µg/L), and iron (40 µg/L in unfiltered water and 9 µg/L in filtered water), as shown in table 6. Metal concentrations, especially lithium, uranium, and strontium, were generally higher in samples from wells finished in bedrock than in those finished in sand and gravel. In addition, concentrations of trace elements, especially manganese and iron, were higher in samples from wells in the St. Lawrence Valley than in those in the Adirondack Mountains. Arsenic concentrations in 80 percent of samples were 0.5 µg/L or less, but concentrations of up to 6.2 µg/L were present in samples from wells 125 feet deep or less; none exceeded the USEPA MCL for arsenic (10 µg/L). Iron concentrations were higher in shallow wells than in deep wells. Iron, manganese, and arsenic concentrations were higher in crystalline bedrock areas than other types of bedrock, and concentrations of boron and zinc were higher in areas of carbonate bedrock than other types of bedrock. Concentrations of most trace elements in samples from wells J621 and ST1855 were consistently greater than median concentrations; both wells were finished in shallow noncarbonate bedrock in the St. Lawrence Valley.

Concentrations of several trace elements exceeded USEPA MCLs or SDWS and/or NYSDOH MCLs, including aluminum, iron, manganese, and uranium; all exceedances were in samples from domestic wells. Four samples had aluminum concentrations greater than 50 µg/L, the low end of the USEPA SDWS range for aluminum, but only one sample (3,250 µg/L) exceeded 200 µg/L—the high end of the range. Concentrations of iron in five unfiltered samples and one filtered sample exceeded 300 µg/L, the USEPA SDWS and NYSDOH MCL. Concentrations of manganese in four samples, filtered and unfiltered, exceeded the USEPA SDWS of 50 µg/L, and the concentration in one sample exceeded the NYSDOH MCL of 300 µg/L.

Well J621 had a very high concentration of iron in unfiltered water (45.5 mg/L), although the concentration of iron in filtered water was much less (0.2 mg/L). Concentrations of several other trace elements in the unfiltered sample from this well were greater than the median concentration in the rest of the wells sampled. When the well was pumped, the water became turbid and contained a noticeable amount of sediment (likely drawn in from a fracture) that probably resulted in the high concentrations of trace elements in the acidified unfiltered sample.

Compound	Regulatory limits, µg/L			Samples exceeding lowest standard
	USEPA MCL	USEPA Secondary Standard	NYSDOH MCL	
Aluminum		50-200		4
Iron		300	300	5
Manganese		50	300	4
Iron plus manganese			500	5
Uranium	30			1

Radon-222 concentrations in the ground-water samples ranged from 130 pCi/L to 18,800 pCi/L with a median concentration of 600 pCi/L. Radon concentrations generally were higher in samples from wells finished in bedrock than in samples from wells finished in sand and gravel, as shown in the following table; this is consistent with other published reports on radon in ground water (Gundersen and Wanty, 1991). Radon concentrations in ground water generally depend on the uranium content and physical characteristics of the material the well is finished in; they are typically higher in ground water from granitic rocks and high-grade metamorphic rocks but can vary significantly within the same formation (Brutsaert and others, 1981). Anomalously high concentrations of radon are sometimes found in sheared fault zones (Gundersen, 1991). Radon concentrations are typically lower in glacial sand and gravel aquifers although the source material of the sediments plays an important role (Hall and others, 1987).

Radon is currently not regulated in drinking water; however, the USEPA has proposed a two-part standard for radon in drinking water: (1) a 300 pCi/L MCL for areas that do not implement an indoor air radon mitigation program, and (2) an alternative MCL (AMCL) of 4,000 pCi/L for areas that do (U.S. Environmental Protection Agency, 1999). Concentrations in 15 of the samples (60 percent) exceeded the proposed MCL. Two samples had very high concentrations of radon: 11,000 pCi/L and 18,800 pCi/L; and were the only samples to exceed the proposed AMCL. Both samples came from domestic wells finished in crystalline bedrock, and both also had much

higher uranium concentrations than the other samples. Uranium concentrations ranged from 0.007 to 90.6 µg/L with a median concentration of 0.615 µg/L. The concentration of uranium in one sample was 3 times higher than the USEPA MCL of 30 µg/L.

	Radon-222 in picoCuries per liter	
	Sand & gravel wells (8 samples)	Bedrock wells (17 samples)
Minimum	150	130
Median	320	830
Maximum	860	18,800

Pesticides

Six pesticides and pesticide degradates were detected in four samples; all were herbicides or their degradates, and most were degradates of the triazine and amide broadleaf herbicides atrazine, alachlor, and metolachlor (table 7). All of the pesticide detections were at concentrations of 0.03 µg/L or less, except alachlor ethanesulfonic acid (alachlor ESA), detected in one sample at a concentration of 0.36 µg/L. No concentrations of pesticides or pesticide degradates exceeded established drinking water standards. The compounds detected are all considered Unspecified Organic Compounds under NYSDOH regulations and, as such, have a MCL of 50 µg/L, although several of the parent herbicides have lower MCLs. Pesticides were detected in samples from four wells, one of which was finished in sand and gravel, and three of which were finished in bedrock. Caffeine, which was included in the pesticide analysis, was detected in samples from two wells at estimated concentrations of 0.016 and 0.012 µg/L.

Volatile Organic Compounds and Phenolic Compounds

Five VOCs were detected in samples from 8 of the 25 wells (table 8). Trichloromethane (chloroform) was detected in samples from 4 wells with concentrations ranging from 0.1 µg/L to 0.5 µg/L. Trichloromethane is a trihalomethane, a group of compounds that are byproducts of chlorination; the USEPA and NYSDOH MCLs for total trihalomethanes is 80 µg/L. Total trihalomethanes include bromodichloromethane, dibromochloromethane, tribromomethane (bromoform), and trichloromethane (chloroform). *m*- plus *p*-xylenes were detected in one sample at an estimated concentration of 0.1 µg/L. Xylenes, found in petroleum, are used as solvents and are also present in gasoline. *m*- and *p*-xylenes are designated as Principal Organic Contaminants (POCs) by NYSDOH; the MCL for POCs is 5 µg/L, and the USEPA MCL for total xylenes is 10,000 µg/L. Methyl *tert*-butyl ether (MTBE) was detected in samples from 3 sites at concentrations from an estimated 0.1 to 0.3 µg/L, well below the NYSDOH MCL of 10 µg/L. MTBE is a fuel oxygenate used in reformulated gasoline to meet requirements of the Clean Air Act Reformulated Gasoline Program. Toluene was detected in one sample at a concentration of 0.6 µg/L, well below the NYSDOH MCL of 5 µg/L and USEPA MCL of 1,000 µg/L. Toluene, an aromatic hydrocarbon, is used as a solvent and is a component of gasoline.

Dichlorodifluoromethane (CFC-12) was detected in one sample at an estimated concentration of 0.5 µg/L. Seven of the eight samples that contained detectable VOCs were from wells finished in bedrock, three of which were finished in crystalline bedrock, three in carbonate bedrock, and one in sandstone.

Bacteria

Bacterial analyses included presence/absence tests for total coliform, fecal coliform and *E. coli*, and a heterotrophic plate count. Total coliform, fecal coliform and *E. coli* were each detected in samples from three wells finished in carbonate bedrock, from 125 to 300 feet deep (table 9). All three wells were located in the St. Lawrence Valley, and land cover within a half-mile radius of each of the wells was at least 20 percent agricultural. Any detection in drinking water of coliform bacteria is considered to be above the MCL. The owners of the wells were notified of the results upon receipt from the laboratory. Heterotrophic plate counts ranged from less than one colony-forming unit (CFU) per mL of sample to more than 150 CFU/mL with a median of 8 CFU/mL. The USEPA MCL for the heterotrophic plate count is 500 CFU/mL; only the two samples in which the colonies were too numerous to count (greater than 150 CFU) may have exceeded this MCL.

Summary

Ground-water samples were collected from 14 domestic and 11 production wells between August 2005 and January 2006 to characterize the ground-water quality in the St. Lawrence River Basin in New York State. Samples were analyzed for physical properties, inorganic constituents, nutrients, trace elements, radon-222, pesticides, VOCs, and bacteria. Eight of the wells sampled were finished in sand and gravel, and 17 were finished in bedrock. Bedrock aquifers in the basin include carbonate and sandstone aquifers along the northern edge of the basin, and crystalline aquifers in the Adirondack Mountains. Samples were collected using standard USGS protocols and analyzed in the field and at USGS and private laboratories for 229 properties and constituents; more than half (164) were not detected in any sample above reporting levels.

Sample color ranged from <1 to 12 platinum-cobalt units; no sample exceeded the USEPA SDWS or NYSDOH MCL of 15 units. Water pH ranged from 6.8 to 8 and no sample exceeded the USEPA SDWS range of 6.5 to 8.5. Ground water in the basin is mostly hard or very hard (121 mg/L as CaCO₃ or higher), especially in the St. Lawrence Valley where carbonate and sandstone aquifers predominate. The cation with the highest median concentration was calcium and the anion with the highest median concentration was bicarbonate. The USEPA SDWS and NYSDOH MCL of 250 mg/L for chloride and sulfate was exceeded in one sample for each constituent. The predominant nutrient was nitrate, but no concentrations of nitrate exceeded USEPA or NYSDOH standards. The trace elements with the highest median concentrations were strontium, barium, and iron. Concentrations of aluminum, iron, manganese, and uranium exceeded USEPA SDWS and/or NYSDOH MCLs, most commonly iron and manganese in unfiltered water. One sample had a very high concentration of iron (45.5 mg/L) and one sample had a very high concentration of uranium (90.6 µg/L). Concentrations of radon-222 frequently exceeded the USEPA proposed MCL of 300 pCi/L (60 percent of samples) and in two samples exceeded the proposed AMCL of 4,000 pCi/L (11,100 and 18,800 pCi/L). Six pesticides or pesticide degradates were detected in four samples, most were degradates of triazine and amide broadleaf herbicides detected at concentrations of 0.03 µg/L or less; no concentrations of pesticides or pesticide degradates exceeded established drinking water standards. Caffeine was detected in two samples from wells finished in sand and gravel at

concentrations of 0.016 µg/L or less. Five VOCs were detected in 8 samples at concentrations of 0.5 µg/L or less, and included gasoline components and additives (methyl *tert*-butyl ether, detected in three samples), and disinfection byproducts (trichloromethane, detected in 4 samples). Coliform bacteria, including total coliform, fecal coliform and *E. coli* were detected in three samples from wells finished in carbonate bedrock.

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References Cited

- American Public Health Association, 1998, Standard methods for the examination of water and wastewater (20th ed.): Washington, D.C., American Public Health Association, American Water Works Association, and Water Environment Federation [variously paged].
- ASTM International, 2006, D5072-98(2006), Standard test method for radon in drinking water: ASTM International, accessed 12/28/06 at <http://www.astm.org>.
- Brutsaert, W.F., Norton, S.A., Hess, C.T., and Williams, J.S., 1981, Geologic and hydrologic factors controlling radon-222 in ground water in Maine: *Ground Water*, v. 19, no. 4, p. 407-417.
- Butch, G.K., Murray, P.M., Hebert, G.J., and Weigel, J.F., 2003, Water Resources Data, New York, Water Year 2002: U.S. Geological Survey Water-Data Report, NY-02-1, p. 502-520.
- Childress, C.J.O., Foreman, W.T., Connor, B.F., and Maloney, T.J., 1999, New reporting procedures based on long-term method detection levels and some considerations for interpretations of water-quality data provided by the U.S. Geological Survey National Water Quality Laboratory: U.S. Geological Survey Open-File Report 99-193, 19 p.
- Connor, B.F., Rose, D.L., Noriega, M.C., Murtagh, L.K., and Abney, S.R., 1998, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of 86 volatile organic compounds in water by gas chromatography/mass spectrometry, including detections less than reporting limits: U.S. Geological Survey Open-File Report 97-829, 78 p.
- Fisher, D.W., Isachsen, Y.W., and Rickard, L.V., 1970, Geologic Map of New York State: New York State Museum – Geological Survey, Map and Chart Series no. 15, Adirondack sheet, scale 1:250,000.
- Fishman, M.J., ed., 1993, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of inorganic and organic constituents in water and fluvial sediments: U.S. Geological Survey Open-File Report 93-125, 217 p.

- Furlong, E.T., Anderson, B.D., Werner, S.L., Soliven, P.P., Coffey, L.J., and Burkhardt, M.R., 2001, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of pesticides in water by graphitized carbon-based solid-phase extraction and high-performance liquid chromatography/mass spectrometry: U.S. Geological Survey Water-Resources Investigations Report 01-4134, 73 p.
- Garbarino, J.R. and Damrau, D.L., 2001, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of organic plus inorganic mercury in filtered and unfiltered natural water with cold vapor—atomic fluorescence spectrometry: U.S. Geological Survey Water-Resources Investigations Report 01-4132, 16 p.
- Garbarino, J.R., Kanagy, L.K., and Cree, M.E., 2006, Determination of elements in natural-water, biota, sediment and soil samples using collision/reaction cell inductively coupled plasma-mass spectrometry: U.S. Geological Survey Techniques and Methods, book 5, chap.1, sec. B, 88 p.
- Garbarino, J.R. and Struzeski, T.M., 1998, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of elements in whole-water digests using inductively coupled plasma-optical emission spectrometry and inductively coupled plasma-mass spectrometry: U.S. Geological Survey Open-File Report 98-165, 101 p.
- Government of Canada and U.S. Environmental Protection Agency, 1995, The Great Lakes—An Environmental Atlas and Resource Book: USEPA report 905-B-95-001, 46 p.
- Great Lakes Basin Commission, 1975, Great Lakes Basin Framework Study--Appendix 3, Geology and Ground Water: Great Lakes Basin Commission, 152 p.
- Gundersen, L.C.S., 1991, Radon in sheared metamorphic and igneous rocks, in Gundersen, L.C.S. and Wanty, R.B., eds., Field studies of radon in rocks, soils, and water: U.S. Geological Survey Bulletin 1971, p. 39-50.
- Gundersen, L.C.S., and Wanty, R.B., eds., 1991, Field studies of radon in rocks, soils, and water: U.S. Geological Survey Bulletin 1971, 334 p.
- Hall, F.R., Boudette, E.L., and Olszewski, W.J., Jr., 1987, Geologic controls and radon occurrence in New England, in Graves, B., ed., Radon, radium, and other radioactivity in ground water: Chelsea, Mich., Lewis Publishers, p. 15-30.
- Hem, J.D., 1985, Study and interpretation of the chemical characteristics of natural water: U.S. Geological Survey Water-Supply Paper 2254, 264 p.
- Hetcher-Aguila, K.K., 2005, Ground-water quality in the Chemung River Basin, New York, 2003: U.S. Geological Survey Open-File Report 2004-1329, 19 p. (online only).
- Hetcher-Aguila, K.K. and Eckhardt, D.A., 2006, Ground-water quality in the upper Susquehanna River Basin, New York, 2004: U.S. Geological Survey Open-File Report 2006-1161, 21 p. (online only).

- Hoffman, G.L., Fishman, M.J., and Garbarino, J.R., 1996, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—In-bottle acid digestion of whole-water samples: U.S. Geological Survey Open-File Report 96-225, 28 p.
- Isachsen, Y.W., Landing, Ed, Lauber, J.M., Rickard, L.V., and Rogers, W.B., eds., 2000, *Geology of New York--A simplified account* (2nd ed.): Albany, N.Y., New York State Museum/Geological Survey, 294 p.
- Lee, E.A. and Strahan, A.P., 2003, Methods of analysis by the U.S. Geological Survey Organic Geochemistry Research Group—Determination of acetamide herbicides and their degradations products in water using online solid-phase extraction and liquid chromatography/mass spectrometry: U.S. Geological Survey Open-File Report 03-173, 17 p.
- New York State Department of Environmental Conservation, 1994, Biennial report--Rotating intensive basin studies water quality assessment program 1991-1992: Albany, N.Y., 280 p.
- New York State Department of Health, 1998, New York State Health Department public water systems regulations: Albany, N.Y. [variously paged].
- Nystrom, E.A., 2006, Ground-water quality in the Lake Champlain Basin, New York, 2004: U.S. Geological Survey Open-File Report 2006-1088, 22 p. (online only).
- Patton, C.J. and Truitt, E.P., 2000, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of ammonium plus organic nitrogen by a Kjeldahl digestion method and an automated photometric finish that includes digest cleanup by gas diffusion: U.S. Geological Survey Open-File Report 00-170, 31 p.
- Sandstrom, M.W., Stroppel, M.E., Foreman, W.T., and Schroeder, M.P., 2001, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of moderate-use pesticides and selected degradates in water by C-18 solid-phase extraction and gas chromatography/mass spectrometry: U.S. Geological Survey Water-Resources Investigations Report 01-4098, 70 p.
- Seaber, P.R., Kapinos, F.P., and Knapp, G.L., 1987, Hydrologic Unit Maps: U.S. Geological Survey Water-Supply Paper 2294, 63 p.
- Struzeski, T.M., DeGiacomo, W.J., and Zayhowski, E.J., 1996, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of dissolved aluminum and boron in water by inductively coupled plasma-atomic emission spectrometry: U.S. Geological Survey Open-File Report 96-149, 17 p.
- U.S. Environmental Protection Agency, 1983, Methods for chemical analysis of water and wastes: Washington D.C., U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory Office of Research and Development, EPA 600/4-79-020, p. 420.2-1--5.
- U.S. Environmental Protection Agency, 1997, Guidelines for preparation of the comprehensive state water quality assessments (305(b) Reports) and electronic updates: Washington D.C., U.S.

- Environmental Protection Agency, Office of Water, EPA 841-B-97-002A and EPA 841-B-97-002B, PL95-217, 271 p.
- U.S. Environmental Protection Agency, 1999, Proposed radon in drinking water rule: Washington D.C., U.S. Environmental Protection Agency, Office of Water, EPA 815-F-99-006, 6 p.
- U.S. Environmental Protection Agency, 2003, National primary drinking water standards and national secondary drinking water standards: Washington D.C., U.S. Environmental Protection Agency, Office of Water, EPA 816-F-03-016, 6 p.
- U.S. Environmental Protection Agency, 2004, Test methods for evaluating solid waste, physical/chemical methods: EPA SW-846, p. 9060A1--5.
- U.S. Geological Survey, variously dated, National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chaps. A1-A9, available online at <http://pubs.water.usgs.gov/twri9A>.
- Vogelmann, J.E., Howard, S.M., Yang, L., Larson, C. R., Wylie, B. K., and Van Driel, J. N., 2001, Completion of the 1990's National Land Cover Data Set for the conterminous United States, Photogrammetric Engineering and Remote Sensing, v. 67, p. 650-662.
- Wilde, F.D., Radtke, D.B., Gibbs, Jacob, and Iwatsubo, R.T., eds., April 2004, Processing of water samples (version 2.1): U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A5, accessed 1/11/07 at <http://pubs.water.usgs.gov/twri9A5/>.
- Zaugg, S.D., Sandstrom, M.W., Smith, S.G., and Fehlberg, K.M., 1995, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of pesticides in water by C-18 solid-phase extraction and capillary-column gas chromatography/mass spectrometry with selected-ion monitoring: U.S. Geological Survey Open-File Report 95-181, 60 p.

Table 1. Wells from which ground-water samples were collected in the St. Lawrence River Basin, 2005-06.

[Well locations are shown in figures 2 and 3; Physiographic regions: V, St. Lawrence Valley; Land-cover categories: M, Adirondack Mountains; D, developed; A, agricultural; F, forested; W, wetlands and open water; <, less than; --, unknown]

Well number ¹	Bedrock type	Date sampled	Well depth, feet below land surface	Casing depth, feet	Well type	Physiographic region	Land cover ² , percentage by category ³			
							D	A	F	W
Sand and gravel wells										
CL723		10/3/2005	114	114	Domestic	M	5	27	57	12
F318		9/1/2005	64	64	Domestic	V	0	31	68	0
F529		8/23/2005	125	125	Domestic	V	0	61	39	0
F543		8/24/2005	90	78	Domestic	M	12	2	79	7
F573		1/12/2006	236	152	Production	M	1	2	97	0
ST366		8/30/2005	27	< 20	Production	V	0	8	90	2
ST378		8/30/2005	56	65	Production	V	9	5	76	11
ST1984		9/28/2005	90	90	Domestic	V	0	2	93	4
Carbonate bedrock wells										
F856		9/1/2005	100	33	Domestic	V	0	30	65	5
J175		9/28/2005	125	--	Production	V	5	60	33	2
J177		11/21/2005	450	--	Production	V	16	11	66	7
ST950		9/12/2005	380	--	Production	V	25	14	26	35
ST1415		8/24/2005	250	50-100	Production	V	25	33	39	3
ST1421		9/27/2005	300	33	Production	V	38	23	35	5
ST1818		8/31/2005	132	14	Domestic	V	0	29	65	6
ST2349		10/3/2005	115	73	Domestic	V	0	43	51	6
Sandstone and crystalline bedrock wells										
CL1182	Sandstone	8/23/2005	220	70	Domestic	V	6	20	27	47
H336	Crystalline	8/22/2005	500	21	Domestic	M	6	1	34	59
J621	Crystalline	8/31/2005	100	25	Domestic	V	0	39	61	1
L176	Crystalline	9/13/2005	235	35	Production	V	17	3	78	2
ST1420	Crystalline	9/13/2005	273	51	Production	V	6	32	61	0
ST1720	Crystalline	10/4/2005	200	70	Domestic	M	2	5	74	19
ST1773	Crystalline	9/14/2005	93	10	Domestic	V	0	8	73	19
ST1855	Sandstone	9/29/2005	71	15	Domestic	V	4	28	29	39
ST2136	Crystalline	8/25/2005	260	54	Production	M	5	4	60	31

¹ CL, Clinton County; F, Franklin County; H, Hamilton County; J, Jefferson County; L, Lewis County; ST, St. Lawrence County.

² Land cover by category within a 0.5-mile radius of the well, determined from the National Land Cover Data 1992.

³ Totals may not equal 100% due to rounding.

Table 2. Constituents analyzed for but not detected in ground-water samples from the St. Lawrence River Basin, 2005-06.

[All values are in micrograms per liter]

USGS parameter code	Compound	Laboratory reporting level
Trace Elements		
71900	Mercury	0.01
01077	Silver	.16
01059	Thallium	.2
Pesticides		
50470	2,4-D methyl ester	.016
39732	2,4-D	.04
38746	2,4-DB	.02
82660	2,6-Diethylaniline	.006
62850	2-[(2-Ethyl-6-methylphenyl)amino]-2-oxoethanesulfonic acid	.02
63781	2-Chloro-N-(2,6-diethylphenyl)acetamide	.02
63782	2-Chloro-N-(2-ethyl-6-methylphenyl)acetamide	.02
50355	2-Hydroxy-4-isopropylamino-6-ethylamino-s-triazine	.032
49308	3-Hydroxy carbofuran	.008
50295	3-Ketocarbofuran	.02
61029	Acetochlor ethanesulfonic acid	.02
61030	Acetochlor oxanilic acid	.02
62847	Acetochlor sulfynilacetic acid	.02
49260	Acetochlor	.006
49315	Acifluorfen	.028
61031	Alachlor oxanilic acid	.02
62848	Alachlor sulfynilacetic acid	.02
46342	Alachlor	.005
49313	Aldicarb sulfone	.02
49314	Aldicarb sulfoxide	.022
49312	Aldicarb	.04
34253	alpha-HCH	.005
39632	Atrazine	.007
82686	Azinphos-methyl	.050
50299	Bendiocarb	.02
82673	Benfluralin	.010
50300	Benomyl	.022
61693	Bensulfuron	.02
38711	Bentazon	.01
04029	Bromacil	.02
49311	Bromoxynil	.03
04028	Butylate	.004
49310	Carbaryl	.02
82680	Carbaryl	.041
49309	Carbofuran	.016
82674	Carbofuran	.020

USGS parameter code	Compound	Laboratory reporting level
Pesticides—Continued		
61188	Chloramben methyl ester	.02
50306	Chlorimuron	.032
04039	Chlorodiamino-s-triazine	.04
49306	Chlorothalonil	.04
38933	Chlorpyrifos	.005
82687	cis-Permethrin	.006
49305	Clopyralid	.02
04041	Cyanazine	.018
04031	Cycloate	.01
49304	Dacthal monoacid	.03
82682	DCPA	.003
63778	Dechloroacetochlor	.02
63777	Dechloroalachlor	.02
63779	Dechlorodimethenamid	.02
63780	Dechlorometolachlor	.02
62170	Desulfinyl fipronil	.012
39572	Diazinon	.005
38442	Dicamba	.04
49302	Dichlorprop	.03
39381	Dieldrin	.009
61951	Dimethenamid ethanesulfonic acid	.02
62482	Dimethenamid oxanilic acid	.02
61588	Dimethenamid	.02
49301	Dinoseb	.04
04033	Diphenamid	.01
82677	Disulfoton	.02
49300	Diuron	.01
82668	EPTC	.004
82663	Ethalfuralin	.009
82672	Ethoprop	.005
49297	Fenuron	.02
62169	Desulfinylfipronil amide	.029
62167	Fipronil sulfide	.013
62168	Fipronil sulfone	.024
62166	Fipronil	.016
61952	Flufenacet ethanesulfonic acid	.02
62483	Flufenacet oxanilic acid	.02
62481	Flufenacet	.02
61694	Flumetsulam	.04
38811	Fluometuron	.02
04095	Fonofos	.003
63784	Hydroxyacetochlor	.02

Table 2. Constituents analyzed for but not detected in ground-water samples from the St. Lawrence River Basin, 2005-06.—Continued

[All values are in micrograms per liter]

USGS parameter code	Compound	Laboratory reporting level	USGS parameter code	Compound	Laboratory reporting level
Pesticides—Continued			Pesticides—Continued		
63783	Hydroxylachlor	.02	04035	Simazine	.005
64045	Hydroxydimethenamid	.02	50337	Sulfometuron	.038
63785	Hydroxymetolachlor	.02	82670	Tebuthiuron	.02
50356	Imazaquin	.04	82665	Terbacil	.034
50407	Imazethapyr	.04	04032	Terbacil	.016
61695	Imidacloprid	.020	82675	Terbufos	.02
39341	Lindane	.004	82681	Thiobencarb	.010
82666	Linuron	.035	82678	Triallate	.006
39532	Malathion	.027	49235	Triclopyr	.03
38482	MCPA	.03	82661	Trifluralin	.009
38487	MCPB	.01	Volatile organic compounds in unfiltered water		
50359	Metalaxyl	.01	34506	1,1,1-Trichloroethane	.1
38501	Methiocarb	.010	77652	1,1,2-Trichloro-1,2,2-trifluoroethane	.1
49296	Methomyl	.020	34496	1,1-Dichloroethane	.1
82667	Methyl parathion	.015	34501	1,1-Dichloroethene	.1
61044	Metolachlor oxanilic acid	.02	34536	1,2-Dichlorobenzene	.1
39415	Metolachlor	.006	32103	1,2-Dichloroethane	.2
82630	Metribuzin	.006	34541	1,2-Dichloropropane	.1
61697	Metsulfuron	.03	34566	1,3-Dichlorobenzene	.1
82671	Molinate	.003	34571	1,4-Dichlorobenzene	.1
61692	N-(4-Chlorophenyl)-N'-methylurea	.04	34030	Benzene	.1
82684	Napropamide	.007	32101	Bromodichloromethane	.1
49294	Neburon	.01	34301	Chlorobenzene	.1
50364	Nicosulfuron	.04	77093	cis-1,2-Dichloroethene	.1
49293	Norflurazon	.02	32105	Dibromochloromethane	.2
49292	Oryzalin	.01	34423	Dichloromethane	.2
38866	Oxamyl	.03	81576	Diethyl ether	.2
34653	p,p'-DDE	.003	81577	Diisopropyl ether	.2
39542	Parathion	.010	34371	Ethylbenzene	.1
82669	Pebulate	.004	50005	Methyl tert-pentyl ether	.2
82683	Pendimethalin	.022	77135	o-Xylene	.1
82664	Phorate	.011	77128	Styrene	.1
49291	Picloram	.03	50004	Ethyl tert-Butyl ether	.1
82676	Propyzamide	.004	34475	Tetrachloroethene	.1
62766	Propachlor ethanesulfonic acid	.05	32102	Tetrachloromethane	.2
62767	Propachlor oxanilic acid	.02	34546	trans-1,2-Dichloroethene	.1
04024	Propachlor	.025	32104	Tribromomethane	.2
82679	Propanil	.011	39180	Trichloroethene	.1
82685	Propargite	.02	34488	Trichlorofluoromethane	.2
49236	Propham	.030	39175	Vinyl chloride	.2
50471	Propiconazole	.01	32730	Total phenolic compounds	4
38538	Propoxur	.008			
38548	Siduron	.02			

Table 3. Physical properties of ground-water samples from the St. Lawrence River Basin, 2005-06.

[Pt-Co platinum-cobalt; mm, millimeters; Hg, mercury; mg/L, milligrams per liter; $\mu\text{S}/\text{cm}$ @ 25°C, microsiemens per centimeter at 25 degrees Celsius; (00080), USGS National Water Information System parameter code; --, not analyzed; <, less than]

Well number ¹	Color, filtered, Pt-Co units (00080)	Air pressure, mm Hg (00025)	Dissolved oxygen, mg/L (00300)	pH, standard units (00400)	Specific conductance, $\mu\text{S}/\text{cm}$ @ 25°C (00095)	Water temperature, degrees Celsius (00010)
Sand and gravel wells						
CL723	2	732	11.6	7.9	113	8.3
F318	8	746	.3	7.9	281	9.7
F529	5	742	.1	7.7	324	9.3
F543	5	730	--	7.6 ²	99	9.4
F573	2	725	8.8	7.9	208	7.3
ST366	<1	739	9.7	7.3	389	8.8
ST378	<1	737	9.2	7.8	191	9.2
ST1984	<1	746	.1	8.0	254	10.7
Carbonate bedrock wells						
F856	2	748	.3	7.1	1,830	9.4
J175	<1	755	4.9	7.0	760	9.2
J177	2	744	1.3	7.1	1,460	10.1
ST950	<1	756	1.2	7.3	613	9.2
ST1415	2	759	--	7.4 ²	664	10.2
ST1421	10	754	.4	7.2	364	10.2
ST1818	<1	737	2.2	7.0	656	10.2
ST2349	2	759	.1	7.5	438	9.9
Sandstone and crystalline bedrock wells						
CL1182	10	730	1.9	7.3	446	9.2
H336	<1	711	.8	7.5	155	8.4
J621	12	734	3.9	6.8	314	10.5
L176	<1	741	3.5	7.4	317	8.9
ST1420	<1	743	4.8	7.5	327	9.5
ST1720	2	730	7.4	7.4	115	8.4
ST1773	2	749	3.0	6.9	465	10.7
ST1855	10	740	3.7	6.8	584	12.2
ST2136	2	727	--	7.9 ²	594	9.4

¹ CL, Clinton County; F, Franklin County; H, Hamilton County; J, Jefferson County; L, Lewis County; ST, St. Lawrence County.

² Samples not analyzed in the field for dissolved oxygen or pH because of instrument malfunction; laboratory pH value is shown instead.

Table 4. Concentrations of major ions in ground-water samples from the St. Lawrence River Basin, 2005-06.

[ANC, Acid-neutralizing capacity; CaCO₃, calcium carbonate; mg/L, milligrams per liter; (90410), USGS National Water Information System parameter code; --, not analyzed; <, less than; E, estimated value. Bold text indicates sample exceeds water quality standards]

Well number ¹	ANC, unfiltered, mg/L as CaCO ₃ (90410)	Alkalinity, filtered, mg/L as CaCO ₃ (29801)	Hardness, filtered, mg/L as CaCO ₃ (00900)	Noncarbonate hardness, filtered, mg/L as CaCO ₃ (00905)	Calcium, filtered, mg/L (00915)	Magnesium, filtered, mg/L (00925)	Potassium, filtered, mg/L (00935)
Sand and gravel wells							
CL723	83	83	82	--	23.5	5.68	0.55
F318	134	215	140	--	38.1	11.7	.97
F529	116	145	170	22	38.8	17.0	2.36
F543	33	33	42	9	11.1	3.40	.66
F573	89	91	99	9	27.3	7.56	.66
ST366	142	124	200	80	47.9	20.5	.83
ST378	86	86	94	8	24.5	8.08	.91
ST1984	108	108	120	13	27.6	12.8	.49
Carbonate bedrock wells							
F856	173	169	490	320	117	48.5	2.13
J175	195	105	400	300	105	33.7	3.17
J177	165	132	800	670	255	40.2	3.17
ST950	206	206	260	58	55.1	30.7	3.70
ST1415	122	162	310	150	91.3	20.7	1.73
ST1421	118	118	150	28	33.6	15.1	1.60
ST1818	180	169	340	170	85.2	30.1	9.15
ST2349	223	200	210	14	30.7	33.5	2.57
Sandstone and crystalline bedrock wells							
CL1182	112	117	230	110	69.7	12.9	3.62
H336	74	74	67	--	22.5	2.51	.37
J621	146	115	170	52	47.9	11.6	.92
L176	128	137	150	17	47.6	8.68	.99
ST1420	145	140	170	32	41.0	16.8	.79
ST1720	41	41	50	9	15.2	2.89	2.36
ST1773	130	130	170	44	49.3	12.3	1.00
ST1855	221	177	240	65	61.5	21.4	2.82
ST2136	83	83	220	140	62.0	16.1	2.14

¹ CL, Clinton County; F, Franklin County; H, Hamilton County; J, Jefferson County; L, Lewis County; ST, St. Lawrence County.

Table 4. Concentrations of major ions in ground-water samples from the St. Lawrence River Basin, 2005-06.—
Continued

[ANC, Acid-neutralizing capacity; CaCO₃, calcium carbonate; mg/L, milligrams per liter; (90410), USGS National Water Information System parameter code; --, not analyzed; <, less than; E, estimated value. Bold text indicates sample exceeds water quality standards]

Well number ¹	Sodium, filtered, mg/L(00930)	Bicarbonate ² , filtered, mg/L(29805)	Chloride, filtered, mg/L(00940)	Fluoride, filtered, mg/L(00950)	Silica, filtered, mg/L(00955)	Sulfate, filtered, mg/L(00945)	Residue on evaporation, filtered, mg/L(70300)
Sand and gravel wells							
CL723	1.50	101	0.47	<0.1	10.5	6.8	101
F318	6.90	262	.99	.1	14.8	14.5	177
F529	4.36	177	1.43	.2	24.6	26.5	197
F543	2.59	40	3.32	E.1	14.4	7.4	73
F573	3.24	111	6.26	E.1	9.76	9.5	110
ST366	4.80	151	8.55	<.1	9.13	17.8	221
ST378	2.50	105	3.48	E.1	10.2	9.4	112
ST1984	3.98	132	.74	.1	11.4	27.9	151
Carbonate bedrock wells							
F856	167	206	386	E.1	9.87	41.4	997
J175	91.1	128	213	.4	9.60	50.6	713
J177	34.9	161	59.4	.8	15.8	501	1,130
ST950	25.6	251	30.0	.6	12.7	49.8	359
ST1415	24.9	198	49.7	<.1	7.83	36.1	392
ST1421	16.0	144	28.6	.2	6.52	26.4	210
ST1818	10.8	206	8.57	1.1	14.5	33.4	381
ST2349	15.0	244	4.21	.4	14.0	21.0	259
Sandstone and crystalline bedrock wells							
CL1182	5.36	143	21.9	E.1	8.15	14.1	264
H336	7.39	90	1.00	1.5	12.5	4.5	100
J621	4.72	140	2.53	.2	12.1	16.6	180
L176	7.23	167	10.3	.2	11.1	15.6	186
ST1420	1.71	171	.53	.2	10.5	15.6	178
ST1720	3.88	50	8.19	.3	14.8	8.4	85
ST1773	27.6	159	53.8	.4	13.6	23.4	263
ST1855	20.8	216	39.3	.6	11.9	33.0	348
ST2136	21.6	101	124	.4	13.9	19.0	411

¹ CL, Clinton County; F, Franklin County; H, Hamilton County; J, Jefferson County; L, Lewis County; ST, St. Lawrence County.

² Bicarbonate values calculated from alkalinity.

Table 5. Concentrations of nutrients and organic carbon in ground-water samples from the St. Lawrence River Basin, 2005-06.

[mg/L, milligrams per liter; N, nitrogen; P, Phosphorus; (00623), USGS National Water Information System parameter code; <, less than; E, estimated value]

Well number ¹	Ammonia plus organic-N, 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						
CL723	<0.10	<0.04	0.20	<0.008	0.04	<1.0
F318	.60	.51	<.06	<.008	.19	2.1
F529	<.10	<.04	<.06	<.008	<.02	<1.0
F543	<.10	<.04	.93	<.008	<.02	<1.0
F573	E.07	<.04	.23	<.008	<.02	<1.0
ST366	E.07	<.04	3.45	<.008	<.02	<1.0
ST378	E.09	<.04	.17	<.008	<.02	<1.0
ST1984	<.10	<.04	<.06	<.008	<.02	<1.0
Carbonate bedrock wells						
F856	E.05	<.04	.09	E.004	<.02	1.1
J175	E.06	<.04	.31	<.008	<.02	1.3
J177	E.10	<.04	.37	<.008	<.02	1.2
ST950	.21	.12	<.06	<.008	<.02	1.1
ST1415	<.10	<.04	.38	<.008	<.02	<1.0
ST1421	.15	E.03	<.06	<.008	<.02	2.7
ST1818	.12	<.04	2.42	<.008	<.04	1.5
ST2349	E.08	.06	<.06	<.008	<.02	<1.0
Sandstone and crystalline bedrock wells						
CL1182	E.10	<.04	<.06	<.008	<.02	2.2
H336	<.10	<.04	.07	<.008	<.02	<1.0
J621	E.06	<.04	<.06	<.008	<.04	1.3
L176	<.10	<.04	.64	<.008	<.02	1.1
ST1420	<.10	<.04	.12	<.008	<.02	<1.0
ST1720	<.10	<.04	.38	<.008	.02	<1.0
ST1773	.13	<.04	.83	<.008	<.02	2.2
ST1855	.19	.06	<.06	<.008	<.02	4.2
ST2136	<.10	<.04	<.06	<.008	<.02	<1.0

¹ CL, Clinton County; F, Franklin County; H, Hamilton County; J, Jefferson County; L, Lewis County; ST, St. Lawrence County.

Table 6. Concentrations of trace elements and radionuclides in ground-water samples from the St. Lawrence River Basin, 2005-06.

[µg/L, micrograms per liter; (01105), USGS National Water Information System parameter code; E, estimated value; <, less than; M, presence verified but not quantified. Bold text indicates sample exceeds water quality standards]

Well number ¹	Aluminum, unfiltered, µg/L (01105)	Antimony, unfiltered, µg/L (01097)	Arsenic, unfiltered, µg/L (01002)	Barium, unfiltered, µg/L (01007)	Beryllium, unfiltered, µg/L (01012)	Boron, filtered, µg/L (01020)	Cadmium, unfiltered, µg/L (01027)	Chromium, unfiltered, µg/L (01034)
Sand and gravel wells								
CL723	3	<0.2	E0.10	30	<0.06	E4.0	<0.04	1.0
F318	E1	<.2	<.12	70	<.06	11	<.04	.17
F529	151	<.2	1.9	28	<.06	7.4	<.04	E.6
F543	4	<.2	E.09	7	<.06	E6.8	E.02	.43
F573	3	<.2	.46	18	<.06	E4.2	<.04	.98
ST366	E2	<.2	E.10	43	<.06	12	<.04	.69
ST378	E1	<.2	.16	46	<.06	7.2	<.04	.36
ST1984	4	<.2	1.8	42	E.03	E4.2	<.04	.48
Carbonate bedrock wells								
F856	10	E.1	.41	237	<.06	14	E.02	.19
J175	3	<.2	.13	127	E.04	198	<.04	.52
J177	E1	<.2	.21	63	<.06	356	<.04	.50
ST950	<2	<.2	.28	97	<.06	132	<.04	.11
ST1415	<2	<.2	.15	90	<.06	16	<.04	.26
ST1421	28	<.2	.36	64	<.06	27	<.04	.47
ST1818	11	E.1	.15	82	<.06	69	<.04	.25
ST2349	69	<.2	3.1	94	<.06	28	<.04	.80
Sandstone and crystalline bedrock wells								
CL1182	3	<.2	.27	156	<.06	9.9	<.04	E.6
H336	3	<.2	<2	M	<.06	22	<.04	<.8
J621	3,250	.3	6.2	134	1.14	14	.11	3.4
L176	<2	E.1	.19	41	<.06	39	<.04	.15
ST1420	<2	E.1	.19	51	<.06	14	<.04	.32
ST1720	2	<.2	.27	M	<.06	7.3	<.04	1.1
ST1773	5	<.2	.20	228	E.03	22	<.04	.22
ST1855	75	E.1	1.7	70	.19	118	.05	.72
ST2136	<2	<.2	.19	3	<.06	19	<.04	.37

¹ CL, Clinton County; F, Franklin County; H, Hamilton County; J, Jefferson County; L, Lewis County; ST, St. Lawrence County.

Table 6. Concentrations of trace elements and radionuclides in ground-water samples from the St. Lawrence River Basin, 2005-06.—Continued

[µg/L, micrograms per liter; (01105), USGS National Water Information System parameter code; E, estimated value; <, less than; M, presence verified but not quantified. Bold text indicates sample exceeds water quality standards]

Well number ¹	Cobalt, unfiltered, µg/L (01037)	Copper, unfiltered, µg/L (01042)	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								
CL723	0.072	5.7	<6	184	0.17	<0.6	<0.6	2.5
F318	.095	1.8	127	144	.26	.9	92.9	90.0
F529	.224	.7	51	765	.18	3.3	18.2	25.5
F543	.063	71.6	7	37	.22	.8	3.4	2.8
F573	.076	12.0	<6	<6	<.06	1.0	<.6	<.6
ST366	.195	1.9	<6	<6	E.04	.7	<.6	<.6
ST378	.088	.8	<6	E4	1.41	E.6	<.6	<.6
ST1984	.099	E.4	132	190	E.04	1.3	4.9	5.7
Carbonate bedrock wells								
F856	.521	1.8	10	161	.42	2.2	35.8	35.5
J175	.335	1.9	<6	11	.08	35.1	E.5	1.0
J177	.788	3.8	24	28	<.06	11.7	27.0	28.2
ST950	.210	1.6	48	49	E.03	21.6	7.7	8.1
ST1415	.271	1.9	12	18	.14	1.4	3.7	4.1
ST1421	.199	2.5	47	153	.50	3.1	19.0	21.5
ST1818	.423	4.0	<6	41	1.25	5.2	1.7	14.3
ST2349	.393	1.8	260	710	11.8	8.8	31.1	32.4
Sandstone and crystalline bedrock wells								
CL1182	.334	1.6	57	399	.70	1.3	385	419
H336	.061	.9	9	E6	E.04	24.9	1.2	1.6
J621	4.47	21.4	189	45,500 ²	9.80	4.8	137	239
L176	.140	1.6	<6	<6	.14	9.0	<.6	<.6
ST1420	.143	9.9	<6	E4	E.03	2.1	<.6	<.6
ST1720	E.026	4.4	6	44	.08	1.9	<.6	.8
ST1773	.154	7.0	<6	11	.19	3.0	E.4	E.4
ST1855	.828	2.6	962	3,530	6.76	12.0	140	137
ST2136	.141	<.6	<6	20	E.05	6.8	3.8	3.7

¹ CL, Clinton County; F, Franklin County; H, Hamilton County; J, Jefferson County; L, Lewis County; ST, St. Lawrence County.

² This concentration is very high and is probably due to the presence of sediment in the well water.

Table 6. Concentrations of trace elements and radionuclides in ground-water samples from the St. Lawrence River Basin, 2005-06.—Continued

[µg/L, micrograms per liter; (01105), USGS National Water Information System parameter code; E, estimated value; <, less than; M, presence verified but not quantified. Bold text indicates sample exceeds water quality standards]

Well number ¹	Molybdenum, unfiltered, µg/L (01062)	Nickel, unfiltered, µg/L (01067)	Selenium, unfiltered, µg/L (01147)	Strontium, unfiltered, µg/L (01082)	Zinc, unfiltered, µg/L (01092)	Radon-222, unfiltered, picoCuries per liter (82303)	Uranium, unfiltered, µg/L (28011)
Sand and gravel wells							
CL723	0.3	0.39	<0.08	60.4	4	210	0.258
F318	.9	.54	<.08	302	<2	240	E.007
F529	1.1	1.83	E.3	156	<2	150	1.16
F543	E.2	.56	<.4	27.8	E1	860	.042
F573	.7	.29	.10	73.4	E1	430	.314
ST366	E.2	1.27	<.4	57.1	9	400	.218
ST378	.5	.56	<.4	35.0	4	680	.285
ST1984	1.7	.68	<.08	77.6	<2	160	.207
Carbonate bedrock wells							
F856	4.2	3.77	.24	167	3	600	1.57
J175	.5	2.45	.16	4,500	4	830	.690
J177	1.4	6.15	E.06	4,530	114	260	1.40
ST950	1.4	1.04	<.08	2,160	E1	150	.133
ST1415	1.4	1.54	<.4	179	3	1,220	.895
ST1421	3.0	.98	<.08	312	E1	200	.222
ST1818	.9	2.56	E.4	226	E1	2,620	4.12
ST2349	3.2	1.03	<.08	606	10	1,820	.652
Sandstone and crystalline bedrock wells							
CL1182	2.3	2.48	.4	231	E2	130	.097
H336	4.8	.61	E.3	161	E1	18,800	90.6
J621	.8	6.97	.55	117	29	250	2.93
L176	.7	1.06	E.2	684	5	280	.527
ST1420	.8	.83	E.2	107	5	1,040	2.29
ST1720	1.7	E.13	.09	36.7	<2	880	.578
ST1773	3.1	1.03	1.0	87.0	<2	11,100	16.1
ST1855	2.1	1.65	E.06	1,490	42	3,210	5.28
ST2136	3.4	.76	E.2	413	23	710	4.55

¹ CL, Clinton County; F, Franklin County; H, Hamilton County; J, Jefferson County; L, Lewis County; ST, St. Lawrence County.

Table 7. Concentrations of pesticides and caffeine detected in ground-water samples from the St. Lawrence River Basin, 2005-06.

[µg/L, micrograms per liter; CIAT, 2-chloro-4-isopropylamino-6-amino-s-triazine; CEAT, 2-chloro-6-ethylamino-4-amino-s-triazine; ESA, ethanesulfonic acid; SA, secondary amide; (04040), USGS National Water Information System parameter code; <, less than; E, estimated value]

Well number ¹	CIAT, filtered, µg/L (04040)	CEAT, filtered, µg/L (04038)	Alachlor ESA SA, filtered, µg/L (62849)	Alachlor ESA, filtered, µg/L (50009)	Caffeine, filtered, µg/L (50305)	Metolachlor ESA, filtered, µg/L (61043)	Prometon, filtered, µg/L (04037)
Sand and gravel wells							
CL723	<0.006	<0.08	<0.02	<0.02	<0.018	<0.02	<0.01
F318	<.006	<.08	<.02	<.02	<.018	<.02	<.01
F529	<.006	<.08	<.02	<.02	<.018	<.02	<.01
F543	<.006	<.08	<.02	<.02	<.018	<.02	<.01
F573	<.006	<.08	<.02	<.02	<.018	<.02	<.01
ST366	E.011	E.01	.02	.36	E.016	<.02	<.01
ST378	<.006	<.08	<.02	<.02	E.012	<.02	<.01
ST1984	<.006	<.08	<.02	<.02	<.018	<.02	<.01
Carbonate bedrock wells							
F856	<.006	<.08	<.02	<.02	<.018	<.02	<.01
J175	<.006	<.08	<.02	<.02	<.018	<.02	<.01
J177	<.006	<.08	<.02	<.02	<.018	<.02	<.01
ST950	<.006	<.08	<.02	<.02	<.018	<.02	<.01
ST1415	<.006	<.08	<.02	<.02	<.018	<.02	.02
ST1421	<.006	<.08	<.02	<.02	<.018	<.02	<.01
ST1818	<.006	<.08	<.02	<.02	<.018	<.02	<.01
ST2349	<.006	<.08	<.02	<.02	<.018	<.02	<.01
Sandstone and crystalline bedrock wells							
CL1182	<.006	<.08	<.02	<.02	<.018	<.02	<.01
H336	<.006	<.08	<.02	<.02	<.018	<.02	<.01
J621	<.006	<.08	<.02	<.02	<.018	<.02	<.01
L176	<.006	<.08	<.02	<.02	<.018	<.02	<.01
ST1420	E.013	<.08	<.02	<.02	<.018	.03	<.01
ST1720	<.006	<.08	<.02	<.02	<.018	<.02	<.01
ST1773	<.006	<.08	<.02	<.02	<.018	.02	<.01
ST1855	<.006	<.08	<.02	<.02	<.018	<.02	<.01
ST2136	<.006	<.08	<.02	<.02	<.018	<.02	<.01

¹ CL, Clinton County; F, Franklin County; H, Hamilton County; J, Jefferson County; L, Lewis County; ST, St. Lawrence County.

Table 8. Concentrations of volatile organic compounds detected in ground-water samples from the St. Lawrence River Basin, 2005-06.

[µg/L, micrograms per liter; (34668), USGS National Water Information System parameter code; <, less than; E, estimated value]

Well number ¹	Dichloro-difluoromethane, unfiltered, µg/L (34668)	<i>m</i> - + <i>p</i> -Xylene, unfiltered, µg/L (85795)	Methyl <i>tert</i> -butyl ether, unfiltered, µg/L (78032)	Toluene, unfiltered, µg/L (34010)	Trichloromethane, unfiltered, µg/L (32106)
Sand and gravel wells					
CL723	<.2	<.2	<.2	<.1	<.1
F318	<.2	<.2	<.2	<.1	<.1
F529	<.2	<.2	<.2	<.1	<.1
F543	<.2	<.2	<.2	<.1	<.1
F573	<.2	<.2	<.2	<.1	<.1
ST366	<.2	<.2	<.2	<.1	<.1
ST378	<.2	<.2	.3	<.1	<.1
ST1984	<.2	<.2	<.2	<.1	<.1
Carbonate bedrock wells					
F856	<.2	<.2	<.2	<.1	<.1
J175	<.2	<.2	<.2	<.1	<.1
J177	<.2	<.2	<.2	<.1	.2
ST950	<.2	<.2	<.2	<.1	<.1
ST1415	<.2	<.2	E.1	<.1	<.1
ST1421	<.2	<.2	<.2	<.1	<.1
ST1818	<.2	<.2	<.2	<.1	<.1
ST2349	<.2	E.1	<.2	.6	<.1
Sandstone and crystalline bedrock wells					
CL1182	<.2	<.2	<.2	<.1	.4
H336	<.2	<.2	<.2	<.1	.1
J621	<.2	<.2	<.2	<.1	<.1
L176	<.2	<.2	.2	<.1	.5
ST1420	<.2	<.2	<.2	<.1	<.1
ST1720	<.2	<.2	<.2	<.1	<.1
ST1773	E.5	<.2	<.2	<.1	<.1
ST1855	<.2	<.2	<.2	<.1	<.1
ST2136	<.2	<.2	<.2	<.1	<.1

¹ CL, Clinton County; F, Franklin County; H, Hamilton County; J, Jefferson County; L, Lewis County; ST, St. Lawrence County.

Table 9. Bacteria in ground-water samples from the St. Lawrence River Basin, 2005-06.

[Coliform bacteria presence/absence in 100 mL of sample. CFU, colony forming units; mL, milliliter; (31684), USGS National Water Information System parameter code; >, greater than; <, less than. Bold text indicates sample exceeds water quality standards]

Well number ¹	Total Coliform, unfiltered, presence/absence (31501)	Fecal Coliform, unfiltered, presence/absence (31625)	<i>Escherichia coli</i> , unfiltered, presence/absence (50278)	Heterotrophic plate count, unfiltered, CFU/mL (78943)
Sand and gravel wells				
CL723	Negative	Negative	Negative	69
F318	Negative	Negative	Negative	>150
F529	Negative	Negative	Negative	6
F543	Negative	Negative	Negative	10
F573	Negative	Negative	Negative	14
ST366	Negative	Negative	Negative	8
ST378	Negative	Negative	Negative	<1
ST1984	Negative	Negative	Negative	<1
Carbonate bedrock wells				
F856	Negative	Negative	Negative	15
J175	Positive	Positive	Positive	26
J177	Negative	Negative	Negative	<1
ST950	Negative	Negative	Negative	<1
ST1415	Negative	Negative	Negative	6
ST1421	Positive	Positive	Positive	76
ST1818	Positive	Positive	Positive	>150
ST2349	Negative	Negative	Negative	43
Sandstone and crystalline bedrock wells				
CL1182	Negative	Negative	Negative	11
H336	Negative	Negative	Negative	4
J621	Negative	Negative	Negative	6
L176	Negative	Negative	Negative	<1
ST1420	Negative	Negative	Negative	<1
ST1720	Negative	Negative	Negative	52
ST1773	Negative	Negative	Negative	36
ST1855	Negative	Negative	Negative	<1
ST2136	Negative	Negative	Negative	7

¹ CL, Clinton County; F, Franklin County; H, Hamilton County; J, Jefferson County; L, Lewis County; ST, St. Lawrence County.



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