Occurrence of Pesticides in Groundwater and Sediments and Mineralogy of Sediments and Grain Coatings underlying the Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey, 2007

Data Series 811

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

Cover. U.S. Geological Survey scientists collecting groundwater-quality samples from a research plot at the Rutgers Agricultural Research and Extension Center in Upper Deerfield, New Jersey.

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SALLY JEWELL, Secretary

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Conversion Factors, Abbreviations, Acronyms

SI to Inch/Pound

Multiply	By	To obtain
	Length	
nanometer (nm)	3.937×10^{-8}	inch (in.)
micrometer (µm)	3.937×10^{-5}	inch (in.)
centimeter (cm)	0.3937	inch (in.)
millimeter (mm)	0.03937	inch (in.)
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
	Area	
square kilometer (km^2)	247.1	acre
square kilometer (km^2)	0.3861	square mile (mi^2)
	Volume	
microliter (µL)	1.057×10^{-6}	quart (qt)
milliliter (mL)	1.057×10^{-3}	quart (qt)
cubic centimeter (cm^3)	1.057×10^{-3}	quart (qt)
liter (L)	1.057	quart (qt)
liter (L)	0.2642	gallon (gal)
	Mass	
nanogram (ng)	3.527×10^{-11}	ounce, avoirdupois (oz)
microgram (µg)	3.527×10^{-8}	ounce, avoirdupois (oz)
milligram (mg)	3.527×10^{-5}	ounce, avoirdupois (oz)
gram (g)	0.03527	ounce, avoirdupois (oz)
kilogram (kg)	2.205	pound avoirdupois (lb)
	Pressure	
kilopascal (kPa)	0.1450	pound per square inch (lb/in^2)

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

°F=(1.8×°C)+32

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

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

Altitude, as used in this report, refers to distance above the vertical datum.

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25 °C).

Concentrations of chemical constituents in water are given in either milligrams per liter (mg/L), micrograms per liter (µg/L), or nanograms per liter (ng/L).

Concentrations of chemical constituents in sediment are given in either grams per kilogram (g/kg), milligrams per kilogram (mg/kg), or nanograms per kilogram (ng/kg).

Abbreviations

<	less than
≤	less than or equal to
°C	degrees Celsius
cm	centimeters
cc	cubic centimeters
dd	decimal degrees
ft	feet
g	grams
Hz	hertz
in.	inches
i.d.	internal diameter
kg	kilograms
L	liters
lb	pounds
mi	miles
min	minutes
mg	milligrams
mL	milliliters
M	molar
mM	millimolar
mm	millimeters
m/z	mass to charge ratio
N	normal
N_2	nitrogen gas
nd	not detected
ng	nanograms
nm	nanometers
NTU	nephelometric turbidity units
psi	pounds per square inch
rpm	rotations per minute
s	seconds
u/cm	units per centimeter
µA	microamps
µg	micrograms

µL	microliters
µm	micrometers
µS	microsiemens
uv	ultraviolet
V	volts
v/v	volume to volume
v/w	volume to weight
w/w	weight to weight

Acronyms

AAS	atomic absorption spectrometer
AMPA	aminomethylphosphonic acid
ANC	acid-neutralizing capacity
APCI	atmospheric pressure chemical ionization
ASE	Accelerated Solvent Extractor
DCM	dichloromethane
DI	deionized water
DOC	dissolved organic carbon
EC	electrical conductivity
ESI	electrospray ionizations
ETU	ethylenethiourea
GC-EIMS	gas chromatograph/electron ionization mass spectrometer
GC-ITMS	gas chromatography/ion trap mass spectrometry
GC/MS	gas chromatography/mass spectrometry
GF/F	glass-fiber filter
GPC/HPLC	gel permeation chromatography/high performance liquid chromatography
HCl	hydrochloric acid
HLB	hydrophilic-lipophilic-balanced
HPLC	high pressure liquid chromatography
ICP-OES	inductively coupled plasma optical emission spectrometer
LC	liquid chromatograph
LC/MS	liquid chromatography/mass spectrometry
LC-MS/MS	liquid chromatography-tandem mass spectrometry
LOD	limit of detection

LOQ	limit of quantitation
LRL	laboratory reporting level
LTMDL	long-term method detection limit
MDL	method detection limit
MS	mass spectrometer
MRM	multiple reaction monitoring
MS2	selected ion scan
NCSU-STL	North Carolina State University Soil Testing Laboratory
NWQL	National Water Quality Laboratory
OLSPE	on-line solid-phase extraction
PAH	polycyclic aromatic hydrocarbon
QA/QC	quality assurance/quality control
RAREC	Rutgers Agricultural Research and Extension Center
RPD	relative percent difference
SC	specific conductance
SEM-EDAX	scanning electron microscopy and energy dispersive spectroscopy
SPE	solid-phase extraction
TOC	total organic carbon
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
UV	ultraviolet light
XRD	x-ray diffraction

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Abstract

Water and sediment samples were collected from June through October 2007 from seven plots at the Rutgers Agricultural Research and Extension Center in Upper Deerfield, New Jersey, and analyzed for a suite of pesticides (including fungicides) and other physical and chemical parameters (including sediment mineralogy) by the U.S. Geological Survey. Plots were selected for inclusion in this study on the basis of the crops grown and the pesticides used. Forty-one pesticides were detected in 14 water samples; these include 5 fungicides, 13 herbicides, 1 insecticide, and 22 pesticide degradates. The following pesticides and pesticide degradates were detected in 50 percent or more of the groundwater samples: 1-amide-4-hydroxy-chorothalonil, alachlor sulfonic acid, metolachlor oxanilic acid, metolachlor sulfonic acid, metalaxyl, and simazine. Dissolved-pesticide concentrations ranged from below their instrumental limit of detection to 36 micrograms per liter (for metolachlor sulfonic acid, a degradate of the herbicide metolachlor). The total number of pesticides found in groundwater samples ranged from 0 to 29. Fourteen pesticides were detected in sediment samples from continuous cores collected within each of the seven sampled plots; these include 4 fungicides, 2 herbicides, and 7 pesticide degradates. Pesticide concentrations in sediment samples ranged from below their instrumental limit of detection to 34.2 nanograms per gram (for azoxystrobin). The total number of pesticides found in sediment samples ranged from 0 to 8. Quantitative whole-rock and grain-coating mineralogy of sediment samples were determined by x-ray diffraction. Whole-rock analysis indicated that sediments were predominantly composed of quartz. The materials coating the quartz grains were removed to allow quantification of the trace mineral phases present.

Introduction

Pesticides are used in conventional agriculture to protect crops from a loss of yield or damage due to the presence of unwanted plants, insects, and (or) fungal pathogens. More than 4,900 active ingredients are present in the approximately 64,000 pesticide products currently registered for use in the United States (U.S. Environmental Protection Agency, 2012). In 2007, 684 million pounds of active pesticide ingredients were applied for agricultural use in the United States at a total cost of more than $7.8 billion (Grube and others, 2011). Even with the use of pesticides, there were losses in yields of commodity crops (such as wheat, corn, potatoes, and rice) of 26 to 40 percent worldwide during 2001–03 (Oercke, 2006). Pesticide manufacturers are continually developing new chemicals and formulations in an effort to find more effective treatments and to outpace the rate at which agricultural pests acquire resistance to them. This research and development, together with the deregistration of pesticides by regulatory bodies, causes pesticide-use patterns to change over time.

Although the presence of pesticides and pesticide degradates in groundwater supplies is well documented (Barbash and Resek, 1996; Kolpin and others, 2000; Stuart and others, 2006; Steele and others, 2008), changes in use patterns, the introduction of new pesticides, and the advent of new analytical approaches motivates continued study. The purpose of many studies to date has been to document the concentrations of pesticides in a given groundwater supply, which is accomplished by sampling drinking-water, irrigation, or monitoring wells screened within the subject aquifer. Although such studies provide valuable information about the ambient concentrations of pesticides in an aquifer, the source or sources of the pesticides present can be difficult to ascertain as a result of differences in the size of the contributing area, recharge rates, and pesticide usage associated with the wells. In studies in which a primary objective is to determine whether a pesticide can reach the aquifer, a more focused approach is required.

To ensure that the composition of the sampled groundwater is directly related to the overlying land-use practice, the contributing area of the sampled well must be minimized. This objective can be accomplished by installing temporary monitoring wells where the well screen penetrates the aquifer only as far as is necessary to produce sufficient water for sampling. If such a well is sampled at as low a flow rate as possible, the contributing area is minimized and the effect of land use can be characterized by the practices employed near the well head. Such wells can be installed, sampled, and properly abandoned by using direct-drive systems mounted to trucks or small all-terrain vehicles within 1 day. This approach allows access to sensitive areas (such as active farm fields) where larger scale drilling equipment would be disruptive and permanent well installations are not possible. This method can also be used to evaluate temporal changes in water quality by repeating the installation at the desired time intervals.

A study was conducted by the U.S. Geological Survey (USGS) as part of its Toxic Substances Hydrology (Toxics) Program to measure the concentrations of currently used pesticides (especially fungicides) present in shallow groundwater (generally 1–5 feet (ft) below the water table) and in saturated and unsaturated sediments beneath fields with known pesticide use. The composition of grain coatings present on underlying sediments was determined to assess the role of grain coatings in the storage of organic and inorganic chemicals in the unsaturated and saturated zones. In 2007, field sampling focused on seven research plots at an agricultural research station in New Jersey. Water-quality results from this study can be used to focus future efforts of the USGS Toxics Program and other researchers to better understand the occurrence and fate of pesticides (particularly fungicides) in the unsaturated-zone and shallow groundwater systems.

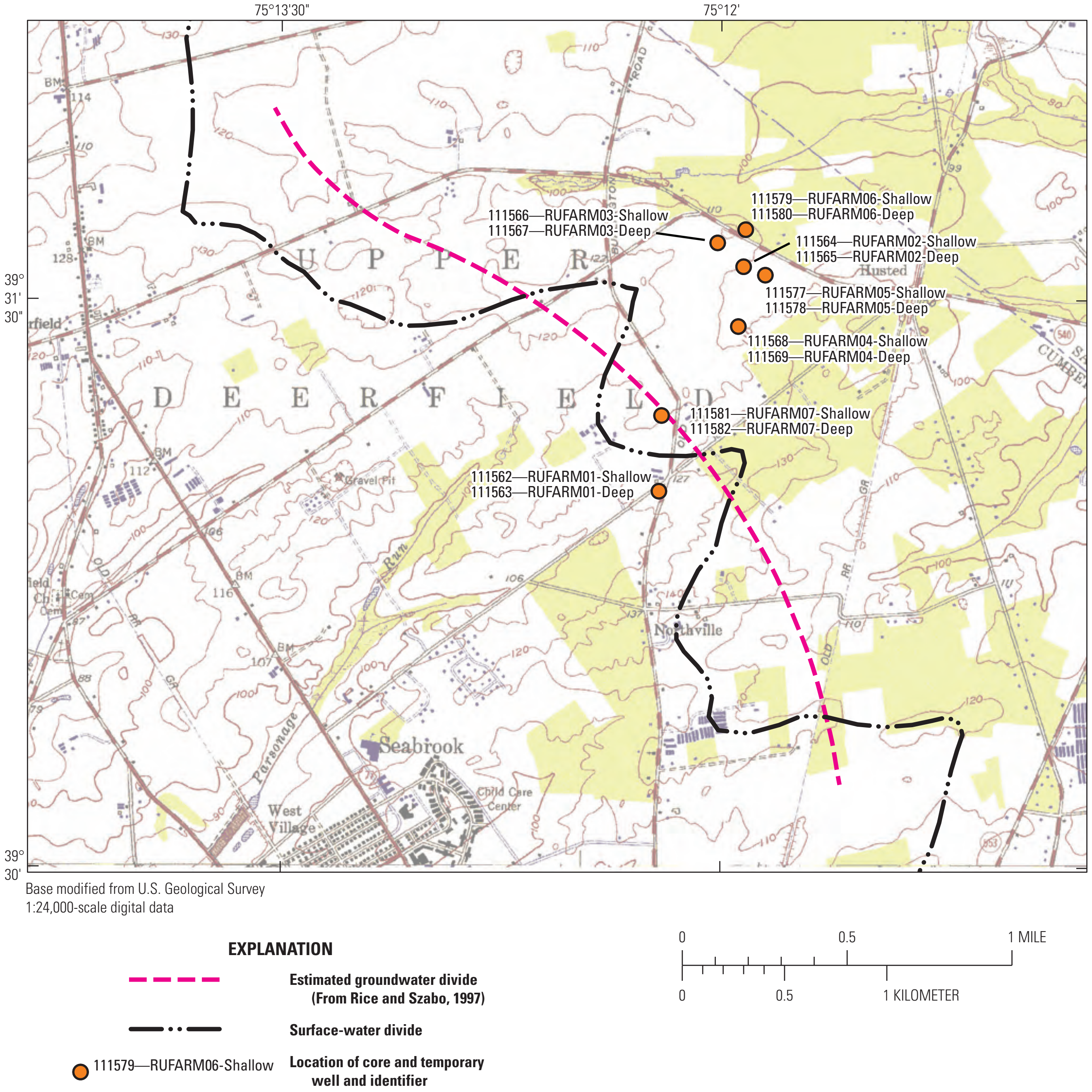
Purpose and Scope

This report documents the presence of currently used pesticides and pesticide degradates (particularly fungicides) in groundwater and sediments underlying treated agricultural fields, evaluates the composition of and depositional and digenetic history of grain coatings present on Bridgeton Formation and weathered Coastal Plain sediments, and describes the role of grain coatings in the storage of organic and inorganic chemicals in the unsaturated and saturated zones. In 2007, groundwater and sediments were collected and analyzed for a suite of currently used pesticides and degradates. Sampling focused on seven research plots at the Rutgers Agricultural Research and Extension Center (RAREC) in Upper Deerfield, New Jersey (fig. 1). Six of the seven plots are routinely used by the RAREC staff to conduct variety trials of row crops that, when grown using conventional agricultural practices, are regularly treated with fungicides. The variety trial plots at RAREC are typically treated with pesticides in accordance with the recommendations that the RAREC staff provide to local growers. Consequently, the timing, amount, and type of pesticide treatments used on RAREC variety trial plots are similar to those used by local growers. This study was conducted at the RAREC to take advantage of the comprehensive pesticide application records it maintains and because RAREC was willing to permit USGS scientists to sample plots prior to harvest. Groundwater and sediment from a plot at the RAREC that has not been treated with pesticides within the past 20 years or more was included in the study to serve as a control plot. This report documents the water- and sediment-quality results from this study. Concentrations of total and dissolved organic carbon, nutrients, metals and major ions, and water-quality field parameters in water samples; physical characteristics of sediments (core descriptions, mineralogy, and grain size); and concentrations of sediment-associated organic carbon, nutrients, and ions are also presented.

Geologic Setting

The study area is located within an agricultural watershed in Upper Deerfield Township, New Jersey (fig. 1). The watershed is in the Coastal Plain of southern New Jersey, a seaward-dipping wedge of unconsolidated sands and clays that range in age from Cretaceous to Holocene (Zapecza, 1989). Sediments that compose the unsaturated zone and the shallow aquifer in the study area are made up of the Miocene Bridgeton Formation and weathered Coastal Plain deposits (Newell and others, 2000). The Bridgeton Formation is characterized by coarse, pebbly, orange sands and was deposited in the late Miocene Epoch in a former fluvial plain environment (Zapecza, 1989; Newell and others, 2000). This formation is present as the caps of hills in the southern Coastal Plain with a maximum thickness of approximately 40 ft (Newell and others, 2000). Newell and others (2000) described weathered Coastal Plain deposits as exposures of weathered outcrops of Coastal Plain formations overlain by thin alluvium and colluvium. The Cohansey Formation underlies the Bridgeton Formation and is an unconsolidated, medium-to-coarse quartz sand with locally substantial clay beds, and was deposited in the inner neritic to nearshore environments during a Miocene regression (Zapecza, 1989). Distinctive strata local to this study area have been documented by Baehr and others (2003). Field observations distinguish the unsaturated zone from the overlying soils on the basis of differing color, grain size, and the presence of plant fragments in the soils.

Salisbury (1898) first described the Bridgeton Formation as a surficial feldspathic sand. Later refinements by Salisbury and Knapp (1917) divided the formation into two members, the Glassboro phase and the Woodmansie phase. The Glassboro phase, underlying the present study location, is described as locally arkosic. Owens and Minard (1979) refined previous work and identified the southern portion of the Bridgeton Formation as the Intermediate Uplands and described the sediments of the study area as a massive, dark red, very clayey



Base modified from U.S. Geological Survey
1:24,000-scale digital data

Figure 1. Location map of sites sampled on the Rutgers Agricultural Research and Extension Center, 2007.

sand overlying lighter colored, extensively coarse, stratified sand. They reported reddish-brown-stained quartz grains throughout the unit and widespread black iron oxides present as thin layers within lighter colored sands. Martino (1981) described the Bridgeton Formation as a deeply weathered, stained, pebbly coarse sand with colors ranging from red (2.5YR 4/8) to brownish yellow (10YR 6/8). Recent study of the Bridgeton Formation and weathered Coastal Plain deposits by Reilly and others (2009) found that sediment grains within these units are largely quartz and chert (80–94 percent weight to weight (w/w)), coated with a very fine-grained, less than (<) 20 micrometers (µm), complex mixture of kaolinite, halloysite, goethite, and possibly gibbsite and lepidocrocite. They determined that mineral coatings are present as an open fabric, resulting in a large surface area in contact with pore water. Results of their study indicate that the mineralogy and structure of grain coatings in these formations can have demonstrable effects on the storage of nitrate and sulfate in the unsaturated zone.

Sampling Site Descriptions and Watershed Characteristics

The RAREC is located in Upper Deerfield, New Jersey, on or near the surface-water divide between two predominantly agricultural basins: Parsonage Run to the west and Muddy Run to the east (fig. 1). Rice and Szabo (1997) estimated the position of the groundwater divide in the study area as roughly following the surface-water divide (fig. 1). Seven research plots at the RAREC were selected for inclusion in this study on the basis of the crops grown and the pesticides applied to those crops (fig. 1). Plots range in size from 0.83 to 4.49 acres. Four wells (USGS station names 111562—RUFARM01-Shallow, 111563—RUFARM01-Deep, 111581—RUFARM07-Shallow, and 111582—RUFARM07-Deep) are 69 to 690 ft southwest of the estimated groundwater divide. The other 10 wells included in this study lie 1,814 to 2,999 ft northwest of the groundwater divide.

Table 1. Location and depth of groundwater sampling sites, Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey.

[USGS, U.S. Geological Survey; dd, decimal degrees; ft bls, feet below land surface]

USGS station number	USGS station name	Latitude (dd)	Longitude (dd)	Static water level (ft bls)	Top, screened interval (ft bls)	Bottom, screened interval (ft bls)
393100075121301	111562—RUFARM01-Shallow	39.51658	-75.20352	24.77	25.45	26.45
393100075121302	111563—RUFARM01-Deep	39.51658	-75.20352	24.77	30.44	31.44
393135075115601	111564—RUFARM02-Shallow	39.52648	-75.19873	11.73	11.98	12.98
393135075115602	111565—RUFARM02-Deep	39.52648	-75.19873	11.73	16.96	17.96
393139075120101	111566—RUFARM03-Shallow	39.52753	-75.20022	23.92	24.00	26.00
393139075120102	111567—RUFARM03-Deep	39.52753	-75.20022	23.92	27.00	29.00
393126075115601	111568—RUFARM04-Shallow	39.52383	-75.19902	8.81	8.99	10.99
393126075115602	111569—RUFARM04-Deep	39.52383	-75.19902	9.35	14.88	16.88
393134075115101	111577—RUFARM05-Shallow	39.52612	-75.19750	9.62	9.99	10.99
393134075115102	111578—RUFARM05-Deep	39.52612	-75.19750	9.53	14.99	15.99
393141075115501	111579—RUFARM06-Shallow	39.52812	-75.19863	12.72	13.92	14.92
393141075115502	111580—RUFARM06-Deep	39.52812	-75.19863	12.72	17.91	18.91
393112075121201	111581—RUFARM07-Shallow	39.51992	-75.20338	22.37	26.97	27.97
393112075121202	111582—RUFARM07-Deep	39.51992	-75.20338	22.45	32.00	33.00

Pesticide Usage

The RAREC staff records the date, product name, active ingredients, amount, and U.S. Environmental Protection Agency (USEPA) registration number for each pesticide applied to plots at its facility. Pesticide usage records for six of the seven sampled plots are shown in tables 2 through 7. The amount of active ingredient applied was calculated by determining the percentage of active ingredient in the applied pesticide and the mass of pesticide formulation applied. No record of pesticide applications exists for two wells (USGS station names 111562—RUFARM01-Shallow and 111563—RUFARM01-Deep) that are located on a barren plot at the RAREC that has not been treated with pesticides for at least the past 20 years. Pesticide usage records corresponding to two wells (USGS station names 111579—RUFARM06-Shallow and 111580—RUFARM06-Deep) are incomplete as certain pesticide applications within that plot in 2007 are included in a confidentiality agreement between the RAREC and a pesticide manufacturer.

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Table 2. Pesticide usage data corresponding to U.S. Geological Survey stations 111564—RUFARM02-Shallow and 111565—RUFARM02-Deep, Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey.

[USEPA, U.S Environmental Protection Agency]

Application date	Crop treated	Product name	USEPA registration number	Active ingredient	Mass of active ingredient applied (grams)
6/12/2003	Tomato	Sencor	3125-325	Metribuzin	112
6/12/2003	Tomato	Devrinol 50-WP	476-2108	Napropamide	680
7/15/2003	Tomato	Bravo 720	50534-188	Chlorothalonil	652
7/29/2003	Tomato	Vydate	352-372	Oxamyl	595
8/8/2003	Tomato	Previcur Flex	264-678	Propamocarb hydrochloride	471
8/12/2003	Tomato	Actara	100-938	Thiamethoxam	51
6/9/2005	Tomato	Sencor	3125-325	Metribuzin	112
6/9/2005	Tomato	Devrinol 50-WP	476-2108	Napropamide	454
7/21/2005	Tomato	Select 2EC	59639-3-1387	Clethodim	116
7/21/2005	Tomato	Select 2EC	59639-3-1387	Naphthalene	32
7/21/2005	Tomato	Select 2EC	59639-3-1387	Trimethylbenzene	12
7/29/2005	Tomato	Baythroid	3125-351	Cyfluthrin	20
8/15/2005	Tomato	Baythroid	3125-351	Cyfluthrin	20
8/26/2005	Tomato	Warrior	10182-96	Lambda-cyhalothrin	17
8/26/2005	Tomato	Matrix	352-556	Rimsulfuron	17
6/15/2006	Tomato	Dual	101-818	S-Metolachlor	565
7/14/2006	Tomato	Spintor	62719-294	Spinosad	22
7/17/2006	Tomato	Sencor	3125-325	Metribuzin	102
7/17/2006	Tomato	Matrix	352-556	Rimsulfuron	17
7/27/2006	Tomato	Baythroid	3125-351	Cyfluthrin	19
8/8/2006	Tomato	Actara	100-938	Thiamethoxam	36
6/19/2007	Pumpkin	Admire Pro	264-827	Imiacloprid	4
6/20/2007	Pumpkin	Strategy	34704-836	Clomazone	118
6/20/2007	Pumpkin	Strategy	34704-836	Ethalfluranlin	337
7/2/2007	Pumpkin	Admire Pro	264-827	Imiacloprid	95

Table 3. Pesticide usage data corresponding to U.S. Geological Survey stations 111566—RUFARM03-Shallow and 111567—RUFARM03-Deep, Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey.

[USEPA, U.S Environmental Protection Agency]

Application date	Crop treated	Product name	USEPA registration number	Active ingredient	Mass of active ingredient applied (grams)
4/2/2003	Sod	2,4-D	34704-120	2,4-D	694
5/7/2003	Potato	Sencor	3125-325	Metribuzin	102
5/7/2003	Potato	Dual	101-818	S-Metolachlor	565
7/15/2003	Potato	Bravo 720	50534-188	Chlorothalonil	652
7/15/2003	Potato	Dimethoate 4E	5905-493	Dimethoate	325
7/30/2003	Potato	Quadris	10182-415	Azoxystrobin	73
8/20/2003	Potato	Gramoxone	10182-280	Paraquat dichloride	438
7/20/2004	Asparagus	Select	59639-3	Clethodim	37
3/22/2005	Potato	Touchdown	10182-324	Glyphosate-trimesium	933
4/18/2005	Potato	Sencor	3125-325	Metribuzin	102
4/18/2005	Potato	Prowl 3.3 EC	241-337	Pendimethalin	538
6/20/2005	Potato	Baythroid	3125-351	Cyfluthrin	20
6/20/2005	Potato	Dithane	707-180	Mancozeb	680
7/1/2005	Potato	Quadris	10182-415	Azoxystrobin	24
7/1/2005	Potato	Bravo 720	50534-188	Chlorothalonil	1,303
7/1/2005	Potato	Actara	100-938	Thiamethoxam	18
7/5/2005	Potato	Baythroid	3125-351	Cyfluthrin	20
7/5/2005	Potato	Dithane	707-180	Mancozeb	680
7/12/2005	Tomato	Baythroid	3125-351	Cyfluthrin	20
7/12/2005	Tomato	Dithane	707-180	Mancozeb	680
7/29/2005	Potato	Bravo 720	50534-188	Chlorothalonil	434
7/29/2005	Potato	Baythroid	3125-351	Cyfluthrin	20
8/15/2005	Potato	Gramoxone	10182-280	Paraquat dichloride	219
7/25/2006	Soybean	Touchdown	10182-324	Glyphosate-trimesium	933
3/23/2007	Rye	Roundup	524-475	Glyphosate	675
4/11/2007	Potato	Sencor	3125-325	Metribuzin	102
4/11/2007	Potato	Prowl	241-337	Pendimethalin	538
6/12/2007	Potato	Dithane	707-180	Mancozeb	680
6/28/2007	Potato	Baythroid	264-840	beta-Cyfluthrin	15
6/28/2007	Potato	Bravo 720	50534-188	Chlorothalonil	434

Table 4. Pesticide usage data corresponding to U.S. Geological Survey stations 111568—RUFARM04-Shallow and 111569—RUFARM04-Deep, Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey.

[USEPA, U.S Environmental Protection Agency]

Application date	Crop treated	Product name	USEPA registration number	Active ingredient	Mass of active ingredient applied (grams)
4/19/2004	Potato	Sencor	3125-314	Metribuzin	56
4/19/2004	Potato	Prowl 3.3 EC	241-337	Pendimethalin	4,141
5/19/2004	Sweet corn	Lasso	524-314	Alachlor	724
5/19/2004	Sweet corn	Bladex 90DF	352-495	Cyanazine	327
6/10/2004	Sweet corn	Lasso	524-314	Alachlor	724
6/10/2004	Sweet corn	Bladex 90DF	352-495	Cyanazine	327
6/10/2004	Potato	Dithane	707-180	Mancozeb	680
6/18/2004	Potato	Bravo 720	50534-188	Chlorothalonil	1,303
7/16/2004	Potato	Bravo 720	50534-188	Chlorothalonil	782
7/16/2004	Potato	Spintor	62719-294	Spinosad	64
7/21/2004	Potato	Bravo 720	50534-188	Chlorothalonil	1,303
7/21/2004	Potato	Baythroid	3125-351	Cyfluthrin	20
8/2/2004	Potato	Curzate 60DF	352-592	Cymoxanil	119
8/2/2004	Potato	Provado 1.6	3125-457	Imiacloprid	24
8/2/2004	Potato	Dithane	707-180	Mancozeb	680
5/4/2005	Rye	Touchdown	10182-324	Glyphosate-trimesium	933
4/13/2006	Potato	Sencor	3125-325	Metribuzin	102
4/13/2006	Potato	Dual	101-818	S-Metolachlor	565
6/9/2006	Potato	Dithane	707-180	Mancozeb	680
6/16/2006	Potato	Baythroid	3125-351	Cyfluthrin	13
6/16/2006	Potato	Dithane	707-180	Mancozeb	680
6/30/2006	Potato	Bravo	50534	Chlorothalonil	1,303
6/30/2006	Potato	Baythroid	3125-351	Cyfluthrin	20
6/30/2006	Potato	Tanos	352-604	Cymoxanil	81
6/30/2006	Potato	Tanos	352-604	Famoxzdone	81
7/10/2006	Potato	Bravo	50534	Chlorothalonil	1,303
7/10/2006	Potato	Baythroid	3125-351	Cyfluthrin	20
7/10/2006	Potato	Tanos	352-604	Cymoxanil	81
7/10/2006	Potato	Tanos	352-604	Famoxzdone	81
5/1/2007	Rye	Roundup	524-537	Glyphosate	807
5/11/2007	Rye	Roundup	524-537	Glyphosate	807
7/3/2007	Soybean	Roundup	524-537	Glyphosate	807
7/6/2007	Soybean	Roundup	524-537	Glyphosate	807

Table 5. Pesticide usage data corresponding to U.S. Geological Survey stations 111577—RUFARM05-Shallow and 111578—RUFARM05-Deep, Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey.

[USEPA, U.S Environmental Protection Agency]

Application date	Crop treated	Product name	USEPA registration number	Active ingredient	Mass of active ingredient applied (grams)
6/27/2003	Soybean	Micro-Tech	524-344	Alachlor	890
6/27/2003	Tomato	Dupont Canopy	352-444	Chlorimuron ethyl	25
6/27/2003	Tomato	Dupont Canopy	352-444	Metribuzin	124
5/3/2005	Rye	Touchdown	10182-324	Glyphosate-trimesium	933
5/4/2006	Rye	Roundup	524-475	Glyphosate	675
5/5/2006	Rye	Roundup	524-475	Glyphosate	675
7/20/2006	Soybean	Touchdown	10182-324	Glyphosate-trimesium	933
5/30/2007	Tomato	Sencor 75DF	264-738	Metribuzin	132
5/30/2007	Tomato	Devrinol	70506-36	Napropamide	680
6/21/2007	Tomato	Bravo WS	50534-188-100	Chlorothalonil	434
6/27/2007	Tomato	Amistar	100-1164	Azoxystrobin	1
6/27/2007	Tomato	Bravo WS	50534-188-100	Chlorothalonil	434
7/5/2007	Tomato	Bravo WS	50534-188-100	Chlorothalonil	434
7/16/2007	Tomato	Amistar	100-1164	Azoxystrobin	1
7/16/2007	Tomato	Bravo WS	50534-188-100	Chlorothalonil	434
7/24/2007	Tomato	Bravo WS	50534-188-100	Chlorothalonil	434
7/24/2007	Tomato	Spintor	62719-294	Spinosad	18
7/25/2007	Tomato	Select	59639-3	Clethodim	37
7/30/2007	Tomato	Amistar	100-1164	Azoxystrobin	1
7/30/2007	Tomato	Bravo WS	50534-188-100	Chlorothalonil	434
8/7/2007	Tomato	Bravo WS	50534-188-100	Chlorothalonil	434
8/13/2007	Tomato	Amistar	100-1164	Azoxystrobin	1
8/13/2007	Tomato	Bravo WS	50534-188-100	Chlorothalonil	434
8/13/2007	Tomato	Spintor	62719-294	Spinosad	18
8/15/2007	Tomato	Select	59639-3	Clethodim	37
8/23/2007	Tomato	Bravo WS	50534-188-100	Chlorothalonil	434
8/23/2007	Tomato	Oberon	264-719	Spiromesifen	64
9/4/2007	Tomato	Amistar	100-1164	Azoxystrobin	1
9/4/2007	Tomato	Bravo WS	50534-188-100	Chlorothalonil	434
9/10/2007	Tomato	Bravo WS	50534-188-100	Chlorothalonil	434

Table 6. Pesticide usage data corresponding to U.S. Geological Survey stations 111579—RUFARM06-Shallow and 111580—RUFARM06-Deep, Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey.

[USEPA, U.S Environmental Protection Agency; NR, not reported]

Application date	Crop treated	Product name	USEPA registration number	Active ingredient	Mass of active ingredient applied (grams)
5/1/2003	Holly	Devrinol	70506-36	Napropamide	NR
6/16/2004	Carrot	Poast	7969-58	Sethoxydim	89
7/6/2004	Corn	Lorox DF	1812-320	Linuron	227
8/3/2004	Carrot	Bravo Ultrex	50534-201	Chlorothalonil	748
8/6/2004	Carrot	Bravo 720	50534-188	Chlorothalonil	42
8/11/2004	Carrot	Cabrio	7969-187	Pyraclostrobin	104
8/27/2004	Carrot	Bravo 720	50534-188	Chlorothalonil	1,303
6/23/2005	Beans	Select	59639-3	Clethodim	37
6/6/2006	Field corn	Touchdown	10182-324	Glyphosate-trimesium	933
5/24/2007	Peppers	Command 3ME	279-3158-5905	Calcium chloride	41
5/24/2007	Peppers	Command 3ME	279-3158-5905	Clomazone	175
5/24/2007	Peppers	Devrinol	70506-36	Napropamide	680
6/11/2007	Field corn	Roundup	524-504	Glyphosate	1,169

Table 7. Pesticide usage data corresponding to U.S. Geological Survey stations 111581—RUFARM07-Shallow and 111582—RUFARM07-Deep, Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey.

[USEPA, U.S Environmental Protection Agency]

Application date	Crop treated	Product name	USEPA registration number	Active ingredient	Mass of active ingredient applied (grams)
6/22/2005	Pumpkin	Admire Pro	264-827	Imiacloprid	61
6/23/2005	Pumpkin	Strategy	34704-836	Clomazone	118
6/23/2005	Pumpkin	Strategy	34704-836	Ethalfluranlin	337
7/7/2005	Pumpkin	Strategy	34704-836	Clomazone	118
7/7/2005	Pumpkin	Strategy	34704-836	Ethalfluranlin	337
7/25/2005	Pumpkin	Nova 40	62719-411	Myclobutanil	3
8/1/2005	Pumpkin	Bravo	50534	Chlorothalonil	4
8/1/2005	Pumpkin	Nova 40	62719-411	Myclobutanil	13
8/8/2005	Pumpkin	Nova 40	62719-411	Myclobutanil	4
8/13/2005	Pumpkin	Bravo	50534	Chlorothalonil	6
8/13/2005	Pumpkin	Nova 40	62719-411	Myclobutanil	21
8/15/2005	Pumpkin	Agri-Mek	100-8692	Abamectin	11
8/24/2005	Pumpkin	Nova 40	62719-411	Myclobutanil	4
8/30/2005	Pumpkin	Bravo	50534	Chlorothalonil	6
8/30/2005	Pumpkin	Nova 40	62719-411	Myclobutanil	21
9/6/2005	Pumpkin	Nova 40	62719-411	Myclobutanil	4
9/9/2005	Pumpkin	Sevin 80 WSP	264-526	Carbaryl	833
9/13/2005	Pumpkin	Bravo	50534	Chlorothalonil	6
9/13/2005	Pumpkin	Nova 40	62719-411	Myclobutanil	21
9/19/2005	Pumpkin	Nova 40	62719-411	Myclobutanil	4
9/28/2005	Pumpkin	Bravo	50534	Chlorothalonil	6
9/28/2005	Pumpkin	Nova 40	62719-411	Myclobutanil	21
4/3/2006	Rye	Roundup	524-475	Glyphosate	675
6/22/2006	Pumpkin	Strategy	34704-836	Clomazone	8
6/22/2006	Pumpkin	Strategy	34704-836	Ethalfluranlin	22
6/22/2006	Pumpkin	Admire Pro	264-827	Imiacloprid	61
6/23/2006	Pumpkin	Strategy	34704-836	Clomazone	118
6/23/2006	Pumpkin	Strategy	34704-836	Ethalfluranlin	337
7/25/2006	Pumpkin	Nova 40	62719-411	Myclobutanil	3
7/27/2006	Pumpkin	Gavel	62719-441	Mancozeb	608
7/27/2006	Pumpkin	Pounce	279-3014	Permethrin	71
7/27/2006	Pumpkin	Gavel	62719-441	Zoxamide	75
7/31/2006	Pumpkin	Danitol	59639-35	Fenpropathrin	121
8/1/2006	Pumpkin	Bravo	50534	Chlorothalonil	4
8/1/2006	Pumpkin	Nova 40	62719-411	Myclobutanil	13
8/8/2006	Pumpkin	Gavel	62719-441	Mancozeb	608
8/8/2006	Pumpkin	Nova 40	62719-411	Myclobutanil	4
8/8/2006	Pumpkin	Phostrol	55146-83	Potassium phosphite	1,750
8/8/2006	Pumpkin	Gavel	62719-441	Zoxamide	73
8/13/2006	Pumpkin	Bravo	50534	Chlorothalonil	6
8/13/2006	Pumpkin	Nova 40	62719-411	Myclobutanil	21
8/15/2006	Pumpkin	Asana	352-515	Esfenvalerate	26
8/15/2006	Pumpkin	Gavel	62719-441	Mancozeb	608

Table 7. Pesticide usage data corresponding to U.S. Geological Survey stations 111581—RUFARM07-Shallow and 111582—RUFARM07-Deep, Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey.—Continued

[USEPA, U.S Environmental Protection Agency]

Application date	Crop treated	Product name	USEPA registration number	Active ingredient	Mass of active ingredient applied (grams)
8/15/2006	Pumpkin	Phostrol	55146-83	Potassium phosphite	1,750
8/15/2006	Pumpkin	Gavel	62719-441	Zoxamide	73
8/22/2006	Pumpkin	Agri-Mek	100-8692	Abamectin	11
8/22/2006	Pumpkin	Gavel	62719-441	Mancozeb	608
8/22/2006	Pumpkin	Phostrol	55146-83	Potassium phosphite	1,750
8/22/2006	Pumpkin	Fulfill	100-912	Pymetrozine	59
8/22/2006	Pumpkin	Gavel	62719-441	Zoxamide	73
8/24/2006	Pumpkin	Nova 40	62719-411	Myclobutanil	4
8/29/2006	Pumpkin	Gavel	62719-441	Mancozeb	608
8/29/2006	Pumpkin	Phostrol	55145-83	Potassium phosphite	1,750
8/29/2006	Pumpkin	Fulfill	100-912	Pymetrozine	59
8/29/2006	Pumpkin	Gavel	62719-441	Zoxamide	73
8/30/2006	Pumpkin	Bravo	50534	Chlorothalonil	6
8/30/2006	Pumpkin	Nova 40	62719-411	Myclobutanil	21
9/6/2006	Pumpkin	Nova 40	62719-411	Myclobutanil	4
9/9/2006	Pumpkin	Sevin 80 WSP	264-526	Carbaryl	833
9/13/2006	Pumpkin	Bravo	50534	Chlorothalonil	6
9/13/2006	Pumpkin	Nova 40	62719-411	Myclobutanil	21
9/19/2006	Pumpkin	Nova 40	62719-411	Myclobutanil	4
9/28/2006	Pumpkin	Bravo	50534	Chlorothalonil	6
9/28/2006	Pumpkin	Nova 40	62719-411	Myclobutanil	21
5/1/2007	Rye	Roundup	524-537	Glyphosate	807
6/19/2007	Pumpkin	Admire Pro	264-827	Imiacloprid	61
6/20/2007	Pumpkin	Strategy	34704-836	Clomazone	118
6/20/2007	Pumpkin	Strategy	34704-836	Ethalfluranlin	337
7/3/2007	Soybean	Roundup	524-537	Glyphosate	807
7/11/2007	Pumpkin	Poast	7969-58	Sethoxydim	89
7/25/2007	Pumpkin	Nova 40	62719-411	Myclobutanil	3
7/27/2007	Grasses	Drive	7969-130	Quinclorac	170
8/1/2007	Pumpkin	Bravo	50534	Chlorothalonil	4
8/1/2007	Pumpkin	Nova 40	62719-411	Myclobutanil	13
8/8/2007	Pumpkin	Nova 40	62719-411	Myclobutanil	4
8/13/2007	Pumpkin	Bravo	50534	Chlorothalonil	6
8/13/2007	Pumpkin	Nova 40	62719-411	Myclobutanil	21
8/24/2007	Pumpkin	Nova 40	62719-411	Myclobutanil	4
8/30/2007	Pumpkin	Bravo	50534	Chlorothalonil	6
8/30/2007	Pumpkin	Nova 40	62719-411	Myclobutanil	21
9/6/2007	Pumpkin	Nova 40	62719-411	Myclobutanil	4
9/13/2007	Pumpkin	Bravo	50534-191	Chlorothalonil	3
9/13/2007	Pumpkin	Nova 40	62719-411	Myclobutanil	21
9/19/2007	Pumpkin	Nova 40	62719-411	Myclobutanil	4
9/28/2007	Pumpkin	Bravo	50534	Chlorothalonil	6
9/28/2007	Pumpkin	Nova 40	62719-411	Myclobutanil	21

Methods

Field sampling methods and laboratory analytical methods for both water and sediment samples are documented in the following sections.

Field Sampling Methods for Water and Sediment Samples

Sediment and shallow groundwater samples were obtained from within each of the seven sampled plots (fig. 1) using a Geoprobe direct push system (Geoprobe Systems, Salina, Kansas). Cores were obtained by driving a coring barrel through sediment using a high-frequency (30-Hertz) pneumatic hammer. The cores were contained in 1.5-inch- (in.) diameter, 4-ft-long acrylic core liners. The material brought to the surface was then used for sediment analysis. A pair of continuous cores was collected at each site about 1 ft apart (each from land surface to 5 ft below the water table where possible). One core was immediately subsampled for moisture, grain size, nutrients, and inorganic ions. The second was chilled to 4 °C (degrees Celsius) and transported to the USGS New Jersey Water Science Center (formerly in West Trenton, New Jersey), where it was frozen to preserve the sediment samples for additional chemical analyses.

Shallow (generally 0-1 ft below the water table) and deep (generally 5-6 ft below the water table) groundwater samples were obtained from each of the seven locations sampled in this study using a Geoprobe direct push system. The depth to the water table was determined by driving a 2-ft-long mill slotted drilling rod to depth and measuring the water level with a steel measuring tape. Temporary wells were created at each site by driving a precleaned (deionized (DI)-water- and methanol-rinsed), 4-ft-long Geoprobe retractable stainless-steel 10-slot well screen (Geoprobe model SP-15) to a depth appropriate to span the desired screened interval. Groundwater samples were collected by inserting precleaned 1/4-in. inner diameter (i.d.) Teflon® tubing through the annular space of the driving rods to the bottom of the screen. The temporary wells were developed and sampled at 1 liter per minute (L/min) using a peristaltic pump. Sample water was pumped into a precleaned 14-liter (L) Teflon® churn prior to processing. Development criteria included purging fine particles from the screen and pumping until temperature, specific conductance (SC), and pH readings had stabilized. Onsite sample processing was conducted after the samples were collected using standard USGS procedures (U.S. Geological Survey, 2006; Shelton, 1994).

Laboratory Analytical Methods for Water and Sediment Samples

Water samples were analyzed for dissolved pesticides and pesticide degradates, organic carbon, nutrients, metals, and major ions using the analytical procedures detailed below. Sediment samples were analyzed for moisture content, particle size, mineralogy, associated pesticides and degradates, organic carbon, nitrogen, and other characteristics using the analytical procedures discussed below.

Water Analyses

Groundwater samples were analyzed for a suite of pesticides, pesticide degradates, total and dissolved organic carbon, nutrients, metals, and major ions at three USGS laboratories.

Dissolved Pesticides and Pesticide Degradates

Groundwater samples were analyzed for a suite of pesticides and pesticide degradates at three USGS laboratories. All samples were filtered using 0.7-µm glass-fiber filters (GF/F) (Whatman, Piscataway, New Jersey) to remove suspended material into a 125-milliliter (mL) or 1-L baked amber glass bottle and shipped overnight at 4 °C to each laboratory. Concentrations of certain pesticides were measured at multiple laboratories utilizing different methods with varying sensitivities and detection limits.

U.S. Geological Survey Organic Chemistry Laboratory

The USGS Organic Chemistry Laboratory in Sacramento, California, analyzed filtered water samples for a suite of 66 pesticides by extracting 1 L of sample water onto Oasis hydrophilic-lipophilic-balanced (HLB) solid-phase extraction (SPE) cartridges (6 cubic centimeters (cm^3), 500 milligrams (mg), 60 µm) (Waters Corporation, Milford, Massachusetts). Samples were held no longer than 48 hours at 4 °C prior to extraction. All samples were spiked with $^{13}C_3$-atrazine and diazinon diethyl-d_{10} (Cambridge Isotopes, Andover, Massachusetts) as recovery surrogates. After the samples were extracted, the SPE cartridges were dried, eluted with 12 mL of ethyl acetate, and reduced under nitrogen. Approximately 1 gram (g) of sodium sulfate (Na_2SO_4) was added to the sample bottles to remove any residual water; and the bottles were rinsed three times with dichloromethane (DCM). The bottle rinses were reduced to 1 mL and combined with the ethyl acetate fraction. The entire sample (bottle rinse plus SPE elution) was reduced to a final volume of 200 microliters (µL) for analysis. Deuterated polycyclic aromatic hydrocarbon (PAH) compounds were used as internal standards and included acenaphthene-d_{10} and pyrene-d_{10}. All sample extracts were analyzed by gas chromatography—ion trap mass spectrometry (GC-ITMS). Method detection limits (MDLs) for all compounds measured ranged from 1 to 12 nanograms per liter (ng/L). Additional details are given in Hladik and others (2008).

Organic Geochemistry Research Laboratory

The USGS Kansas Water Science Center Organic Geochemistry Research Laboratory in Lawrence, Kansas, analyzed water samples (two 125-mL sample bottles) for 6 acetanilide, 6 triazine, and 3 phenylurea herbicides; 26 acetanilides and

12 triazine herbicide degradates; glyphosate and 2 glyphosate degradates; chlorothalonil and 3 chlorothalonil degradates; and ethylenethiourea (ETU), an organometallic fungicide degradate. Samples for determination of acetanilide herbicides and acetanilide degradates were analyzed using an on-line solid-phase extraction (OLSPE) liquid chromatography/mass spectrometry (LC/MS) with electrospray ionizations (ESI) and positive- and negative-ion switching modified from the USGS-approved method of Lee and Strahan (2003). Samples were analyzed for triazine and phenylurea herbicides and triazine degradates using the off-line SPE LC/MS atmospheric pressure chemical ionization (APCI) positive-ion USGS-approved method of Lee and others (2002). The limit of quantitation (LOQ) for all compounds measured using these methods ranged from 0.02 to 0.2 micrograms per liter (µg/L).

Samples were analyzed for chlorothalonil and chlorothalonil degradates using the off-line SPE LC/MS APCI negative-ion method outlined in Scribner and others (2006). These samples were stored for 513 to 618 days in the dark at 4 °C prior to analysis. A holding-time study was conducted to ensure the stability of the chlorothalonil degradates during prolonged storage. Six sets of samples composed of three separate aliquots of nine different groundwater samples were individually spiked at 2,000 mg/L with 4-hydroxy chlorothalonil, 2,3,6-trichloro-5-cyano-4-hydroxybenzamide (amide of 4-hydroxy chlorothalonil), or 2,4,5,6-tetrachloroisophthalamide (diamide of chlorothalonil) and were stored in the dark at 4 °C. No degradation of any of these compounds was observed within 1,130 days (the age of the oldest samples in the holding-time study). The LOQs for chlorothalonil and the chlorothalonil degradates were 0.02 and 0.05 µg/L, respectively.

Water samples (125 mL) were analyzed for glufosinate, glyphosate, and the major degradate of glyphosate, aminomethylphosphonic acid (AMPA). Filtered water samples were stored at 4 ºC and derivatized within 5 days after collection using a 5-percent borate buffer to adjust the pH to 9.0, after which a 2.5-millimolar (mM) solution of 9-fluorenylmethylchloroformate in acetonitrile was added. Derivatization was carried out in the dark in a water bath at 40 °C for approximately 24 hours. Following derivatization, the samples were extracted onto SPE cartridges and the SPE cartridges were rinsed with 500 microliters (µL) of DI water. All sample extracts for determination of glufosinate, glyphosate, and AMPA were analyzed by liquid chromatography-tandem mass spectrometry (LC-MS/MS) with ESI in negative-ion mode using multiple reaction monitoring (MRM). The LOQs for glufosinate, glyphosate, and AMPA in surface water were 0.02 µg/L. Complete details of the method are described in Meyer and others (2009).

Water samples (125 mL) were analyzed for ETU by direct aqueous sample injection LC-MS/MS with ESI in positive-ion mode using MRM. One-milliliter sample aliquots were amended with 10 µL of a 0.01-nanogram-per-microliter (ng/µL) solution of simetone. One hundred microliters of each amended sample was injected and separated using a liquid chromatograph (LC) gradient with 5 mM ammonia acetate (aqueous) and acetonitrile, mobile phases A and B, respectively. The estimated LOQ using a peak height-to-background signal to noise ratio of at least 7 to 1 was 0.03 µg/L.

U.S. Geological Survey National Water Quality Laboratory

The USGS National Water Quality Laboratory (NWQL) in Denver, Colorado, analyzed filtered water samples (1 L) for a suite of 84 pesticides and pesticide degradates (NWQL Laboratory Schedule 2033) by C-18 SPE and gas chromatography-mass spectrometry (GC-MS) using approved methods originally developed by Zaugg and others (1995), which subsequently have been modified to include additional compounds and reduce detection limits (Lindley and others, 1996; Madsen and others, 2003; Sandstrom and others, 2001). Additionally, seven fungicides were isolated from 1-L water samples into a 0.5-g octadecyl-bonded silica SPE column and eluted with 2 mL of ethyl acetate. After solvent evaporation and exchange to toluene, the extract was analyzed by gas chromatography, with selected ion-monitoring mass spectrometry (Battaglin and others, 2011). The laboratory reporting level (LRL) (Childress and others, 1999) for NWQL pesticide analyses ranged from 0.004 to 0.12 µg/L (Battaglin and others, 2011).

Organic Carbon

Whole-water samples for total organic carbon (TOC) analysis (NWQL Laboratory Code 3211) were collected directly into 125-mL baked amber glass bottles. Water samples analyzed for dissolved organic carbon (DOC) (NWQL Laboratory Code 2612) and ultraviolet-light- (UV) absorbing compound at 254 and 280 nanometers (nm) (NWQL Laboratory Codes 2616 and 2617, respectively) analyses were filtered using a 0.45-µm tortuous-path capsule filter. Filtered-water samples for DOC analysis were acidified to a pH of less than 2 using 4.5-normal (N) sulfuric acid (H_2SO_4). All water samples were chilled to 4 °C and shipped overnight to the NWQL.

The NWQL analyzed whole and filtered water samples for organic carbon using several different methods. TOC analysis was conducted using a USGS-approved high-temperature combustion method with a LRL of 0.23 milligrams per liter (mg/L) (Wershaw and others, 1987). DOC analysis was conducted using a USGS-approved, UV-promoted persulfate oxidation and infrared spectrometry method with a LRL of 0.23 mg/L (Brenton and Arnett, 1993). UV absorption at 254 and 280 nm were determined using the USGS-approved American Public Health Association Standard Method 5910B, with a long-term method detection limit (LTMDL) of 0.005 units per centimeter (u/cm) (American Public Health Association, 1995).

Nutrients

Whole and filtered water samples were collected and analyzed for a suite of nutrients (NWQL Laboratory Schedule

1865). Whole-water samples for determination of total phosphorus and total nitrogen (NWQL Laboratory Codes 2333 and 2756, respectively) were collected directly into 125-mL clear polyethylene bottles. Water samples for determination of dissolved ammonia, nitrite, nitrate plus nitrite, total nitrogen, orthophosphate, and total phosphorous (NWQL Laboratory Codes 3116, 3117, 3157, 2754, 2331, and 3118, respectively) were filtered using a 0.45-µm tortuous-path capsule filter into 125-mL brown polyethylene bottles. Whole-water samples were acidified to a pH of less than 2 using 4.5-N H_2SO_4. All water samples were chilled to 4 °C and shipped overnight to the NWQL.

The NWQL analyzed water samples for nutrients using several different methods. Dissolved orthophosphate, ammonia, nitrite plus nitrate, and nitrite analyses of filtered water samples were conducted using USGS-approved colorimetric methods with LTMDLs of 0.004 and 0.01 and MDLs of 0.001 and 0.01 mg/L, respectively (Fishman, 1993). Total nitrogen (the sum of nitrate, nitrite, organic nitrogen, and ammonia) analyses of whole and filtered water samples were conducted using a USGS-approved alkaline persulfate digestion method with a LTMDL of 0.05 mg/L (Patton and Kryskalla, 2003). Total phosphorous analyses of whole and filtered water samples were conducted using a USGS-approved USEPA standard semiautomated colorimetric method with LTMDLs of 0.003 and 0.004 mg/L, respectively (O'Dell, 1993).

Metals and Major Ions

Whole and filtered water samples were collected and analyzed for pH, acid-neutralizing capacity (ANC), SC, and a suite of metals and major ions (NWQL Laboratory Schedule 1 and Laboratory Code 657) using USGS-approved methods (Fishman, 1993). Whole-water samples for determination of pH, ANC, and SC (NWQL Laboratory Codes 70, 68, and 69, respectively) were collected directly into 250-mL clear polyethylene bottles. Water samples for determination of dissolved cations (calcium, copper, iron, magnesium, manganese, potassium, silica, and sodium) and anions (chloride, fluoride, and sulfate) were filtered using a 0.45-µm tortuous-path capsule filter into 1-L acid-rinsed clear polyethylene bottles. Water samples for cation analysis were acidified to a pH of less than 2 using 7.5-N nitric acid (HNO_3). All water samples were chilled to 4 °C and shipped overnight to the NWQL. The MDLs for cation and anion measurements ranged from 0.16 to 90 µg/L (Fishman, 1993).

Sediment Analyses

Sediment samples were analyzed for a suite of pesticides as well as physical and chemical properties at USGS and university laboratories as described below.

Physical Characteristics and Mineralogy

Sediment cores were described and the moisture content, mineralogy, and grain size of selected subsamples were determined. Paired cores (roughly 1 ft apart) were collected from each site. Sediment samples (approximately 100 g) were collected every 0.25 ft along the length of one set of cores and placed into clear glass jars with polytetrafluorethylene-lined lids to prevent moisture loss. Moisture content was determined gravimetrically by comparing wet and dry weights (Reilly and Baehr, 2006). After the moisture content of the samples was determined, subsamples were shipped to a USGS laboratory in Menlo Park, California, where particle-size distribution was determined by optical diffraction using a Beckman Coulter LS-230 (Brea, California) particle-size analyzer. The particle-size analyzer uses a laser to scatter light through a sample suspended in filtered tap water (Gee and Or, 2002). As the sample is circulated through a transparent cell, the diffraction pattern from the laser is measured by a series of detectors. A mathematical algorithm in which particles are assumed to be spherically shaped (Fraunhofer diffraction model) is used to convert the diffraction pattern into particle sizes.

Previously frozen, selected sediment cores were visually examined to determine color, composition, texture, and sedimentary structures (where evident). Cores were defrosted overnight and the acrylic core liners were cut open to expose the cores. Sediment coloration was determined by comparison to a soil color book with Munsell notations (Munsell Soil Color Charts, 2000). Sediment texture (grain size and shape), composition, and sedimentary structures (where evident) were described and recorded.

Quantitative whole-rock mineralogy was performed on bulk samples to measure the weight percentage of the minerals present, including clay minerals. For whole-rock mineralogy, x-ray diffraction (XRD) data were collected on randomly oriented powdered samples using Cu Kα radiation; scans were from 5° to 65° 2θ, using scanning parameters of 0.02 steps and a 10-second count time per step. Mineralogic quantification from the whole-rock XRD results was conducted using the automated technique developed by Eberl (2003). This technique is a combination of (1) the matrix flushing technique of Chung (1974) using an internal standard or analysis using quartz as the internal standard; (2) the whole-pattern fitting routine of Smith and others (1987), with the exception that key parts of the pattern that contain the 060 reflections for clay minerals may also be fitted separately; and (3) the methods of Srodon and others (2001) for sample preparation and the method of measuring clay-mineral content from nonbasal reflections.

After preliminary petrologic and mineralogic analysis, it was determined that the dominant mineral (quartz) was inhibiting quantification of trace phases present as grain coatings. Trace phases present in the material coating quartz crystals, identified by scanning electron microscopy and energy dispersive spectroscopy (SEM-EDAX) analysis, needed to be concentrated to facilitate their quantification by means of XRD. Samples were sieved in an automatic sieve shaker for 120 minutes (2 60-minute (min) intervals). The sieving was used to separate grain coatings attached to quartz crystals without changing the properties of possibly hydrated mineral phases. Material collected from the < 53-µm fraction was prepared according to Eberl (2003). Using a standardless analysis modified to accommodate small sample volumes allowed quantitative determination of mineralogy while maintaining random mineral orientation. The < 53-µm material was ground in methanol and slurry mounts were prepared on zero-background silica slides with Vertrel® XF specialty fluid. Synthetic mineral mixtures were created to validate this modification. Material collected from the 53-to-150-µm size fraction was prepared according to Eberl (2003).

Clay mineralogy was confirmed by XRD using oriented mounts of the < 2-µm fraction of the sediment; the sample preparation used in this study followed the methods of Drever (1973) and Pollastro (1982). The clay mounts were x-rayed before treatment (air drying), from 2° to 40° 2θ at a scan rate of 10 seconds (s) per count and a step size of 0.02° 2θ per step. The mount was then placed over a reservoir of ethylene glycol in a covered container and held in an oven overnight at 60 °C; the glycolated sample was then x-rayed across the same 2θ interval and using the same scanning parameters as those used for the untreated mount. The clay mount was then heated for at least 1 hour at various temperatures (100, 200, 300, 400, and 550 °C) and x-rayed after each temperature treatment. The untreated and treated diffractograms were interpreted by using multiple techniques described in Brown and Brindley (1980), Moore and Reynolds (1997), and Hillier and Ryan (2002).

Pesticides and Pesticide Degradates

Sediment samples were extracted for determination of 72 pesticides by using the methods described by Smalling and Kuivila (2008). Samples were stored frozen at -20 °C and held for no longer than 2 years prior to extraction. Prior to extraction, sediment samples were spiked with trifluralin-d_{10}, ring-^{13}C-*p,p'*-DDE, and phenoxy-^{13}C-*cis*-permethrin (Cambridge Isotopes, Andover, Massachusetts) as recovery surrogates. Wet sediments were homogenized with Na_2SO_4 using a solvent-rinsed mortar and pestle, and extracted by pressurized liquid extraction using a Dionex 200 (Sunnyvale, California) Accelerated Solvent Extractor (ASE). Samples were extracted three times with DCM at 100 ºC and 1,500 pounds per square inch (psi). Sample extracts were then dried over Na_2SO_4 and reduced to 0.5 mL using a Turbovap II (Zymark Corporation, Hopkins, Massachusetts) evaporation system. Sulfur was removed using a gel permeation chromotography/high performance liquid chromatography system (GPC/HPLC) with DCM as the carrier solvent. Samples were again reduced to 0.5 mL, split into two aliquots, and subjected to two different clean-up methods depending on compounds of interest.

The first clean-up method included all compounds except the 13 fungicides. Interfering matrix was removed by passing the sample extract through two stacked SPE cartridges, each containing 500 mg of nonporous, graphitized carbon (Restek Corporation, Bellefonte, Virginia) and 500 mg of alumina (Varian, Inc., Palo Alto, California). The cartridges were washed in tandem with 10 mL of DCM before the sample extract was added. Compounds of interest were eluted off both SPE cartridges with 10 mL of DCM and collected as Fraction 1 (F1). The carbon SPE was removed and the alumina SPE was eluted with 10 mL of ethyl acetate and DCM (50:50 volume per volume (v/v)) and collected as Fraction 2 (F2) (Smalling and others, 2005). Both fractions were evaporated separately under a gentle stream of purified nitrogen gas (N-evap, Organomation Associates, Berlin, Massachusetts) to 0.2 mL and the deuterated PAH internal standard mixture was added.

The second clean-up method was designed for the 13 fungicides. The interfering matrix was removed using a 200-mL glass column (400 millimeters (mm) long x 10 mm i.d.) dry packed with 6-percent water volume to weight (v/w) of deactivated Florisil (60-100 mesh chromatographic grade, Thermo-Fisher Scientific, Waltham, Massachusetts). The Florisil had been previously activated at 550 °C in a muffle furnace for 16 hours. The compounds of interest were eluted with 20 mL of 20-percent DCM in hexane followed by 100 mL of 60-percent ethyl acetate in hexane collected in the same flask. Following Florisil clean-up and fractionation, both extracts were reduced to about 0.2 mL under a gentle steam of N_2 and exchanged to ethyl acetate. Deuterated PAH internal standards were added prior to GC-ITMS analysis. MDLs for all compounds measured ranged from 0.6 to 8.9 micrograms per kilogram (µg/kg) sediment dry weight. Additional details of the method are described in Smalling and Kuivila (2008).

Chlorothalonil and Degradates

Sediment samples were extracted for determination of chlorothalonil and three chlorothalonil degradates: 4-hydroxy chlorothalonil, 2,3,6-trichloro-5-cyano-4-hydroxybenzamide (amide of 4-hydroxy chlorothalonil), and 2,4,5,6-tetrachloroisophthalamide (diamide of chlorothalonil) according to the procedure outlined in Hladik and Kuivila (2008). Samples were stored frozen at -20 °C and held for 43 to 46 months prior to extraction. Ten grams (dry weight) of sediment was extracted with acetone using sonication. Matrix interferences were removed from the extract using an Oasis HLB extraction cartridge. The final extract was reduced to 200 µL in acetonitrile and analyzed by liquid chromatography tandem mass spectrometry (LC-MS/MS) with the following procedures.

Aliquots of the sample extracts (10 µL) are injected and the compounds separated on an Agilent (Palo Alto, California) 1100 high pressure liquid chromatograph coupled to a 6430 tandem mass spectrometer (MS) system with a Zorbax Eclipse XDB-C18 column (2.1 mm × 150 mm × 3.5 µm; Agilent).

The column flow rate is 0.6 mL/min and the column temperature is 30 ºC. The mobile phases are acetonitrile (A channel) and 5 mM ammonium acetate in water (B channel). The gradient is 5 percent:95 percent (A:B) from 0 to 2 min; a 2- to 6-min increase to 90 percent:10 percent (A:B), hold for 3 min (10 mins total); a 9- to 10-min decrease to 5 percent:95 percent (A:B), hold for 3 min (13 mins total). Tandem MS conditions are APCI negative mode; drying gas temperature, 300 ºC; drying gas flow, 6 L/min; capillary voltage, 3,500 V; nebulizer pressure, 60 psi; Corona current, 20 microamps. Data are collected in the MRM and selected ion scan (MS2) modes; details of the MRM parameters are shown in table 8. Limits of detection are 2 nanograms per gram (ng/g) for 4-hydroxy chlorothalonil and the amide of 4-hydroxy chlorothalonil and 5 ng/g for the diamide of chlorothalonil.

Organic Carbon and Total Nitrogen

Sediments were analyzed for organic carbon and total nitrogen content by combustion and thermal conductivity using a Perkin Elmer CHNS/O elemental analyzer (Perkin Elmer Corporation, Waltham, Massachusetts) according to a modified version of USEPA Method 440.0 (Zimmerman and others, 2007). Dry, homogenized sediments were combusted at 925 °C in silver boats after being exposed to concentrated hydrochloric acid (HCl) fumes in a desiccator for 24 hours to remove inorganic carbon. Before analysis, sediments were dried at 100 °C for 3 hours. Acetanilide was used for instrument calibration. The instrument was calibrated using blanks and standards prior to sample analysis. Standards were required to be within 98 percent of the nominal value. Blanks, replicates, and standards were analyzed every 10 samples to assess instrument stability. Replicate samples were rerun if the relative percent difference (RPD) between the two was greater than 20 percent. MDLs for carbon and nitrogen were 0.01 percent.

pH, Electrical Conductivity, Nutrients, and Inorganic Ions

Sediment pH, electrical conductivity (EC), and concentrations of total carbon and nitrogen, nitrate, ammonium, water-extractable chloride and sulfate, total sulfur, and selected extractable cations were measured at the North Carolina State University Soil Testing Laboratory (NCSU-STL) in Raleigh. Triplicate samples were prepared for pH measurement by mixing sediments with an equal mass of DI water, stirring for 1 min, then allowing the slurry to equilibrate (with occasional stirring) for 1 hour. After pH measurements were made using a pH meter and electrode, an equivalent volume (equal to the volume of DI water) of 0.02 molar (M) calcium chloride ($CaCl_2$) was added to the same beaker and a second pH measurement was made. The pH meter and probe were calibrated using buffer solutions with pHs of 4, 7, and 10. Calibration was verified once for every 10 samples by measuring the pH of a known solution. Additional details of the method are described in Burt (2004).

Triplicate samples were prepared for EC measurement by creating a 1:2 mixture of sediment and DI water. The resulting suspension was stirred for 1 min and allowed to equilibrate for 10 min prior to measuring with the EC meter using an EC electrode. The EC electrode was rinsed 10 times with DI water between successive samples. Additional details of the method are described in Thomas (1996).

Triplicate samples were prepared for total carbon and nitrogen measurements by drying at 110 °C and were ground to < 250 µm. Ground sediment samples were weighed (24–27 mg) into tin capsules and analyzed using a Perkin Elmer Series II CHNS/O analyzer. Control soils were analyzed after every 22 soil samples to evaluate instrument performance. The LOQ for both measurements is 0.02 grams per kilogram (g/kg). Additional details of the method are described in Nelson and Sommers (1996).

Triplicate samples for nitrate and ammonium measurements were extracted by creating a 1:10 mixture of sediment and 1-M potassium chloride (KCl) in polycarbonate centrifuge tubes. The resulting suspension was allowed to equilibrate for 1 hour, centrifuged, and filtered. Filtrates were analyzed colorimetrically on a QuickChem 8000 Automated Ion Analyzer (Lachat Instruments, Milwaukee, Wisconsin) at 520 nm ammonium as nitrogen (NH_4-N) and 620 nm nitrate as nitrogen (NO_3-N). The LOQ for both measurements is 0.1 milligrams per kilogram (mg/kg). Additional details of the method are described in Mulvaney (1996).

Triplicate samples for measurement of water-soluble chloride and sulfate were prepared by weighing 2 g of sediment into 50-mL polycarbonate tubes and adding 20 mL of DI water. Suspensions were shaken for 1 hour to equilibrate, then centrifuged at 15,000 rotations per minute (rpm) for 15 min and filtered through a 0.45-µm filter. Filtrate was analyzed by ion chromatography. The LOQs for water-soluble chloride and sulfate are 2 and 1 mg/kg, respectively. Additional details of the method are described in Frankenberger and others (1996).

Triplicate samples for measurement of total sulfur were prepared by weighing 2 g of sediment into 50-mL polycarbonate tubes. Then, 20 mL of calcium monophosphate solution (500 mg/L of phosphorous) was added to each tube and shaken for 1 hour, centrifuged at 15,000 rpm for 15 min, and filtered through a 0.45-µm filter. Filtrate was analyzed using a Perkin Elmer 2000 inductively coupled plasma-optical emission spectrometer (ICP-OES). Additional details of the method are described in Tabatabai (1996).

Triplicate samples for measurement of extractable calcium, magnesium, sodium, potassium, and aluminum were prepared by extracting 5 g of sediment five times sequentially with 30 mL of 0.2-M NH_4Cl (ammonium chloride) in glass volumetric flasks. The suspensions were shaken for 5 min on a reciprocal floor shaker at 120 cycles per minute. An aliquot of extract solution was removed from each flask and diluted 10 times. Calcium, magnesium, sodium, and potassium concentrations were determined using a Perkin Elmer 3100 Atomic Absorption Spectrometer (AAS). Aluminum concentrations were determined using a Perkin Elmer 2000 ICP-OES. The LOQ for this method ranged from 9.5 to 52 mg/kg. Effective cation exchange capacities of sediments were calculated by converting the measured concentrations to milliequivalents and accounting for the sample mass. Additional details of the method are described in Sumner and Miller (1996).

Three different extraction methods were used to determine the phosphorus content of sediments. All analyses were conducted in triplicate. Using a method modified from Amacher (1996), 20 mL of Mehlich III extracting solution was added to 2-g sediment samples. The suspensions were shaken on a reciprocal floor shaker at 180 cycles per minute for 5 min, then filtered through a 0.45-µm membrane filter. For the second extraction method, 2 g of soil was shaken with 20 mL of 1-N HCl for 24 h, then filtered through a 0.45-µm filter. The LOQ for this method is 2.0 mg/kg.

Quality Assurance/Quality Control

Water- and sediment-quality measurements were validated against a comprehensive set of performance-based quality-assurance/quality-control (QA/QC) criteria. Laboratory blanks, field blanks, source solution blanks, replicates, and surrogate recovery were analyzed. All environmental and QA/QC data were reviewed by project staff, and, unless otherwise noted in the following section, results for the target constituents analyzed under the same conditions were of acceptable quality.

Table 8. Analysis parameters for chlorothalonil and selected degradates by liquid chromatography tandem mass spectrometry.

[m/z, mass to charge ratio; V, volts; min, minutes; NA, not applicable]

Compound	Precursor ion (m/z)	Quantitation ion (m/z)	Qualitative ion (m/z)	Fragmentor (V)	Quantitation ion collision energy (V)	Qualitative ion collision energy (V)	Retention time (min)
Multiple-Reaction-Monitoring (MRM) mode							
4-Hydroxy chlorothalonil	245	175	182	143	24	24	6.3
2,3,6-Trichloro-5-cyano-4-hydroxybenzamide (amide of 4 hydroxy chlorothalonil)	263	220	184	138	12	12	1.5
Selected ion scan (MS2) mode							
2,4,5,6-Tetrachloroisophthalamide (diamide of chlorothalonil)	281	281	283	101	NA	NA	5.6
Chlorothalonil	245	246	245	140	NA	NA	7.8
Chloroxynil (surrogate)	186	186	NA	111	NA	NA	5.3

Occurrence of Pesticides in Groundwater and Sediment

Groundwater

Groundwater samples from 14 temporary wells were analyzed for pesticides, pesticide degradates, total and dissolved organic carbon, nutrients, metals, and major ions at three USGS laboratories.

Dissolved Pesticides

Groundwater samples from 14 temporary wells were analyzed for a suite of pesticides and pesticide degradates at the USGS Organic Chemistry Laboratory in Sacramento, California; the USGS Organic Geochemistry Research Laboratory in Lawrence, Kansas; and the USGS National Water Quality Laboratory in Denver, Colorado.

U.S. Geological Survey Organic Chemistry Laboratory

Groundwater samples from 12 temporary wells at the RAREC were analyzed for 66 currently used pesticides, including 10 fungicides, at the USGS Organic Chemistry Laboratory in Sacramento, California. Eight pesticides were detected (table 9, at end of report). Pesticide concentrations ranged from less than the instrumental limit of detection (LOD) to 1,670 ng/L (for metolachlor). At least one currently used pesticide was detected in each water sample. The maximum number of pesticides detected in a single water sample using these methods was three. The most frequently detected compounds and their detection frequencies were metolachlor, in 33 percent; simazine, in 33 percent; tetraconazole, in 33 percent; and chlorothalonil, in 25 percent of the samples. Alachlor, myclobutanil, pendimethalin, and propiconazole were each detected once during this study.

Organic Geochemistry Research Laboratory

Groundwater samples from 14 temporary wells at the RAREC were analyzed for 59 currently used pesticides and pesticide degradates at the Organic Geochemistry Research Laboratory. Twenty-eight pesticides or pesticide degradates were detected (tables 10 and 11, at end of report). Concentrations ranged from less than the instrumental LOD to 9.87 µg/L (for metolachlor oxanilic acid). At least one currently used pesticide or pesticide degradate was detected in all but two groundwater samples. The maximum number of pesticides or pesticide degrades detected in a single water sample using these methods was 22. The most frequently detected compounds and their detection frequencies were alachlor sulfonic acid, in 79 percent; 1-amide-4-hydroxy-chorothalonil, in 64 percent; metolachlor oxanilic acid, in 64 percent; and metolachlor sulfonic acid, in 64 percent of the samples. 2-Chloro-N-(2,6-diethylphenyl) acetamide, acetochlor, cyanazine acid, cyanazine amide, dechloroalachlor, dechlorometolachlor, deethylcyanazine acid, diuron, hydroxyalachlor, hydroxymetolachlor, and hydroxysimazine were each detected once during this study.

U.S. Geological Survey National Water Quality Laboratory

Groundwater samples collected from 14 temporary wells at the RAREC were analyzed for 77 currently used pesticides at NWQL. Twelve pesticides or pesticide degradates were detected (table 12, at end of report). Concentrations ranged from less than the instrumental LOD to 2.07 µg/L (for metolachlor). At least one currently used pesticide was detected in all but three water samples. The maximum number of pesticides detected in a single water sample using this method was nine. The most frequently detected compounds and their detection frequencies were metalaxyl, in 50 percent; simazine, in 50 percent; atrazine, in 36 percent; metolachlor, in 36 percent; and metribuzin, in 15 percent of the samples. 3,4-Dichloroaniline, acetochlor, alachlor, benfluralin, cyanazine, malathion, and myclobutanil were each detected once during this study.

Organic Carbon and Ultraviolet-Light-Absorbing Compounds

Groundwater samples from 14 temporary wells on the RAREC were analyzed for TOC, DOC, and dissolved UV-absorbing compounds at 254 and 280 nm at the NWQL (table 13, at end of report). Concentrations of TOC and DOC in environmental samples ranged from 0.4 to 4.1 and 0.55 to 5.06 mg/L, respectively. Dissolved organic carbon was detected in a field (equipment) blank at a concentration of 0.55 mg/L and was not detected in the accompanying source-water solution blank. Concentrations of UV-absorbing compounds at 254 and 280 nm ranged from 0.005 to 0.024 and 0.005 to 0.016 absorbance u/cm, respectively.

Field Water-Quality Parameters

Water-quality parameters (pH, SC, dissolved-oxygen concentration, and air and water temperature) were measured prior to sample collection at 14 temporary wells at the RAREC. Results of these analyses are shown in table 14 (at end of report).

Nutrients

Groundwater samples from 14 temporary wells at the RAREC were analyzed for a suite of total and dissolved nutrients at the NWQL. Results of analyses for total phosphorus, total nitrogen, dissolved ammonia, dissolved nitrite, the sum of dissolved nitrate and dissolved nitrite, total nitrogen, dissolved orthophosphate, and total phosphorous are shown in table 15 (at end of report). Dissolved orthophosphate was detected in a source-water solution blank at an estimated concentration of 0.003 mg/L as phosphorus.

Metals and Major Ions

Groundwater samples from 14 temporary wells at the RAREC were analyzed for a suite of dissolved metals and major ions at the NWQL. Results of these analyses are shown in table 16 (at end of report). Calcium was detected in a source solution blank at an estimated concentration of 0.011 mg/L, but was not detected in the field blank.

Sediments

Sediment samples from cores collected from seven plots at the RAREC were described and analyzed for moisture content, whole-rock and grain-coating mineralogy, grain size, pesticides, pesticide degradates, organic carbon, total nitrogen, pH, electrical conductivity (EC), nutrients, inorganic ions at three laboratories.

Physical Characteristics and Mineralogy

Sediment cores collected from seven plots at the RAREC were described and the moisture content, mineralogy, and grain size of selected subsamples of those cores were determined. The sediment color, texture, and stratigraphy of selected cores are described in table 17 (at end of report). Results of determination of whole-rock and grain-coating mineralogy are listed in tables 18 and 19 (at end of report). Results of particle-size distribution analyses are listed in table 20 (at end of report).

Pesticides and Pesticide Degradates

Twenty-five sediment samples from seven continuous cores colocated with sampled temporary wells at the RAREC were analyzed for 72 currently used pesticides and pesticide degradates, including 13 fungicides, at the USGS Organic Chemistry Laboratory in Sacramento, California. Eleven pesticides or pesticide degradates were detected (table 21, at end of report). Pesticide concentrations ranged from less than the instrumental LOD to 34.2 ng/g (for azoxystrobin). The maximum number of pesticides detected in a single sediment sample was six. The most frequently detected compounds and their detection frequencies were *p p′*-DDE, in 33 percent; chlorothalonil, in 24 percent; *p p′*-DDT, in 16 percent; trifluralin, in 16 percent; and, azoxystrobin, in 12 percent of the samples. Boscalid, fipronil sulfide, *p p′*-DDD, pendimethalin, and tebuconazole were each detected in less than 10 percent of sediment samples.

Fourteen sediment samples from seven continuous cores colocated with sampled temporary wells at the RAREC were analyzed for three degradates of chlorothalonil. Each of the chlorothalonil degradates was detected in at least two of the sediment samples (table 21, at end of report). Chlorothalonil degradate concentrations ranged from 3.4 (4-hydroxy chlorothalonil) to 30.3 ng/g (amide of 4-hydroxy chlorothalonil). The maximum number of chlorothalonil degradates detected in a single sample was three. The detection frequencies were diamide of chlorothalonil, in 64 percent, 4-hydroxy chlorothalonil, in 36 percent, and amide of 4-hydroxy chlorothalonil in 14 percent of the samples.

Organic Carbon and Total Nitrogen

The organic carbon and total nitrogen content of sediment samples collected during this study ranged from 0.04 to 0.8 percent and from 0.02 to 0.1 percent, respectively. Results of the analysis of sediment for organic carbon and nitrogen are shown in table 22 (at end of report).

pH, Electrical Conductivity, Nutrients, and Inorganic Ions

Sediment pH, EC, total carbon and nitrogen, nitrate, ammonium, water-extractable chloride and sulfate, total sulfur, and selected extractable cations were measured on triplicate sediment samples at the NCSU-STL. The averages of the results of these triplicate analyses are shown in table 23 (at end of report).

Summary

The U.S. Geological Survey, as part of its Toxic Substances Hydrology Program, investigated the presence of currently used pesticides and pesticide degradates (particularly fungicides) in groundwater and sediments underlying agricultural test plots. The composition and depositional and digenetic history of grain coatings present on Bridgeton Formation and weathered Coastal Plain formation sediments were evaluated to determine their role in the storage of organic and inorganic chemicals in the unsaturated and saturated zones.

Water and sediment samples were collected from June through October 2007 from seven plots at the Rutgers Agricultural Research and Extension Center in Upper Deerfield, New Jersey, and analyzed for a suite of pesticides (including fungicides) and other physical and chemical parameters by the U.S. Geological Survey. Plots were selected for inclusion in this study on the basis of the crops grown and the pesticides used. A total of 41 pesticides were detected in 14 water samples, including 5 fungicides, 13 herbicides, 1 insecticide, and 22 pesticide degradates. The following pesticides and pesticide degradates were detected in 50 percent or more of the groundwater samples: alachlor sulfonic acid, 1-amide-4-hydroxy-chorothalonil, metolachlor oxanilic acid, metolachlor sulfonic acid, metalaxyl, and simazine. Dissolved pesticide concentrations ranged from below their instrumental limit of detection to 36 micrograms per liter (for metolachlor sulfonic acid, a degradate of the herbicide metolachlor). The total number of pesticides found in groundwater samples ranged from 0 to 29. A total of 13 pesticides were detected in sediment samples from continuous cores collected within each of the 7 sampled plots, including 4 fungicides, 2 herbicides and 7 pesticide degradates. Pesticide concentrations in sediment samples ranged from below their instrumental limit of detection to 34.2 nanograms per gram (for azoxystrobin). The total number of pesticides found in sediment samples ranged from 0 to 8. Concentrations of total and dissolved organic carbon, nutrients, metals, and major ions; water-quality field parameters for water samples; and concentrations of sediment-associated organic carbon, nitrogen, nutrients, and ions are also documented.

Physical characteristics of sediments (core descriptions, mineralogy, and grain size) were determined. After preliminary petrologic and mineralogic analysis, it was determined that the dominant mineral (quartz) was inhibiting quantification of trace phases present as grain coatings. Trace phases present in the material coating quartz crystals, identified by scanning electron microscopy and energy dispersive spectroscopy (SEM-EDAX) analysis, needed to be concentrated to facilitate their quantification by means of XRD. Grain coatings were removed to allow quantification of trace minerals present.

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Table 9. Concentrations of dissolved pesticides measured in groundwater samples collected from temporary wells at the Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey, by the U.S. Geological Survey Organic Chemistry Laboratory, Sacramento, California, 2007.

[Numbers in brackets are USGS National Water Information System (NWIS) parameter codes. Values are in nanograms per liter. Results in parentheses ( ) are below method detection limits and are estimates. The following compounds were analyzed for but were not detected in any samples: 3,4-DCA; allethrin; atrazine; bifenthrin; butylate; carbaryl; carbofuran; chlorpyrifos; cycloate; cyfluthrin; cyhalothrin; cypermethrin; DCPA; deltamethrin; diazinon; disulfoton; EPTC; esfenvalerate; ethalfluralin; fenpropathrin; fipronil; fipronil desulfinyl; fipronil sulfide; fipronil sulfone; hexazinone; iprodione; malathion; metconazole; methidathion; methoprene; methylparathion; molinate; napropamide; oxyfluorfen; *p,p′*-DDD; *p,p′*-DDE; *p,p′*-DDT; PCA; PCNB; pebulate; permethrin; phenothrin; phosmet; piperonyl butoxide; prometryn; propanil; pyraclostrobin; resmethrin; τ-fluvalinate; tebuconazole; tefluthrin; terbuthylazine; tetramethrin; thiobencarb; trifloxystrobin; triflualin. USGS, U.S. Geological Survey; mm/dd/yyyy, month/day/year; hh:mm, hours minutes; nd, not detected]

USGS station number	USGS station name	Sample type	Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Alachlor [65064]	Chlorothalonil [65071]	Metolachlor [65091]	Myclobutanil [66633]	Pendimethalin [65098]	Propiconazole [66643]	Simazine [65105]	Tetraconazole [66654]
393135075115601	111564—RUFARM02-Shallow	Environmental	07/05/2007	16:20	nd	nd	1,230	nd	nd	nd	nd	nd
393135075115602	111565—RUFARM02-Deep	Environmental	07/05/2007	13:30	nd	nd	5.4	nd	nd	nd	nd	nd
393139075120101	111566—RUFARM03-Shallow	Environmental	07/26/2007	12:20	nd	nd	nd	nd	nd	nd	413	nd
393139075120102	111567—RUFARM03-Deep	Environmental	07/26/2007	15:00	nd	nd	nd	nd	nd	nd	564	nd
393126075115601	111568—RUFARM04-Shallow	Environmental	08/01/2007	15:25	nd	nd	3.7	nd	nd	nd	8.8	nd
393126075115601	111568—RUFARM04-Shallow	Replicate	08/01/2007	15:40	nd	nd	3.9	nd	nd	nd	8.0	nd
393126075115602	111569—RUFARM04-Deep	Environmental	08/01/2007	13:30	1,160	nd	1,670	nd	nd	(0.7)	nd	nd
393126075115602	111569—RUFARM04-Deep	Field blank	08/01/2007	10:40	nd	nd	nd	nd	nd	nd	nd	nd
393126075115602	111569—RUFARM04-Deep	Source blank	08/01/2007	16:00	nd	nd	nd	nd	nd	nd	nd	nd
393134075115101	111577—RUFARM05-Shallow	Environmental	09/06/2007	13:40	nd	nd	nd	nd	nd	nd	nd	(1.5)
393134075115102	111578—RUFARM05-Deep	Environmental	09/06/2007	12:00	nd	(2.2)	nd	nd	(0.6)	nd	16.4	(0.6)
393141075115501	111579—RUFARM06-Shallow	Environmental	09/13/2007	14:30	nd	nd	nd	nd	nd	nd	nd	(8)
393141075115502	111580—RUFARM06-Deep	Environmental	09/13/2007	12:00	nd	nd	nd	nd	nd	nd	nd	(1.6)
393112075121201	111581—RUFARM07-Shallow	Environmental	10/03/2007	15:00	nd	29.7	nd	(6.8)	nd	nd	nd	nd
393112075121202	111582—RUFARM07-Deep	Environmental	10/03/2007	14:00	nd	(1.5)	nd	nd	nd	nd	nd	nd

Table 10. Concentrations of dissolved glyphosate and selected degradates of glyphosate and chlorothalonil measured in groundwater samples collected from temporary wells at the Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey, by the U.S. Geological Survey Organic Geochemistry Research Laboratory, Lawrence, Kansas, 2007.

[Numbers in brackets are USGS National Water Information System (NWIS) parameter codes. Values are in micrograms per liter. USGS, U.S. Geological Survey; mm/dd/yyyy, month/day/year; hh:mm, hours minutes; nd, not detected]

USGS station number	USGS station name	Sample type	Sample date (mm/dd/yyyy)	Sample time (hh:mm)	1-Amide-4-hydroxy-chorothalonil	4-Hydroxy-chlorothalonil	Aminomethyl-phosphonic acid [62649]	Glufosinate [62721]	Glyphosate [62721]
393100075121301	111562—RUFARM01-Shallow	Environmental	06/20/2007	14:30	nd	nd	nd	nd	nd
393100075121302	111563—RUFARM01-Deep	Environmental	06/20/2007	16:45	nd	nd	nd	nd	nd
393135075115601	111564—RUFARM02-Shallow	Environmental	07/05/2007	16:20	1.2	nd	nd	nd	nd
393135075115602	111565—RUFARM02-Deep	Environmental	07/05/2007	13:30	2	nd	0.06	nd	nd
393139075120101	111566—RUFARM03-Shallow	Environmental	07/26/2007	15:00	0.3	nd	nd	nd	nd
393139075120102	111567—RUFARM03-Deep	Environmental	07/26/2007	12:20	0.2	nd	nd	nd	nd
393126075115601	111568—RUFARM04-Shallow	Environmental	08/01/2007	15:25	1	0.05	nd	nd	nd
393126075115601	111568—RUFARM04-Shallow	Replicate	08/01/2007	15:40	2.6	0.08	nd	nd	nd
393126075115602	111569—RUFARM04-Deep	Environmental	08/01/2007	13:30	3.2	0.57	nd	nd	nd
393126075115602	111569—RUFARM04-Deep	Field blank	08/01/2007	10:40	nd	nd	nd	nd	nd
393126075115602	111569—RUFARM04-Deep	Source blank	08/01/2007	16:00	nd	nd	nd	nd	nd
393134075115101	111577—RUFARM05-Shallow	Environmental	09/06/2007	13:40	nd	nd	nd	nd	nd
393134075115102	111578—RUFARM05-Deep	Environmental	09/06/2007	12:00	0.2	nd	nd	nd	nd
393141075115501	111579—RUFARM06-Shallow	Environmental	09/13/2007	14:30	0.5	nd	0.03	nd	nd
393141075115502	111580—RUFARM06-Deep	Environmental	09/13/2007	12:00	0.5	nd	nd	nd	nd
393112075121201	111581—RUFARM07-Shallow	Environmental	10/03/2007	15:00	nd	nd	nd	nd	nd
393112075121202	111582—RUFARM07-Deep	Environmental	10/03/2007	14:00	nd	nd	nd	nd	nd

Table 11. Concentrations of selected dissolved acetamide, phenylurea, and triazine herbicides and degradates measured in groundwater samples collected from temporary wells at the Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey, by the U.S. Geological Survey Organic Geochemistry Research Laboratory, Lawrence, Kansas, 2007.

[Numbers in brackets are USGS National Water Information System (NWIS) parameter codes. Values are in micrograms per liter. The following compounds were analyzed for but were not detected in any samples: 2-chloro-4-isopropylamino-6-amino-s-triazine; 2-chloro-N-(2-ethyl-6-methylphenyl)acetamide; 2-hydroxy-4-isopropylamino-6-amino-s-triazine; 2-hydroxy-4-isopropylamino-6-ethylamino-s-triazine; 2-hydroxy-6-ethylamino-4-amino-s-triazine; acetochlor oxanilic acid; acetochlor sulfynilacetic acid; alachlor sulfynilacetic acid; atrazine; bromacil; cyanazine; dechloroacetochlor; dechlorodimethenamid; deethylcyanazine amide; deethylcyanazine; demethyl fluometuron; dimethenamid oxanilic acid; dimethenamid sulfonic acid; dimethenamid; flufenacet oxanilic acid; flufenacet sulfonic acid; flufenacet; fluometuron; hydroxyacetochlor; hydroxydimethenamid; linuron; prometon; propachlor; propachlor oxanilic acid; propachlor sulfonic acid; propazine. USGS, U.S. Geological Survey; mm/dd/yyyy, month/day/year; hh:mm, hours minutes; nd, not detected]

USGS station number	USGS station name	Sample type	Sample date (mm/dd/yyyy)	Sample time (hh:mm)	2-[(2-Ethyl-6-methyl-phenyl)amino]-2-oxoethanesulfonic acid [62850]	2-Chloro-6-ethyl-amino-4-amino-s-triazine [04038]	Acetochlor sulfonic acid [61029]	Acetochlor [49260]
393100075121301	111562—RUFARM01-Shallow	Environmental	06/20/2007	14:35	nd	nd	nd	nd
393100075121302	111563—RUFARM01-Deep	Environmental	06/20/2007	16:50	nd	nd	nd	nd
393135075115601	111564—RUFARM02-Shallow	Environmental	07/05/2007	16:25	4.7	nd	nd	nd
393135075115602	111565—RUFARM02-Deep	Environmental	07/05/2007	13:35	0.07	0.03	nd	nd
393139075120101	111566—RUFARM03-Shallow	Environmental	07/26/2007	15:05	0.21	0.29	0.38	nd
393139075120102	111567—RUFARM03-Deep	Environmental	07/26/2007	12:25	0.28	0.39	0.54	nd
393126075115601	111568—RUFARM04-Shallow	Environmental	08/01/2007	15:30	0.1	nd	nd	nd
393126075115601	111568—RUFARM04-Shallow	Replicate	08/01/2007	15:45	0.09	nd	nd	nd
393126075115602	111569—RUFARM04-Deep	Environmental	08/01/2007	13:35	0.05	0.05	nd	0.04
393126075115602	111569—RUFARM04-Deep	Field blank	08/01/2007	10:50	nd	nd	nd	nd
393126075115602	111569—RUFARM04-Deep	Source blank	08/01/2007	16:01	nd	nd	nd	nd
393134075115101	111577—RUFARM05-Shallow	Environmental	09/06/2007	13:45	nd	nd	nd	nd
393134075115102	111578—RUFARM05-Deep	Environmental	09/06/2007	12:05	nd	0.05	nd	nd
393141075115501	111579—RUFARM06-Shallow	Environmental	09/13/2007	14:35	nd	nd	nd	nd
393141075115502	111580—RUFARM06-Deep	Environmental	09/13/2007	12:05	0.06	0.03	nd	nd
393112075121201	111581—RUFARM07-Shallow	Environmental	10/03/2007	15:05	nd	nd	nd	nd
393112075121202	111582—RUFARM07-Deep	Environmental	10/03/2007	14:05	0.09	nd	nd	nd

Table 11. Concentrations of selected dissolved acetamide, phenylurea, and triazine herbicides and degradates measured in groundwater samples collected from temporary wells at the Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey, by the U.S. Geological Survey Organic Geochemistry Research Laboratory, Lawrence, Kansas, 2007.—Continued

[Numbers in brackets are USGS National Water Information System (NWIS) parameter codes. Values are in micrograms per liter. The following compounds were analyzed for but were not detected in any samples: 2-chloro-4-isopropylamino-6-amino-s-triazine; 2-chloro-N-(2-ethyl-6-methylphenyl)acetamide; 2-hydroxy-4-isopropylamino-6-amino-s-triazine; 2-hydroxy-4-isopropylamino-6-ethylamino-s-triazine; 2-hydroxy-6-ethylamino-4-amino-s-triazine; acetochlor oxanilic acid; acetochlor sulfynilacetic acid; alachlor sulfynilacetic acid; atrazine; bromacil; cyanazine; dechloroacetochlor; dechlorodimethenamid; deethylcyanazine amide; deethylcyanazine; demethyl fluometuron; dimethenamid oxanilic acid; dimethenamid sulfonic acid; dimethenamid; flufenacet oxanilic acid; flufenacet sulfonic acid; flufenacet; fluometuron; hydroxyacetochlor; hydroxydimethenamid; linuron; prometon; propachlor; propachlor oxanilic acid; propachlor sulfonic acid; propazine. USGS, U.S. Geological Survey; mm/dd/yyyy, month/day/year; hh:mm, hours minutes; nd, not detected]

USGS station number	USGS station name	Alachlor oxanilic acid [61031]	Alachlor sulfonic acid [50009]	Alachlor [46342]	Chloro-diamino-s-triazine [04039]	Cyanazine acid [61745]	Cyanazine amide [61709]	Dechloro-alachlor [63777]
393100075121301	111562—RUFARM01-Shallow	nd	nd	nd	nd	nd	nd	nd
393100075121302	111563—RUFARM01-Deep	0.03	0.02	nd	nd	nd	nd	nd
393135075115601	111564—RUFARM02-Shallow	nd	0.06	nd	nd	nd	nd	nd
393135075115602	111565—RUFARM02-Deep	nd	0.25	nd	0.03	nd	nd	nd
393139075120101	111566—RUFARM03-Shallow	nd	0.04	nd	0.19	nd	nd	nd
393139075120102	111567—RUFARM03-Deep	nd	0.11	nd	0.23	nd	nd	nd
393126075115601	111568—RUFARM04-Shallow	nd	0.03	0.03	nd	nd	nd	nd
393126075115601	111568—RUFARM04-Shallow	nd	0.03	nd	nd	nd	nd	nd
393126075115602	111569—RUFARM04-Deep	0.46	1.1	1.1	0.04	1.2	0.25	0.14
393126075115602	111569—RUFARM04-Deep	nd	nd	nd	nd	nd	nd	nd
393126075115602	111569—RUFARM04-Deep	nd	0.02	nd	nd	nd	nd	nd
393134075115101	111577—RUFARM05-Shallow	nd	0.03	nd	nd	nd	nd	nd
393134075115102	111578—RUFARM05-Deep	nd	0.21	nd	0.06	nd	nd	nd
393141075115501	111579—RUFARM06-Shallow	nd	0.03	nd	nd	nd	nd	nd
393141075115502	111580—RUFARM06-Deep	nd	0.09	nd	0.06	nd	nd	nd
393112075121201	111581—RUFARM07-Shallow	nd	nd	nd	nd	nd	nd	nd
393112075121202	111582—RUFARM07-Deep	nd	0.03	nd	nd	nd	nd	nd

Table 11. Concentrations of selected dissolved acetamide, phenylurea, and triazine herbicides and degradates measured in groundwater samples collected from temporary wells at the Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey, by the U.S. Geological Survey Organic Geochemistry Research Laboratory, Lawrence, Kansas, 2007.—Continued

[Numbers in brackets are USGS National Water Information System (NWIS) parameter codes. Values are in micrograms per liter. The following compounds were analyzed for but were not detected in any samples: 2-chloro-4-isopropylamino-6-amino-s-triazine; 2-chloro-N-(2-ethyl-6-methylphenyl)acetamide; 2-hydroxy-4-isopropylamino-6-amino-s-triazine; 2-hydroxy-4-isopropylamino-6-ethylamino-s-triazine; 2-hydroxy-6-ethylamino-4-amino-s-triazine; acetochlor oxanilic acid; acetochlor sulfynilacetic acid; alachlor sulfynilacetic acid; atrazine; bromacil; cyanazine; dechloroacetochlor; dechlorodimethenamid; deethylcyanazine amide; deethylcyanazine; demethyl fluometuron; dimethenamid oxanilic acid; dimethenamid sulfonic acid; dimethenamid; flufenacet oxanilic acid; flufenacet sulfonic acid; flufenacet; fluometuron; hydroxyacetochlor; hydroxydimethenamid; linuron; prometon; propachlor; propachlor oxanilic acid; propachlor sulfonic acid; propazine. USGS, U.S. Geological Survey; mm/dd/yyyy, month/day/year; hh:mm, hours minutes; nd, not detected]

USGS station number	USGS station name	Dechloro-metolachlor [63780]	Deethyl-cyanazine acid [61750]	Diuron [50374]	Hydroxy-alachlor [63783]	Hydroxy-metolachlor [63785]	Hydroxy-simazine [63154]	Metolachlor oxanilic acid [61044]
393100075121301	111562—RUFARM01-Shallow	nd	nd	nd	nd	nd	nd	nd
393100075121302	111563—RUFARM01-Deep	nd	nd	nd	nd	nd	nd	nd
393135075115601	111564—RUFARM02-Shallow	nd	nd	nd	nd	nd	nd	9.9
393135075115602	111565—RUFARM02-Deep	nd	nd	nd	nd	nd	nd	1.1
393139075120101	111566—RUFARM03-Shallow	nd	nd	nd	nd	nd	nd	2.7
393139075120102	111567—RUFARM03-Deep	nd	nd	nd	nd	nd	nd	3.1
393126075115601	111568—RUFARM04-Shallow	nd	nd	nd	nd	nd	nd	0.4
393126075115601	111568—RUFARM04-Shallow	nd	nd	nd	nd	nd	nd	0.37
393126075115602	111569—RUFARM04-Deep	0.03	0.04	0.6	0.04	0.03	nd	0.4
393126075115602	111569—RUFARM04-Deep	nd	nd	nd	nd	nd	nd	nd
393126075115602	111569—RUFARM04-Deep	nd	nd	nd	nd	nd	nd	nd
393134075115101	111577—RUFARM05-Shallow	nd	nd	nd	nd	nd	nd	nd
393134075115102	111578—RUFARM05-Deep	nd	nd	nd	nd	nd	nd	0.04
393141075115501	111579—RUFARM06-Shallow	nd	nd	nd	nd	nd	nd	0.02
393141075115502	111580—RUFARM06-Deep	nd	nd	nd	nd	nd	0.03	0.02
393112075121201	111581—RUFARM07-Shallow	nd	nd	nd	nd	nd	nd	nd
393112075121202	111582—RUFARM07-Deep	nd	nd	nd	nd	nd	nd	nd

Table 11. Concentrations of selected dissolved acetamide, phenylurea, and triazine herbicides and degradates measured in groundwater samples collected from temporary wells at the Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey, by the U.S. Geological Survey Organic Geochemistry Research Laboratory, Lawrence, Kansas, 2007.—Continued

[Numbers in brackets are USGS National Water Information System (NWIS) parameter codes. Values are in micrograms per liter. The following compounds were analyzed for but were not detected in any samples: 2-chloro-4-isopropylamino-6-amino-s-triazine; 2-chloro-N-(2-ethyl-6-methylphenyl)acetamide; 2-hydroxy-4-isopropylamino-6-amino-s-triazine; 2-hydroxy-4-isopropylamino-6-ethylamino-s-triazine; 2-hydroxy-6-ethylamino-4-amino-s-triazine; acetochlor oxanilic acid; acetochlor sulfynilacetic acid; alachlor sulfynilacetic acid; atrazine; bromacil; cyanazine; dechloroacetochlor; dechlorodimethenamid; deethylcyanazine amide; deethylcyanazine; demethyl fluometuron; dimethenamid oxanilic acid; dimethenamid sulfonic acid; dimethenamid; flufenacet oxanilic acid; flufenacet sulfonic acid; flufenacet; fluometuron; hydroxyacetochlor; hydroxydimethenamid; linuron; prometon; propachlor; propachlor oxanilic acid; propachlor sulfonic acid; propazine. USGS, U.S. Geological Survey; mm/dd/yyyy, month/day/year; hh:mm, hours minutes; nd, not detected]

USGS station number	USGS station name	Metolachlor sulfonic acid [61043]	Metolachlor [39415]	sec-Alachlor sulfonic acid [62849]	Simazine [04035]	2-Chloro-N-(2,6-diethylphenyl) acetamide [63781]
393100075121301	111562—RUFARM01-Shallow	nd	nd	nd	nd	nd
393100075121302	111563—RUFARM01-Deep	nd	nd	nd	nd	nd
393135075115601	111564—RUFARM02-Shallow	36	1.6	nd	0.03	nd
393135075115602	111565—RUFARM02-Deep	1.7	nd	nd	0.03	nd
393139075120101	111566—RUFARM03-Shallow	5.3	0.02	nd	0.34	nd
393139075120102	111567—RUFARM03-Deep	5.6	nd	nd	0.4	nd
393126075115601	111568—RUFARM04-Shallow	3.1	0.04	0.06	0.03	nd
393126075115601	111568—RUFARM04-Shallow	3	0.03	0.06	0.03	nd
393126075115602	111569—RUFARM04-Deep	0.77	1.3	0.06	nd	0.03
393126075115602	111569—RUFARM04-Deep	nd	nd	nd	nd	nd
393126075115602	111569—RUFARM04-Deep	nd	nd	nd	nd	nd
393134075115101	111577—RUFARM05-Shallow	nd	nd	nd	nd	nd
393134075115102	111578—RUFARM05-Deep	0.55	nd	nd	0.03	nd
393141075115501	111579—RUFARM06-Shallow	0.36	nd	nd	nd	nd
393141075115502	111580—RUFARM06-Deep	1.3	nd	nd	nd	nd
393112075121201	111581—RUFARM07-Shallow	nd	nd	nd	nd	nd
393112075121202	111582—RUFARM07-Deep	nd	nd	nd	nd	nd

Table 12. Concentrations of selected dissolved pesticides and degradates measured in groundwater samples collected from temporary wells at the Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey, by the U.S. Geological Survey National Water Quality Laboratory, Denver, Colorado, 2007.

[Numbers in brackets are USGS National Water Information System (NWIS) parameter codes. Results in parentheses ( ) are below method detection limits and are estimates. Values are in micrograms per liter. The following compounds were analyzed for but were not detected in any samples: 2-ethyl-6-methylaniline; 3,5-dichloroaniline; 4-chloro-2-methylphenol; alpha-endosulfan; azinphos-methyl oxygen analog; azinphos-methyl; carbaryl; carbofuran; chlorpyrifos oxygen analog; chlorpyrifos; cis-permethrin; cis-propiconazole; cyfluthrin; cypermethrin; DCPA; desulfinylfipronil amide; desulfinylfipronil; diazinon; dichlorvos; dicrotophos; dieldrin; dimethoate; disulfoton sulfone; disulfoton; endosulfan sulfate; EPTC; ethion monoxon; ethion; ethoprop; fenamiphos sulfone; fenamiphos sulfoxide; fenamiphos; fipronil sulfide; fipronil sulfone; fipronil; fonofos; hexazinone; iprodione; isofenphos; lambda-cyhalothrin; malaoxon; methidathion; methyl paraoxon; methyl parathion; molinate; oxyfluorfen; pendimethalin; phorate oxygen analog; phorate; phosmet oxygen analog; phosmet; prometon; prometryn; propanil; propargite; propyzamide; tebuthiuron; tefluthrin; terbufos oxygen analog sulfone; terbufos; terbuthylazine; thiobencarb; trans-propiconazole; tribuphos; trifluralin. USGS; U.S. Geological Survey; mm/dd/yyyy, month/day/year; hh:mm, hours:minutes; nd, not detected]

USGS station number	USGS station name	Sample type	Sample date (mm/dd/yyyy)	Sample time (hh:mm)	3,4-Dichloro-aniline [61625]	Acetochlor [49260]	Alachlor [46342]	Atrazine [39632]	Benfluralin [82673]
393100075121301	111562—RUFARM01-Shallow	Environmental	06/20/2007	14:30	nd	nd	nd	nd	nd
393100075121302	111563—RUFARM01-Deep	Environmental	06/20/2007	16:45	nd	nd	nd	nd	nd
393135075115601	111564—RUFARM02-Shallow	Environmental	07/05/2007	16:20	nd	nd	nd	nd	nd
393135075115602	111565—RUFARM02-Deep	Environmental	07/05/2007	13:30	nd	nd	nd	(0.005)	nd
393139075120101	111566—RUFARM03-Shallow	Environmental	07/26/2007	15:00	nd	nd	nd	nd	nd
393139075120102	111567—RUFARM03-Deep	Environmental	07/26/2007	12:20	nd	nd	nd	nd	nd
393126075115601	111568—RUFARM04-Shallow	Environmental	08/01/2007	15:25	nd	nd	nd	(0.007)	nd
393126075115601	111568—RUFARM04-Shallow	Replicate	08/01/2007	15:40	nd	nd	nd	(0.007)	nd
393126075115602	111569—RUFARM04-Deep	Environmental	08/01/2007	13:30	(0.022)	(0.006)	1.64	0.025	nd
393126075115602	111569—RUFARM04-Deep	Field blank	08/01/2007	10:40	nd	nd	nd	nd	nd
393126075115602	111569—RUFARM04-Deep	Source blank	08/01/2007	16:00	nd	nd	nd	nd	nd
393134075115101	111577—RUFARM05-Shallow	Environmental	09/06/2007	13:40	nd	nd	nd	nd	nd
393134075115102	111578—RUFARM05-Deep	Environmental	09/06/2007	12:00	nd	nd	nd	(0.005)	nd
393141075115501	111579—RUFARM06-Shallow	Environmental	09/13/2007	14:30	nd	nd	nd	nd	nd
393141075115502	111580—RUFARM06-Deep	Environmental	09/13/2007	12:00	nd	nd	nd	(0.007)	(0.007)
393112075121201	111581—RUFARM07-Shallow	Environmental	10/03/2007	15:00	nd	nd	nd	nd	nd
393112075121202	111582—RUFARM07-Deep	Environmental	10/03/2007	14:00	nd	nd	nd	nd	nd

Table 12. Concentrations of selected dissolved pesticides and degradates measured in groundwater samples collected from temporary wells at the Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey, by the U.S. Geological Survey National Water Quality Laboratory, Denver, Colorado, 2007.—Continued

[Numbers in brackets are USGS National Water Information System (NWIS) parameter codes. Results in parentheses ( ) are below method detection limits and are estimates. Values are in micrograms per liter. The following compounds were analyzed for but were not detected in any samples: 2-ethyl-6-methylaniline; 3,5-dichloroaniline; 4-chloro-2-methylphenol; alpha-endosulfan; azinphos-methyl oxygen analog; azinphos-methyl; carbaryl; carbofuran; chlorpyrifos oxygen analog; chlorpyrifos; cis-permethrin; cis-propiconazole; cyfluthrin; cypermethrin; DCPA; desulfinylfipronil amide; desulfinylfipronil; diazinon; dichlorvos; dicrotophos; dieldrin; dimethoate; disulfoton sulfone; disulfoton; endosulfan sulfate; EPTC; ethion monoxon; ethion; ethoprop; fenamiphos sulfone; fenamiphos sulfoxide; fenamiphos; fipronil sulfide; fipronil sulfone; fipronil; fonofos; hexazinone; iprodione; isofenphos; lambda-cyhalothrin; malaoxon; methidathion; methyl paraoxon; methyl parathion; molinate; oxyfluorfen; pendimethalin; phorate oxygen analog; phorate; phosmet oxygen analog; phosmet; prometon; prometryn; propanil; propargite; propyzamide; tebuthiuron; tefluthrin; terbufos oxygen analog sulfone; terbufos; terbuthylazine; thiobencarb; trans-propiconazole; tribuphos; trifluralin. USGS; U.S. Geological Survey; mm/dd/yyyy, month/day/year; hh:mm, hours:minutes; nd, not detected]

USGS station number	USGS station name	Cyanazine [04041]	Malathion [39532]	Metalaxyl [61596]	Metolachlor [39415]	Metribuzin [82630]	Myclobutanil [61599]	Simazine [04035]
393100075121301	111562—RUFARM01-Shallow	nd	nd	nd	nd	nd	nd	nd
393100075121302	111563—RUFARM01-Deep	nd	nd	nd	0.017	nd	nd	(0.007)
393135075115601	111564—RUFARM02-Shallow	nd	nd	nd	2.1	nd	nd	nd
393135075115602	111565—RUFARM02-Deep	nd	nd	0.009	0.009	nd	nd	(0.005)
393139075120101	111566—RUFARM03-Shallow	nd	nd	0.42	nd	0.69	nd	0.30
393139075120102	111567—RUFARM03-Deep	nd	(0.009)	0.012	nd	nd	nd	0.44
393126075115601	111568—RUFARM04-Shallow	nd	nd	(0.008)	(0.006)	nd	nd	0.015
393126075115601	111568—RUFARM04-Shallow	nd	nd	(0.008)	(0.007)	nd	nd	0.015
393126075115602	111569—RUFARM04-Deep	0.026	nd	0.15	2.0	0.90	nd	0.011
393126075115602	111569—RUFARM04-Deep	nd	nd	nd	nd	nd	nd	nd
393126075115602	111569—RUFARM04-Deep	nd	nd	nd	nd	nd	nd	nd
393134075115101	111577—RUFARM05-Shallow	nd	nd	nd	nd	nd	nd	nd
393134075115102	111578—RUFARM05-Deep	nd	nd	(0.006)	nd	nd	nd	0.011
393141075115501	111579—RUFARM06-Shallow	nd	nd	nd	nd	nd	nd	nd
393141075115502	111580—RUFARM06-Deep	nd	nd	0.081	nd	nd	nd	nd
393112075121201	111581—RUFARM07-Shallow	nd	nd	nd	nd	nd	0.014	nd
393112075121202	111582—RUFARM07-Deep	nd	nd	nd	nd	nd	nd	nd

Table 13. Ultraviolet light absorbance and concentrations of total and dissolved organic carbon measured in groundwater samples collected from temporary wells at the Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey, by the U.S. Geological Survey National Water Quality Laboratory, Denver, Colorado, 2007.

[Numbers in brackets are USGS National Water Information System (NWIS) parameter codes. Values are in milligrams per liter unless otherwise noted. USGS, U.S. Geological Survey; mm/dd/yyyy, month/day/year; hh:mm, hours:minutes; nm, nanometers; nd, not detected]

USGS station number	USGS station name	Sample type	Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Absorbance, 254 nm, filtered, absorbance (units per centimeter) [50624]	Absorbance, 280 nm, filtered, absorbance (units per centimeter) [61726]	Dissolved organic carbon [00681]	Total organic carbon [00680]
393100075121301	111562—RUFARM01-Shallow	Environmental	06/20/2007	14:30	0.01	0.007	2.6	2.6
393100075121302	111563—RUFARM01-Deep	Environmental	06/20/2007	16:45	0.011	0.008	2.4	1.2
393135075115601	111564—RUFARM02-Shallow	Environmental	07/05/2007	16:20	0.012	0.009	3.5	2.2
393135075115602	111565—RUFARM02-Deep	Environmental	07/05/2007	13:30	0.01	0.007	2.6	3.6
393139075120101	111566—RUFARM03-Shallow	Environmental	07/26/2007	15:00	0.013	0.01	0.83	0.8
393139075120102	111567—RUFARM03-Deep	Environmental	07/26/2007	12:20	0.013	0.011	0.76	0.9
393126075115601	111568—RUFARM04-Shallow	Environmental	08/01/2007	15:25	0.014	0.011	2.6	4.1
393126075115601	111568—RUFARM04-Shallow	Replicate	08/01/2007	15:40	0.013	0.01	2.3	2.9
393126075115602	111569—RUFARM04-Deep	Environmental	08/01/2007	13:30	0.012	0.009	2.1	3.3
393126075115602	111569—RUFARM04-Deep	Field Blank	08/01/2007	10:40	nd	nd	0.55	nd
393126075115602	111569—RUFARM04-Deep	Source Blank	08/01/2007	16:01	nd	nd	nd	nd
393134075115101	111577—RUFARM05-Shallow	Environmental	09/06/2007	13:40	0.009	0.007	0.7	0.9
393134075115102	111578—RUFARM05-Deep	Environmental	09/06/2007	12:00	0.005	0.005	0.65	1
393141075115501	111579—RUFARM06-Shallow	Environmental	09/13/2007	14:30	0.011	0.009	1.2	2.1
393141075115502	111580—RUFARM06-Deep	Environmental	09/13/2007	12:00	0.012	0.009	0.76	0.4
393112075121201	111581—RUFARM07-Shallow	Environmental	10/03/2007	15:00	0.024	0.016	1.7	1.6
393112075121202	111582—RUFARM07-Deep	Environmental	10/03/2007	14:00	0.01	0.007	5.1	2

Table 14. Water-quality parameters measured in whole-water groundwater samples collected from temporary wells at the Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey, 2007.

[Numbers in brackets are USGS National Water Information System (NWIS) parameter codes. USGS, U.S. Geological Survey; mm/dd/yyyy, month/day/year; hh:mm, hours:minutes; °C, degrees Celsius; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; --, no data]

USGS station number	USGS station name	Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Air temperature (°C) [00020]	Dissolved-oxygen concentration (mg/L) [00300]	pH (standard units) [00400]	Specific conductance (µS/cm) [00095]	Water temperature (°C) [00010]
393100075121301	111562—RUFARM01-Shallow	06/20/2007	14:30	27	--	5.0	122	--
393100075121302	111563—RUFARM01-Deep	06/20/2007	16:45	27.5	--	4.9	315	--
393135075115601	111564—RUFARM02-Shallow	07/05/2007	16:20	32	8.9	4.5	247	16.8
393135075115602	111565—RUFARM02-Deep	07/05/2007	13:30	32	10	5.6	215	16.6
393139075120101	111566—RUFARM03-Shallow	07/26/2007	15:00	23	8.8	4.5	155	16.6
393139075120102	111567—RUFARM03-Deep	07/26/2007	12:20	23	8.4	4.5	137	15.9
393126075115601	111568—RUFARM04-Shallow	08/01/2007	15:25	--	8.6	5.2	178	19.2
393126075115602	111569—RUFARM04-Deep	08/01/2007	13:30	32	8.8	4.2	187	16.2
393134075115101	111577—RUFARM05-Shallow	09/06/2007	13:40	31	7.7	4.7	145	21
393134075115102	111578—RUFARM05-Deep	09/06/2007	12:00	29	7.7	4.9	118	18.5
393141075115501	111579—RUFARM06-Shallow	09/13/2007	14:30	25.5	7.9	4.7	236	19
393141075115502	111580—RUFARM06-Deep	09/13/2007	12:00	25	8.8	4.3	289	16.9
393112075121201	111581—RUFARM07-Shallow	10/03/2007	15:00	26	--	4.2	117	--
393112075121202	111582—RUFARM07-Deep	10/03/2007	14:00	26	--	4.1	165	17.9

Table 15. Nutrient concentrations measured in groundwater samples collected from temporary wells at the Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey, 2007.

[Numbers in brackets are USGS National Water Information System (NWIS) parameter codes. USGS, U.S. Geological Survey; mm/dd/yyyy, month/day/year; hh:mm, hours:minutes; nd, not detected; mg/L, milligrams per liter; mg/L N, milligrams per liter as nitrogen; mg/L P, milligrams per liter as phosphorus; E, estimated or having a higher degree of uncertainty; nd, not detected; --, no data]

USGS station number	USGS station name	Sample type	Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Ammonia, filtered (mg/L N) [00608]	Nitrate plus nitrite, filtered (mg/L N) [00631]	Nitrate, filtered (mg/L N) [00618]	Nitrite, filtered (mg/L N) [00613]	Organic nitrogen, filtered (mg/L) [00607]	Organic nitrogen, unfiltered (mg/L) [00605]
393100075121301	111562—RUFARM01-Shallow	Environmental	06/20/2007	14:30	E0.011	1.1	1.10	nd	E0.08	E0.02
393100075121302	111563—RUFARM01-Deep	Environmental	06/20/2007	16:45	E0.013	1.4	1.39	nd	E0.09	E0.03
393135075115601	111564—RUFARM02-Shallow	Environmental	07/05/2007	16:20	E0.011	15.7	E15.7	E0.002	E0.35	E0.83
393135075115602	111565—RUFARM02-Deep	Environmental	07/05/2007	13:30	nd	11.4	E11.4	E0.001	nd	nd
393139075120101	111566—RUFARM03-Shallow	Environmental	07/26/2007	15:00	nd	9.6	9.61	nd	nd	--
393139075120102	111567—RUFARM03-Deep	Environmental	07/26/2007	12:20	E0.013	8.8	8.83	nd	E0.39	E0.39
393126075115601	111568—RUFARM04-Shallow	Environmental	08/01/2007	15:25	E0.013	11.2	11.2	0.002	E1	E0.7
393126075115601	111568—RUFARM04-Shallow	Replicate	08/01/2007	15:40	E0.011	11.3	11.3	0.002	E1.2	--
393126075115602	111569—RUFARM04-Deep	Environmental	08/01/2007	13:30	0.039	8.9	E8.91	E0.002	0.66	0.41
393126075115602	111569—RUFARM04-Deep	Field blank	08/01/2007	10:40	nd	nd	nd	nd	nd	nd
393126075115602	111569—RUFARM04-Deep	Source blank	08/01/2007	16:01	nd	nd	nd	nd	nd	nd
393134075115101	111577—RUFARM05-Shallow	Environmental	09/06/2007	13:40	E0.012	8.6	8.57	0.003	E0.63	E0.06
393134075115102	111578—RUFARM05-Deep	Environmental	09/06/2007	12:00	nd	9.2	E9.2	E0.002	nd	nd
393141075115501	111579—RUFARM06-Shallow	Environmental	09/13/2007	14:30	0.035	18.5	18.5	0.013	1.1	--
393141075115502	111580—RUFARM06-Deep	Environmental	09/13/2007	12:00	E0.013	24.3	24.3	0.003	E1.3	E0.23
393112075121201	111581—RUFARM07-Shallow	Environmental	10/03/2007	15:00	0.036	0.035	0.035	nd	0.02	0.05
393112075121202	111582—RUFARM07-Deep	Environmental	10/03/2007	14:00	nd	0.054	0.054	nd	nd	nd

Table 15. Nutrient concentrations measured in groundwater samples collected from temporary wells at the Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey, 2007.—Continued

[Numbers in brackets are USGS National Water Information System (NWIS) parameter codes. USGS, U.S. Geological Survey; mm/dd/yyyy, month/day/year; hh:mm, hours:minutes; nd, not detected; mg/L, milligrams per liter; mg/L N, milligrams per liter as nitrogen; mg/L P, milligrams per liter as phosphorus; E, estimated or having a higher degree of uncertainty; nd, not detected; --, no data]

USGS station number	USGS station name	Orthophosphate, filtered (mg/L P) [00671]	Phosphorus, filtered (mg/L P) [00666]	Phosphorus, unfiltered (mg/L P) [00665]	Total nitrogen (nitrate + nitrite + ammonia + organic-N), filtered, analytically determined (mg/L) [62854]	Total nitrogen (nitrate + nitrite + ammonia + organic-N), unfiltered, analytically determined (mg/L) [62855]
393100075121301	111562—RUFARM01-Shallow	E0.004	nd	0.12	1.2	1.1
393100075121302	111563—RUFARM01-Deep	E0.004	nd	nd	1.5	1.4
393135075115601	111564—RUFARM02-Shallow	E0.003	nd	nd	16.1	16.6
393135075115602	111565—RUFARM02-Deep	nd	0.067	0.059	12.4	12.1
393139075120101	111566—RUFARM03-Shallow	E0.004	nd	nd	10	9.5
393139075120102	111567—RUFARM03-Deep	E0.005	nd	nd	9.2	9.2
393126075115601	111568—RUFARM04-Shallow	E0.003	nd	nd	12.3	11.9
393126075115601	111568—RUFARM04-Shallow	E0.003	nd	nd	12.5	11.1
393126075115602	111569—RUFARM04-Deep	E0.004	nd	nd	9.6	9.4
393126075115602	111569—RUFARM04-Deep	nd	nd	nd	nd	nd
393126075115602	111569—RUFARM04-Deep	E0.003	nd	nd	nd	nd
393134075115101	111577—RUFARM05-Shallow	E0.003	nd	nd	9.2	8.7
393134075115102	111578—RUFARM05-Deep	E0.005	nd	nd	9.8	9.3
393141075115501	111579—RUFARM06-Shallow	E0.003	nd	0.071	19.7	17.7
393141075115502	111580—RUFARM06-Deep	E0.005	nd	nd	25.7	24.6
393112075121201	111581—RUFARM07-Shallow	E0.004	nd	0.021	0.09	0.12
393112075121202	111582—RUFARM07-Deep	E0.004	nd	nd	0.08	0.09

Table 16. Concentrations of dissolved metals and major ions measured in groundwater samples collected from temporary wells at the Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey, 2007.

[Numbers in brackets are USGS National Water Information System (NWIS) parameter codes. USGS, U.S. Geological Survey, mm/dd/yyyy, month/day/year; hh:mm, hours:minutes; mg/L, milligrams per liter; mg/L SiO_2, milligrams per liter as silica; µg/L, micrograms per liter; nd, not detected; E, estimated or having a higher degree of uncertainty]

USGS station number	USGS station name	Sample type	Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Calcium (mg/L) [00915]	Magnesium (mg/L) [00925]	Potassium (mg/L) [00935]	Sodium (mg/L) [00930]	Silica (mg/L SiO_2) [00955]
393100075121301	111562—RUFARM01-Shallow	Environmental	06/20/2007	14:30	9.3	2.5	7.2	2.3	7.1
393100075121302	111563—RUFARM01-Deep	Environmental	06/20/2007	16:45	7.3	3.1	4	43.2	6.5
393135075115601	111564—RUFARM02-Shallow	Environmental	07/05/2007	16:20	22.4	8.7	0.56	1.6	5.1
393135075115602	111565—RUFARM02-Deep	Environmental	07/05/2007	13:30	22	6.5	1.5	1.6	4.2
393139075120101	111566—RUFARM03-Shallow	Environmental	07/26/2007	15:00	11.1	5.3	1.5	1.4	7.6
393139075120102	111567—RUFARM03-Deep	Environmental	07/26/2007	12:20	9.0	4.5	2.1	1.5	8.4
393126075115601	111568—RUFARM04-Shallow	Environmental	08/01/2007	15:25	15.9	6	5.1	1.1	2.6
393126075115601	111568—RUFARM04-Shallow	Replicate	08/01/2007	15:40	15.8	6.1	5.1	1.1	2.6
393126075115602	111569—RUFARM04-Deep	Environmental	08/01/2007	13:30	13.9	4.8	6.6	1.4	7.8
393126075115602	111569—RUFARM04-Deep	Field blank	08/01/2007	10:45	nd	nd	nd	nd	nd
393126075115602	111569—RUFARM04-Deep	Source blank	08/01/2007	16:00	E.011	nd	nd	nd	nd
393134075115101	111577—RUFARM05-Shallow	Environmental	09/06/2007	13:40	10.5	4.8	4.9	0.94	4.2
393134075115102	111578—RUFARM05-Deep	Environmental	09/06/2007	12:00	9.9	3.4	3.1	0.89	7.8
393141075115501	111579—RUFARM06-Shallow	Environmental	09/13/2007	14:30	26.4	5.3	0.99	1.86	6.8
393141075115502	111580—RUFARM06-Deep	Environmental	09/13/2007	12:00	28.6	7	1.9	3.6	6.2
393112075121201	111581—RUFARM07-Shallow	Environmental	10/03/2007	15:00	1.9	4.3	2.2	3.7	13
393112075121202	111582—RUFARM07-Deep	Environmental	10/03/2007	14:00	6	6.3	2.8	2.2	11.3

Table 16. Concentrations of dissolved metals and major ions measured in groundwater samples collected from temporary wells at the Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey, 2007.—Continued

[Numbers in brackets are USGS National Water Information System (NWIS) parameter codes. USGS, U.S. Geological Survey, mm/dd/yyyy, month/day/year; hh:mm, hours:minutes; mg/L, milligrams per liter; mg/L SiO_2, milligrams per liter as silica; µg/L, micrograms per liter; nd, not detected; E, estimated or having a higher degree of uncertainty]

USGS station number	USGS station name	Copper (µg/L) [01040]	Iron (µg/L) [01046]	Manganese (µg/L) [01056]	Chloride (mg/L) [00940]	Fluoride (mg/L) [00950]	Sulfate (mg/L) [00945]
393100075121301	111562—RUFARM01-Shallow	nd	232	22.7	1.8	nd	36.4
393100075121302	111563—RUFARM01-Deep	nd	240	28.6	72.7	nd	16.7
393135075115601	111564—RUFARM02-Shallow	nd	140	17.4	6.2	E.06	32.4
393135075115602	111565—RUFARM02-Deep	nd	440	36.6	4.7	nd	33.5
393139075120101	111566—RUFARM03-Shallow	nd	283	18.8	8.1	0.15	12.6
393139075120102	111567—RUFARM03-Deep	nd	290	19	8.5	0.17	5.94
393126075115601	111568—RUFARM04-Shallow	nd	126	6	6.4	nd	15.6
393126075115601	111568—RUFARM04-Shallow	nd	106	5.4	6.4	nd	15.6
393126075115602	111569—RUFARM04-Deep	E1.1	580	19.5	4.7	0.31	35.2
393126075115602	111569—RUFARM04-Deep	nd	nd	nd	nd	nd	nd
393126075115602	111569—RUFARM04-Deep	nd	nd	nd	nd	nd	nd
393134075115101	111577—RUFARM05-Shallow	nd	324	15.4	1.4	nd	22.4
393134075115102	111578—RUFARM05-Deep	nd	116	26.6	4.5	nd	2.5
393141075115501	111579—RUFARM06-Shallow	nd	554	31.5	4.6	E.09	25.4
393141075115502	111580—RUFARM06-Deep	nd	251	13.7	9.9	0.2	21.5
393112075121201	111581—RUFARM07-Shallow	nd	404	24.3	13.4	nd	20.9
393112075121202	111582—RUFARM07-Deep	nd	587	61	12.9	E.09	45.6

Table 17. Description, including Munsell Color Classification and sediment size description, of selected sediment cores collected from selected plots at the Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey, 2007.

[ft bls, feet below land surface; dd, decimal degrees; ( ), Munsell Color Classification (Munsell Soil Color Charts, 2000); <, less than; in., inches; ft, feet]

Core name	Latitude (dd)	Longitude (dd)	Interval (ft bls)	Description
RUFARM01	39.51658	-75.20352	0.00–0.60	Dark yellowish brown (10 YR 4/4) silty fine sand grading to yellowish brown silty fine sand (10 YR 5/4) with abundant plant fragments and rare coarse sand grains.
			0.60–0.80	Yellowish brown (10 YR 5/4) silty fine sand.
			0.80–1.20	Yellowish brown (10 YR 5/6) silty fine to medium sand with frequent coarse sand and fine gravel.
			9.10–9.45	Reddish yellow (7.5 YR 6/8), well-sorted, subrounded, medium quartz sand with few, rounded, coarse quartz sands, common fine sand mica and black, angular, fine sand grains. In addition to the previous, 19.15–19.45 ft bls contains poorly sorted, subangular, medium to coarse quartz sand with few kaolinite rip-out clasts.
			9.45–10.45	Yellow (10 YR 7/6), well-sorted, subrounded, medium quartz sand with common subrounded coarse quartz sand, common mica and angular, black fine sand grains. The interval from 9.75–9.92 ft bls is stained dark red.
			19.90–20.80	Strong brown (7.5 YR 5/8), poorly sorted, subrounded, medium quartz sand with frequent, subrounded, coarse quartz sand and common, subrounded, fine quartz gravel. Most grains coated with kaolinite and angular, fine black sand. Few rounded, fine gravel kaolinite rip-up clasts from 19.9–20.35 ft bls.
			24.90–25.80	Strong brown (7.5 YR 5/8), moderately sorted, medium, rounded quartz sand with occasional opaque grains.
			25.80–26.00	Strong brown (7.5 YR 5/8), poorly sorted, very coarse quartz sand with frequent fine quartz gravel.
			29.40–29.95	Yellow (10 YR 7/6), moderately sorted, coarse, subangular quartz sand and medium sand with occasional kaolinite coatings on grains. At 29.83 ft bls a very thin (<0.05 in.) lenticular deposit of fine angular black sand.
			29.95–31.10	Yellow (10 YR 8/6), moderately well-sorted, medium, subrounded quartz sand with frequent coarse, well-rounded quartz sand and frequent, very angular, fine black sand. Two 0.01-ft-thick layers of medium quartz sand with frequent coarse quartz sand with kaolinite coated grains at 30.06 ft bls and 30.57 ft bls. Three distinct very thin (<0.05 in.) lenticular deposits of fine angular black sand at 30.25 ft bls, 30.82 ft bls, and 30.86 ft bls.
RUFARM02	39.52648	-75.19873	0.00–0.85	Dark yellowish brown (10 YR 3/4), fine sandy silt with plant fragments from 0.0–0.55 ft bls.
			0.85–1.50	Dark yellowish brown (10 YR 4/6), slightly sandy silt with frequent well-rounded quartz gravels.
			9.10–9.45	Reddish yellow (7.5 YR 6/8), well-sorted, subrounded, medium quartz sand with few, rounded, coarse quartz sand, common fine mica sand and black, angular sand.
			9.45–10.45	Yellow (10 YR 7/6), well-sorted, subrounded medium quartz sand with common, subrounded, coarse sand, common fine mica sand and angular, fine black sand. The interval from 9.75–9.92 ft bls is stained dark red.
			11.80–12.17	Yellow (10 YR 7/6), poorly sorted, kaolinite-coated, subangular, medium quartz grains with frequent angular, fine black sand, common subrounded, coarse quartz sand, few subrounded medium feldspar sands and few, platy, medium mica sands.
			12.17–12.90	Very pale brown (10 YR 7/3), well-sorted, subrounded, medium quartz sand with common, angular, fine black sand. Some kaolinite coating of grains.
			15.80–17.60	Yellow (10 YR 7/6), kaolinite-coated, angular coarse quartz sand with frequent angular, fine black sand, common platy, coarse mica sand and few subangular, fine quartz gravel.

Table 17. Description, including Munsell Color Classification and sediment size description, of selected sediment cores collected from selected plots at the Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey, 2007.—Continued

[ft bls, feet below land surface; dd, decimal degrees; ( ), Munsell Color Classification (Munsell Soil Color Charts, 2000); <, less than; in., inches; ft, feet]

Core name	Latitude (dd)	Longitude (dd)	Interval (ft bls)	Description
RUFARM03	39.52753	-75.20022	0.00–0.65	Strong brown (7.5 YR 4/6), sandy silt with occasional coarse quartz sand.
			0.65–1.70	Yellowish red (5 YR 4/6), slightly sandy clay with occasional coarse, well-rounded quartz sand and gravel.
			19.80–21.00	Yellow (2.5 YR 7/6) well-sorted, subrounded, medium quartz sand with common black, angular fine sand.
			23.80–25.10	Light gray (10 YR 7/1), kaolinite-coated, subrounded, medium quartz sand with frequent black, angular fine sand, common black, subangular, medium sand, common platy, medium mica sand and few subangular, fine quartz gravel.
RUFARM04	39.52383	-75.19902	0.00–0.55	Dark yellowish brown (10 YR 4/4), slightly sandy silt. Plant fragments present from 0.0–0.25 ft bls. Few well-rounded, quartz coarse sand and gravel grains.
			0.55–1.25	Brown (10 YR 5/3) massive, moderately well-sorted, silty fine sand.
			5.40–6.85	Reddish yellow (7.5 YR 6/6) very silty, poorly sorted, angular to subrounded, medium to coarse quartz sand with common, kaolinite-coated, angular, fine quartz gravel associated with areas of common black, angular, fine sand. Well-sorted fine silty sand with few fine mica sands from 6.75–6.85 ft bls.
			9.50–9.85	Strong brown (7.5 YR 5/6) subangular, medium quartz sand with common black, angular, fine sand and few lenticular kaolinite laminations.
			9.85–10.07	Brownish yellow (10 YR 6/8), subrounded, fine quartz sand with common, 0.25-in-thick, well-sorted, subrounded, medium quartz sand crossbeds, common black, angular, fine sand and common platy fine mica sand.
			10.07–10.28	Reddish yellow (7.5 YR 6/8) interfingered, 0.05-in.-thick, lenticular silt layers with cross-beds of 0.025-in.-thick kaolinite layers and frequent platy, fine mica sand.
			10.28–10.63	Strong brown (7.5 YR 5/8) subrounded, medium quartz sand with few black, angular fine sands and rare platy, fine mica sand. A 0.35-in.-thick layer of kaolinite-coated, sub-angular to subrounded medium quartz sand is present at 10.40 ft bls. A 0.1-in.-thick kaolinite lens is present at 10.51 ft bls.
			10.63–11.08	Reddish yellow (7.5 YR 6/8), fining downward, rounded fine quartz sand with frequent, platy, medium mica sand crossbedded with 0.05-in.-thick dark red silt and 0.005-in.-thick kaolinite layers.
			13.65–15.50	Light gray (10 YR 7/1) subrounded, medium quartz sand with abundant black, angular, fine sand, common angular, fine mica sand and few rounded, coarse quartz sands with common 0.05-in.-thick, reddish yellow layers in association with 0.05–0.1-in.-thick lenticular kaolinite lenses.
RUFARM05	39.52612	-75.19750	0.00–1.25	Dark yellowish brown (10 YR 4/4), silty fine sand with some clay nodules. Plant fragments present from 0.15–0.9 ft bls.
			1.25–1.40	Dark yellowish brown (10 YR 4/6), silty fine sand.
			9.00–9.28	Yellowish brown (10YR 5/8) coarse, subangular, poorly sorted, kaolinite-coated quartz gravel with thin (<0.01 ft) layers of well-sorted, subrounded medium quartz sand and frequent angular black sand.
			9.28–9.85	Yellowish brown (10YR 6/8) medium, subrounded, quartz sand with common coarse, subrounded coarse quartz sand cross bedded with 0.05-in.-thick dark red silt and few thin 0.05-in.-thick kaolinite layers. Few dark reddish brown (5 YR 3/4) <0.01-ft-diameter clay clasts throughout the interval.
			9.85–10.05	Yellowish brown (10YR 6/8), well-sorted, medium quartz sand.
			13.50–14.35	Brownish yellow (10 YR 6/8), subangular, medium quartz sand with frequent angular, fine black sands interbedded with few angular, micaceous fine sand, rare subrounded, reddish medium sands and few angular, coarse quartz sands. Kaolinite coatings on sand grains are common throughout this interval. A 0.25-in.-thick kaolinite lens and 0.13-in.-thick pink clay are present from 14.31–14.35 ft bls.
			14.95–15.55	Yellowish brown (10 YR 5/8) subangular, coarse, quartz sand with common subangular, medium quartz sand with few very angular, coarse, iron-cemented sands grading to clay and silt with frequent fine platy mica sand with few small (<0.01-ft-thick) kaolinite deposits at 15.1 ft bls.

Table 17. Description, including Munsell Color Classification and sediment size description, of selected sediment cores collected from selected plots at the Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey, 2007.—Continued

[ft bls, feet below land surface; dd, decimal degrees; ( ), Munsell Color Classification (Munsell Soil Color Charts, 2000); <, less than; in., inches; ft, feet]

Core name	Latitude (dd)	Longitude (dd)	Interval (ft bls)	Description
RUFARM06	39.52812	-75.19863	0.00–0.55	Dark yellowish brown (10YR 4/4), silty, well-sorted, fine sand with some root fragments.
			0.55–1.40	Strong brown (7.5 YR 4/6) very dense, silty fine sand with some clay nodules.
			17.70–17.79	Brownish yellow (10 YR 6/8) well-sorted, subrounded fine quartz sand with frequent angular fine black sand and occasional angular fine micaceous sand.
			17.79–18.75	Pale yellow (2.5 YR 7/3) well-sorted, subrounded fine quartz sand with frequent angular fine black sand and occasional angular fine micaceous sand with a thin (<0.1-ft-thick) layer of kaolinite at 18.37 ft bls.
			18.75–19.10	Yellow (10 YR 7/6), well-sorted, subrounded, fine quartz sand with frequent angular, fine micaceous sand and frequent angular, fine black sand.
			19.10–19.30	Light gray (10 YR 7/1), moderately sorted, subrounded, fine quartz sand with frequent angular, fine black sand, frequent angular micaceous fine sand, and occasional subrounded, medium quartz sand.
			19.30–19.60	Brownish yellow (10 YR 6/6), moderately sorted, subrounded, fine quartz sand with frequent angular medium sand, frequent angular, fine black sand, occasional subrounded, medium quartz sand and few kaolinite nodules.
			13.35–14.90	Reddish yellow(7.5 YR 6/8), subrounded, fine quartz sand with frequent micaceous, medium sand and common black angular fine sands. Very thin (<0.05-in.-thick) layers of well-sorted, fine quartz sand compose roughly 5 percent of interval with greater prevalence from 14.30 to 14.70 ft bls. A thin (0.01-ft-thick) layer of of yellowish red (5 YR 5/8) silt is present at 13.42 ft bls.
			9.65–10.65	Dark red (2.5 YR 3/6), poorly sorted, subrounded, medium, quartz sand with frequent clay and silt grain coatings and poorly sorted, very angular to rounded, coarse quartz sand to fine quartz gravel with common kaolinite clasts (<0.25-in. diameter).
			10.65–10.90	Yellowish red (5YR 5/8), poorly sorted, subrounded, medium quartz sand with frequent clay and silt grain coatings and frequent poorly sorted, very angular to rounded coarse quartz sand to fine quartz gravel and common kaolinite clasts (<0.25-in. diameter).
			10.90–11.10	Dark red (2.5 YR 3/6), poorly sorted, subrounded, medium quartz sand with commom clay and silt grain coatings, frequent poorly sorted, very angular to rounded coarse quartz sand to fine quartz gravels, frequent lignite and frequent gravel-sized kaolinite clasts.
			11.10–11.30	Yellowish red (5YR 5/8), poorly sorted, subrounded, medium quartz sand with common clay and silt grain coatings, frequent poorly sorted, very angular to rounded coarse quartz sand to fine quartz gravel.
RUFARM07	39.51992	-75.20338	0.00–0.55	Dark yellowish brown (10 YR 4/6) silty sand.
			0.55–1.55	Strong brown (7.5 YR 5/6), silty fine to medium sand with some well-rounded coarse quartz sands.
			9.80–20.55	Strong brown (7.5 YR 5/6), subrounded, medium quartz sand with common subangular, coarse quartz sand with few micaceous fine sands. The upper 2 in. of the interval contains thin (<0.1-in.-thick) lenses of black clay.

Table 18. Whole-rock mineralogy (in percent) of sediment samples collected from selected plots at the Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey, 2007.

[ft bls, feet below land surface; dd, decimal degrees; 2M1, two-packet monoclinic symmetry; Fe, iron]

Core name	Latitude (dd)	Longitude (dd)	Interval (ft bls)	Quartz	Potassium feldspar	Kaolin group	2M1 illite	Fe-chlorite	Goethite	Gibbsite
RUFARM01	39.51658	-75.20352	0.0–1.0	86.9	2.3	1.4	4.1	3.9	0.5	0.9
			20.0–20.8	94.4	1.7	3.2	0	0	0.7	0
			24.9–25.8	95.6	1.8	1.8	0	0	0.8	0
			30.1–31.1	96.6	2.8	0.7	0	0	0.0	0
RUFARM02	39.52648	-75.19873	0.0–1.0	84	3.8	3.7	3.3	3.8	0.6	0.7
			9.1–10.1	96.3	2	1.7	0	0	0	0
			11.9–12.9	95.1	1.7	3.2	0	0	0	0
			16.6–17.6	97	1.4	1.7	0	0	0	0
RUFARM03	39.52753	-75.20022	0.0–1.0	85.4	2.5	2.8	4.4	4.2	1	1.3
			20.0–21.0	100	0	0	0	0	0	0
			24.1–25.1	95.4	2	2.6	0	0	0	0
RUFARM04	39.52383	-75.19902	0.0–1.0	86.1	3.0	1.4	3.6	4.3	0.5	1
			6.0–6.85	82.8	2.6	10.4	0	1.6	2.7	0
			10.8–11.8	86.6	1.7	8.7	0	1.6	1.3	0
			14.5–15.5	97	1	1.7	0	0.2	0.2	0
RUFARM05	39.52612	-75.19750	0.0–1.0	88.6	2.4	1.1	3.4	3.9	0.3	0.4
			8.0–9.0	94.8	1.2	3.9	0	0	0.1	0
			9.7–10.7	95.6	2	2.5	0	0	0.1	0
			13.5–14.5	94.2	2.1	3.5	0	0	0.2	0
RUFARM06	39.52812	-75.19863	0.0–1.0	85	3.1	1.5	4	4.9	0.7	0.8
			10.0–11.0	80.6	1.8	9.9	0	0.1	7.6	0
			13.35–14.35	96.8	0.6	1.6	0	0	1	0
			18.6–19.6	97.1	1.3	1.5	0	0	0.1	0
RUFARM07	39.51992	-75.20338	0.0–1.0	89.0	2.2	0.8	3.5	2.7	0.5	1.2
			19.8–20.5	95.6	1.5	1.7	0	0	1.3	0

Table 19. Mineralogy (in percent) of size-fractionated weight-normalized grain coatings removed from sediment samples collected from selected plots at the Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey, 2007.

[ft bls, feet below land surface; dd, decimal degrees; 2M1, two-packet monoclinic symmetry; Fe, iron; µm, micrometer; <, less than]

Core name	Latitude (dd)	Longitude (dd)	Interval (ft bls)	Size fraction (µm)	Quartz	Potassium feldspar	Albite	Halloysite	Kaolinite	2M1 illite	Fe-Chlorite	2M1 illite muscovite	Goethite	Gibbsite
RUFARM01	39.51658	-75.20352	0.0–1.0	<53	10.9	2.0	0.7	0.8	0.6	2.1	0.7	0.3	0.2	0
				53–150	9.8	0.5	0.1	0.2	0.2	0.6	0.3	0.7	0.2	0
				<150	20.7	2.6	0.8	1.0	0.9	2.7	1.0	1.0	0.3	0
			20.0–20.8	<53	0.3	0.1	0	0.2	0.1	0	0.1	0	0.1	0
				53–150	1.5	0.6	0	0.6	0.3	0	0	0	0.2	0
				<150	1.8	0.7	0	0.8	0.3	0.1	0.1	0	0.3	0
			24.9–25.8	<53	0.2	0.2	0	0.2	0.1	0	0.1	0	0.1	0
				53–150	1.3	1.1	0	0.8	0.3	0	0	0	0.3	0
				<150	1.5	1.2	0	1	0.4	0	0.1	0	0.4	0
			30.1–31.1	<53	0.1	0.1	0	0.1	0.1	0	0	0	0	0
				53–150	0.6	0.8	0	0.3	0.2	0	0	0	0	0
				<150	0.7	0.9	0	0.3	0.2	0	0.1	0	0.1	0
RUFARM02	39.52648	-75.19873	0.0–1.0	<53	9.8	1.9	0.6	0.8	0.1	0.5	1.5	1	0.2	0.2
				53–150	8.7	0.6	0.2	0.1	0.2	0.5	0.3	0.3	0.1	0.1
				<150	18.5	2.5	0.8	0.9	0.3	1.1	1.8	1.3	0.3	0.3
			9.6–10.1	<53	0	0	0	0	0	0	0	0	0	0
				53–150	0.7	0.5	0	0.3	0.2	0.1	0.1	0	0	0
				<150	0.7	0.5	0	0.3	0.2	0.1	0.1	0	0	0
			11.9–12.8	<53	0	0	0	0	0	0	0	0	0	0
				53–150	0.9	0.6	0	0.4	0.2	0	0.1	0	0	0
				<150	0.9	0.6	0	0.4	0.2	0	0.1	0	0	0
			16.6–17.6	<53	0.1	0	0	0	0	0	0	0	0	0
				53–150	1.2	0.5	0	0.3	0.3	0.1	0	0	0	0
				<150	1.3	0.6	0	0.3	0.3	0.1	0	0	0	0

Table 19. Mineralogy (in percent) of size-fractionated weight-normalized grain coatings removed from sediment samples collected from selected plots at the Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey, 2007.—Continued

[ft bls, feet below land surface; dd, decimal degrees; 2M1, two-packet monoclinic symmetry; Fe, iron; µm, micrometer; <, less than]

Core name	Latitude (dd)	Longitude (dd)	Interval (ft bls)	Size fraction (µm)	Quartz	Potassium feldspar	Albite	Halloysite	Kaolinite	2M1 illite	Fe-Chlorite	2M1 illite muscovite	Goethite	Gibbsite
RUFARM03	39.52753	-75.20022	0.0–1.0	<53	6.6	1.1	0.3	0.4	0.2	0.6	0.6	0.6	0.2	0.1
				53–150	7.1	0.5	0.2	0.3	0.1	0.5	0.2	0.3	0.1	0.1
				<150	13.8	1.5	0.5	0.8	0.3	1.1	0.7	0.8	0.3	0.2
			20.0–21.0	<53	0	0	0	0	0	0	0	0	0	0
				53–150	0.6	0.6	0	0.2	0.1	0	0	0	0	0
				<150	0.6	0.6	0	0.2	0.1	0	0	0	0	0
			24.1–25.1	<53	0.1	0.1	0	0.1	0.1	0	0	0	0	0
				53–150	0.9	0.5	0	0.3	0.3	0	0	0	0	0
				<150	1.1	0.6	0	0.4	0.4	0	0	0	0	0
RUFARM04	39.52383	-75.19902	0.0–1.0	<53	9.4	1.6	0.6	0.5	0.4	1.2	1.0	0.9	0.2	0.2
				53–150	6.9	0.5	0.2	0.2	0.2	0.4	0.3	0.6	0.1	0.1
				<150	16.3	2.1	0.8	0.7	0.6	1.6	1.3	1.4	0.2	0.3
			6.0–6.85	<53	0.2	0	0	0.1	0	0	0	0	0	0
				53–150	5.6	0.3	0	0.7	0.8	0.3	0	0.2	0.5	0
				<150	5.9	0.4	0	0.8	0.8	0.4	0.1	0.2	0.5	0
			10.8–11.8	<53	3.7	0.4	0	0.4	0.5	0.3	0.4	0.3	0.3	0
				53–150	18.7	0.2	0	0	0.9	0.3	0	0.1	0.3	0
				<150	22.4	0.6	0	0.4	1.4	0.6	0.4	0.4	0.6	0
			14.5–15.5	<53	1	0.1	0	0.1	0.2	0.2	0	0	0.1	0
				53–150	7.7	0.4	0	0.1	0.4	0.2	0	0.1	0.1	0
				<150	8.6	0.5	0	0.3	0.5	0.4	0	0.1	0.2	0

Table 19. Mineralogy (in percent) of size-fractionated weight-normalized grain coatings removed from sediment samples collected from selected plots at the Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey, 2007.—Continued

[ft bls, feet below land surface; dd, decimal degrees; 2M1, two-packet monoclinic symmetry; Fe, iron; µm, micrometer; <, less than]

Core name	Latitude (dd)	Longitude (dd)	Interval (ft bls)	Size fraction (µm)	Quartz	Potassium feldspar	Albite	Halloysite	Kaolinite	2M1 illite	Fe-Chlorite	2M1 illite muscovite	Goethite	Gibbsite
RUFARM05	39.52612	-75.19750	0.0–1.0	<53	12.3	2.4	0.9	1.3	0.1	1.0	1.6	1.2	0.3	0.3
				53–150	12.3	0.3	0.3	0.2	0.2	0.8	0.2	0.4	0.1	0.1
				<150	24.6	2.7	1.2	1.5	0.2	1.7	1.8	1.7	0.4	0.4
			8.0–9.0	<53	0.2	0.1	0	0.2	0.1	0	0	0	0	0
				53–150	0.8	0.6	0	0.6	0.2	0	0	0	0.1	0
				<150	1	0.7	0	0.7	0.2	0.1	0.1	0	0.1	0
			9.7–10.7	<53	0.3	0.2	0	0.2	0.1	0	0.1	0	0	0
				53–150	1.2	0.8	0	0.5	0.3	0	0	0	0.1	0
				<150	1.5	0.9	0	0.7	0.3	0	0.1	0	0.1	0
			13.5–14.5	<53	0.2	0.1	0	0.2	0.1	0.1	0	0	0	0
				53–150	0.7	0.6	0	0.5	0.2	0	0.1	0	0.1	0
				<150	0.9	0.7	0	0.7	0.2	0.1	0.1	0	0.1	0
RUFARM06	39.52812	-75.19863	0.0–1.0	<53	9.0	1.4	0.6	0.7	0.2	1.0	0.8	0.7	0.1	0
				53–150	7.3	0.4	0.2	0.2	0.1	0.5	0.1	0.5	0.1	0
				<150	16.2	1.8	0.8	0.9	0.4	1.5	0.9	1.1	0.2	0
			10.0–11.0	<53	0.4	0.1	0	0.1	0	0	0.2	0.1	0.3	0
				53–150	2.3	0.4	0	1.0	0.4	0.5	0.3	0.2	1.3	0
				<150	2.7	0.5	0	1.1	0.4	0.5	0.5	0.3	1.6	0
			13.35–14.35	<53	0.7	0.1	0	0	0.1	0.1	0.2	0.1	0.1	0
				53–150	15.4	0.1	0	0	0	0.2	0	0	0.3	0
				<150	16.1	0.2	0	0	0.1	0.3	0.2	0.1	0.4	0
			18.6–19.6	<53	1.2	0.1	0	0.1	0	0.2	0.1	0.1	0.1	0
				53–150	25.9	0.2	0	0	0	0	0	0	0	0
				<150	27.1	0.3	0	0.1	0	0.2	0.1	0.1	0.1	0
RUFARM07	39.51992	-75.20338	0.0–1.0	<53	15.9	3.1	1.1	1.4	0.3	1.5	2.1	2.0	0.5	0.2
				53–150	10.1	0.4	0.2	0.3	0.2	0.6	0.2	0.6	0.1	0.1
				<150	26	3.4	1.4	1.7	0.4	2.1	2.4	2.6	0.6	0.3
			19.8–20.5	<53	1.3	0.5	0	0.4	0.1	0.1	0.2	0	0.5	0
				53–150	5.7	0.9	0	0.5	0.2	0	0	0	0.7	0
				<150	6.9	1.4	0	0.9	0.3	0.2	0.3	0	1.2	0

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Table 20. Particle-size distribution (in percent) of sediment samples collected from selected plots at the Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey, 2007.

[dd, decimal degrees; ft bls, feet below land surface; <, less than; >, greater than; µm, micrometers]

Core name	Latitude (dd)	Longitude (dd)	Depth (ft bls)	Clay (<2 µm)	Silt (2-50 µm)	Very fine sand (50–100 µm)	Fine sand (100–250 µm)	Medium sand (250–500 µm)	Coarse sand (500–1,000 µm)	Very coarse sand (1,000–2,000 µm)	Gravel (>2,000 µm)
RUFARM01	39.51658	-75.20352	0.5	6.51	63.27	17.05	4.86	0	0	0	8.34
			3.0	1.23	9.5	7.74	6.77	14.86	33.33	17	9.55
			5.5	0.94	6.08	4.83	5.27	10.76	33.68	23.55	14.9
			8.0	0.60	3.54	2.07	2.48	9.4	41.7	32.90	7.3
			10.5	1.26	6.85	3.62	3	8.59	34.99	30.39	11.28
			13.0	1.31	7.9	4.65	0.79	5.04	24.92	23.51	31.87
			16.0	0.88	4.03	1.85	2.08	7.2	35.74	29.93	18.31
			18.5	1.02	4.31	1.87	3.18	11.69	30.26	34.92	12.75
			21.0	1.40	5.58	2.64	3.74	3.11	22.29	33.17	28.07
			24.0	1.79	8.34	3.69	5.23	4.73	15.89	36.19	24.16
			26.3	2.58	11.55	3.75	4.89	9.48	18.95	22.71	26.13
RUFARM02	39.52648	-75.19873	0.0	2.93	22.54	7.64	5.29	8.91	16.48	4.34	31.86
			2.5	0.77	6.6	4.99	5.05	9.27	32.55	27.33	13.46
			5.0	0.84	4.71	3.87	6.38	3.53	16.50	38.03	26.09
			8.0	1.16	6.13	2.52	3.62	19.77	18.48	19.94	28.38
			10.5	1.23	6.26	2.00	5.22	20.93	34.07	22.92	7.36
			13.0	1.01	6.56	1.69	1.76	6.25	48.68	31.48	2.53
RUFARM03	39.52753	-75.20022	0.0	3.20	26.39	7.19	6.25	15.75	22.66	14.44	4.15
			2.5	2.67	20.20	12.62	10.17	14.28	16.56	10.2	13.3
			5.0	2.58	20.13	11.20	8.77	21.23	30.57	5.34	0.24
			8.0	1.38	11.07	7.69	9.06	15.21	27.32	20.88	7.4
			10.5	1.29	6.31	4.15	7.61	9.39	28.16	33.20	9.86
			13.0	9.3	66.09	13.67	10.71	0.23	0	0	0.04
			15.5	5.25	21.81	5.84	8.05	17.24	20.14	19.37	2.26
			18.0	0.82	3.37	1.06	3.37	17.79	52.02	20.08	1.47
			20.5	0.73	2.81	1.05	2.24	14.58	65.64	12.01	1.02
RUFARM04	39.52383	-75.19902	0.0	4.49	34.68	9.67	5.86	9.32	23.71	4.87	7.36
			2.5	2.31	22.5	10.92	11.67	20.95	17.04	11.16	3.44
			5.0	1.32	10.14	4.99	8.28	21.7	30.21	21.51	1.84
			8.0	8.67	51.18	10.99	26.69	2.29	0.17	0	0
			10.5	1.32	5.53	2.68	7.78	19.74	57.98	4.99	0

Table 20. Particle-size distribution (in percent) of sediment samples collected from selected plots at the Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey, 2007.—Continued

[dd, decimal degrees; ft bls, feet below land surface; <, less than; >, greater than; µm, micrometers]

Core name	Latitude (dd)	Longitude (dd)	Depth (ft bls)	Clay (<2 µm)	Silt (2-50 µm)	Very fine sand (50–100 µm)	Fine sand (100–250 µm)	Medium sand (250–500 µm)	Coarse sand (500–1,000 µm)	Very coarse sand (1,000–2,000 µm)	Gravel (>2,000 µm)
RUFARM05	39.52612	-75.19750	0.0	4.37	33.87	9.22	9.48	16.78	22	2.46	1.83
			2.5	1.99	18.69	6.74	9.93	18.58	17.62	3.27	23.18
			5.0	0.81	7.25	5.63	4.48	7.83	52.94	18.53	2.5
			8.0	0.77	5.72	4.34	4.61	10.05	38.75	31.85	3.9
			10.5	0.97	4.74	2.03	2.3	14.99	45.76	23.01	6.19
RUFARM06	39.52812	-75.19863	0.0	3.53	27.70	6.63	0.59	11.84	29.61	6.87	13.2
			2.5	1.57	13.89	9.58	8.66	7.28	14.36	12.97	31.69
			5.0	0.75	5.43	5.35	8.47	6.33	28.73	29.21	15.74
			8.0	1.31	7.17	5.43	6.75	3.79	33.44	35.01	7.09
			10.5	1.43	5.84	4.13	2.4	0.01	17.64	45.2	23.33
			13.0	2.37	11.76	5.57	11.10	11.25	15.86	3.85	38.25
RUFARM07	39.51992	-75.20338	0.0	2.82	24.32	9.45	8.14	21.50	26.30	4.31	3.17
			2.5	1.51	10.05	6.86	9.04	10.25	15.53	12.10	34.7
			5.0	1.15	9.45	6.01	7.24	12.67	23.34	33.04	7.13
			8.0	1.64	12.30	6.99	6.60	16.72	36.01	17.61	2.15
			10.5	0.78	5.12	3.01	2.85	4.77	23.27	31.44	28.76
			13.0	0.49	2.27	0.85	1.18	1.66	23.88	57.20	12.48
			16.0	1.07	7.28	4.16	1.41	8.50	46.76	30.02	0.78
			18.5	1.88	6.71	1.54	3.01	11.26	25.90	34.33	15.43
			21.0	1.03	3.14	1.06	1.12	2.88	25.97	48.78	15.99

Table 21. Concentrations of pesticides and pesticide degradates measured in sediment samples collected from selected plots at the Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey, 2007.

[Values are in nanograms per gram. Results in parentheses ( ) are below method detection limits and are estimates. The following compounds were analyzed for but were not detected in any samples: 3,4-DCA; 3,5-DCA, alachlor; allethrin; atrazine; bifenthrin; butylate; carbaryl; carbofuran; chlorpyrifos; cycloate; cyfluthrin; cyhalothrin; cypermethrin; cyproconazole; DCPA; deltamethrin; diazinon; disulfoton; EPTC; esfenvalerate; ethalfluralin; etofenprox; fenpropathrin; fipronil; fipronil desulfinyl; fipronil sulfone; hexazinone; iprodione; malathion; metconazole; methidathion; methoprene; methylparathion; metolachlor; molinate; napropamide; oxyfluorfen; PCA; PCNB; pebulate; permethrin; phenothrin; phosmet; piperonyl butoxide; prometryn; propanil; propiconazole; pyraclostrobin; resmethrin; simazine; τ-fluvalinate; tefluthrin; tetraconazole; tetramethrin; thiobencarb; trifloxystrobin; triflumizole; vinclozolin. dd, decimal degrees; ft bls, feet below land surface; nd, not detected; --, no data]

Core name	Latitude (dd)	Longitude (dd)	Interval (ft bls)	Azoxystrobin	Boscalid	Chlorothalonil	4-Hydroxy chlorothalonil	Amide of 4-hydroxy chlorothalonil	Diamide of chlorothalonil	Fipronil sulfide
RUFARM01	39.51658	-75.20352	0–1	nd	nd	nd	nd	nd	nd	nd
			20–20.8	nd	nd	nd	--	--	--	nd
			24.9–25.8	nd	nd	nd	--	--	--	nd
			30.1–31.1	nd	nd	nd	nd	nd	nd	nd
RUFARM02	39.52648	-75.19873	0–1	(3.5)	(1.6)	4.5	22.4	30.3	13.6	nd
			9.1–10.1	nd	nd	nd	--	--	--	nd
			11.9–12.9	nd	nd	nd	--	--	--	nd
			16.6–17.6	nd	nd	nd	nd	11.0	6.4	nd
RUFARM03	39.52753	-75.20022	0–1	(1.3)	nd	2.3	nd	nd	8.4	nd
			20–21	nd	nd	nd	--	--	--	nd
			24.1–25.1	nd	nd	nd	nd	nd	nd	nd
RUFARM04	39.52383	-75.19902	0–1	nd	nd	nd	nd	nd	5.9	nd
			6–6.85	nd	nd	nd	--	--	--	nd
			10.8–11.8	nd	nd	nd	--	--	--	nd
			14.5–15.5	nd	nd	nd	nd	nd	nd	nd
RUFARM05	39.52612	-75.19750	0–1	34.2	nd	5.5	17.3	nd	18.9	nd
			8.0–9.0	nd	nd	nd	--	--	--	nd
			9.7–10.7	nd	nd	nd	--	--	--	nd
			13.5–14.5	nd	nd	nd	nd	nd	nd	nd
RUFARM06	39.52812	-75.19863	0–1	nd	nd	1.7	nd	nd	7.3	(0.7)
			10.0–11.0	nd	nd	nd	--	--	--	nd
			13.35–14.35	nd	nd	nd	--	--	--	nd
			18.6–19.6	nd	nd	nd	3.8	nd	11.4	nd
RUFARM07	39.51992	-75.20338	0–1	nd	nd	14.4	5.5	nd	15.5	nd
			19.8–20.55	nd	nd	4.9	3.4	nd	7.4	nd

Table 21. Concentrations of pesticides and pesticide degradates measured in sediment samples collected from selected plots at the Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey, 2007.—Continued

[Values are in nanograms per gram. Results in parentheses ( ) are below method detection limits and are estimates. The following compounds were analyzed for but were not detected in any samples: 3,4-DCA; 3,5-DCA, alachlor; allethrin; atrazine; bifenthrin; butylate; carbaryl; carbofuran; chlorpyrifos; cycloate; cyfluthrin; cyhalothrin; cypermethrin; cyproconazole; DCPA; deltamethrin; diazinon; disulfoton; EPTC; esfenvalerate; ethalfluralin; etofenprox; fenpropathrin; fipronil; fipronil desulfinyl; fipronil sulfone; hexazinone; iprodione; malathion; metconazole; methidathion; methoprene; methylparathion; metolachlor; molinate; napropamide; oxyfluorfen; PCA; PCNB; pebulate; permethrin; phenothrin; phosmet; piperonyl butoxide; prometryn; propanil; propiconazole; pyraclostrobin; resmethrin; simazine; τ-fluvalinate; tefluthrin; tetraconazole; tetramethrin; thiobencarb; trifloxystrobin; triflumizole; vinclozolin. dd, decimal degrees; ft bls, feet below land surface; nd, not detected; --, no data]

Core name	Latitude (dd)	Longitude (dd)	Interval (ft bls)	Myclobutanil	*p,p'*-DDD	*p,p'*-DDE	*p,p'*-DDT	Pendimethalin	Tebuconazole	Trifluralin
RUFARM01	39.51658	-75.20352	0–1	nd	nd	(0.1)	nd	nd	nd	nd
			20–20.8	nd	nd	nd	nd	nd	nd	nd
			24.9–25.8	nd	nd	nd	nd	nd	nd	nd
			30.1–31.1	nd	nd	nd	nd	nd	nd	nd
RUFARM02	39.52648	-75.19873	0–1	nd	nd	1.9	nd	nd	nd	10.1
			9.1–10.1	nd	nd	nd	nd	nd	nd	nd
			11.9–12.9	nd	nd	nd	nd	nd	nd	nd
			16.6–17.6	nd	nd	nd	nd	nd	(0.8)	nd
RUFARM03	39.52753	-75.20022	0–1	nd	nd	(0.4)	nd	2.4	nd	nd
			20–21	nd	nd	nd	nd	nd	nd	nd
			24.1–25.1	nd	nd	nd	nd	nd	nd	nd
RUFARM04	39.52383	-75.19902	0–1	nd	(0.5)	3.9	2.2	nd	nd	nd
			6–6.85	nd	nd	nd	nd	nd	nd	nd
			10.8–11.8	nd	nd	nd	nd	nd	nd	nd
			14.5–15.5	nd	nd	nd	nd	nd	nd	nd
RUFARM05	39.52612	-75.19750	0–1	nd	nd	2.1	(0.8)	nd	nd	(0.3)
			8.0–9.0	nd	nd	nd	nd	nd	nd	nd
			9.7–10.7	nd	nd	nd	nd	nd	nd	nd
			13.5–14.5	nd	nd	nd	nd	nd	nd	nd
RUFARM06	39.52812	-75.19863	0–1	nd	2.0	14.0	9.7	nd	nd	(0.2)
			10.0–11.0	nd	nd	nd	nd	nd	nd	(0.2)
			13.35–14.35	nd	nd	nd	nd	nd	nd	nd
			18.6–19.6	nd	nd	nd	nd	nd	nd	nd
RUFARM07	39.51992	-75.20338	0–1	11.7	nd	(0.9)	(0.5)	nd	nd	nd
			19.8–20.55	4.4	nd	nd	nd	nd	nd	nd

Table 22. Concentrations of organic carbon and nitrogen measured in sediment samples collected from selected plots at the Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey, 2007.

[ft bls, feet below land surface; dd, decimal degrees]

Core name	Latitude (dd)	Longitude (dd)	Interval (ft bls)	Organic carbon (percent)	Nitrogen (percent)
RUFARM01	39.5166	-75.2035	0–1	0.76	0.09
			20–20.8	0.07	0.02
			24.9–25.8	0.07	0.02
			30.1–31.1	0.04	0.05
RUFARM02	39.5265	-75.1987	0–1	0.8	0.1
			9.1–10.1	0.07	0.02
			11.9–12.9	0.06	0.03
			16.6–17.6	0.1	0.06
RUFARM03	39.5275	-75.2002	0–1	0.63	0.09
			20–21	0.07	0.03
			24.1–25.1	0.05	0.03
RUFARM04	39.5238	-75.1990	0–1	0.68	0.09
			6–6.85	0.09	0.04
			10.8–11.8	0.08	0.04
			14.5–15.5	0.06	0.04
RUFARM05	39.5261	-75.1975	0–1	0.65	0.09
			8.0–9.0	0.07	0.04
			9.7–10.7	0.09	0.05
			13.5–14.5	0.05	0.05
RUFARM06	39.5281	-75.1986	0–1	0.35	0.08
			10.0–11.0	0.09	0.04
			13.35–14.35	0.16	0.05
			18.6–19.6	0.07	0.03
RUFARM07	39.5199	-75.2034	0–1	0.6	0.09
			19.8–20.55	0.12	0.05

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Table 23. pH, electrical conductivity, and concentrations of nutrients and inorganic ions measured in sediment samples collected from selected plots at the Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey, 2007.

[Results in parentheses ( ) are below method detection limits and are estimates. dd, decimal degrees; ft bls, feet below land surface; $CaCl_2$, calcium chloride; µS/cm, microsiemens per centimeter at 25 degrees Celsius; g/kg, grams per kilogram; mg/kg N, milligrams per kilogram as nitrogen; mg/kg, milligrams per kilogram; 1 N HCl, 1 normal hydrochloric acid; nd, not detected; --, no data]

Core name	Latitude (dd)	Longitude (dd)	Interval (ft bls)	pH (standard units, in water)	pH (standard units, in $CaCl_2$)	Electrical conductivity (µS/cm)	Total carbon (g/kg)	Ammonium (mg/kg N)	Nitrate (mg/kg N)	Total nitrogen (g/kg)	Calcium (mg/kg)	Magnesium (mg/kg)
RUFARM01	39.5166	-75.2035	0–1	5.69	4.77	31	4.5	8.4	2.2	0.3	321	58
			20–20.8	5.08	4.38	27	1.3	(0.5)	(0.4)	nd	(27)	(7)
			24.9–25.8	5.19	4.65	34	1	(0.93)	(0.4)	nd	(19)	(6)
			30.1–31.1	5.22	4.59	43	0.8	(0.76)	(0.1)	nd	(2)	(4)
RUFARM02	39.5265	-75.1987	0–1	7.54	6.85	63	13	(0.1)	6.5	1	992	71
			9.1–10.1	4.98	4.4	34	0.9	(0.3)	2.3	nd	(27)	13
			11.9–12.9	4.95	4.52	40	0.7	1.3	4.4	nd	(20)	11
			16.6–17.6	5.23	4.74	29	0.7	(0.79)	3.5	nd	(13)	(8)
RUFARM03	39.5275	-75.2002	0–1	6.07	5.68	225	7.5	(0.2)	52	0.6	561	102
			20–21	4.92	4.51	14	0.7	(0.25)	1.3	nd	nd	(2)
			24.1–25.1	4.78	4.32	24	0.7	(0.5)	2.4	nd	nd	(6)
RUFARM04	39.5238	-75.1990	0–1	6.49	5.77	82	7.3	(0.07)	13	0.6	493	86
			6–6.85	5.61	5.20	38	1.1	(0.36)	3.2	nd	200	70
			10.8–11.8	4.93	4.21	48	0.9	(0.8)	3.7	nd	120	42
			14.5–15.5	4.65	4.05	43	0.8	(0.47)	1.6	nd	(23)	13
RUFARM05	39.5261	-75.1975	0–1	6.51	5.98	133	7.3	(0.11)	20	0.6	536	75
			8.0–9.0	4.99	4.42	37	0.8	1.4	2.1	nd	(28)	18
			9.7–10.7	5.02	4.45	34	0.8	(0.69)	2.9	nd	(6)	12
			13.5–14.5	5.04	4.50	32	0.7	(0.55)	3.6	nd	(3)	9
RUFARM06	39.5281	-75.1986	0–1	6.89	5.99	57	4.2	(0.1)	3.5	0.3	494	86
			10.0–11.0	5.09	4.57	50	1.3	1.7	1.4	nd	161	53
			13.35–14.35	4.86	4.34	47	1.0	(0.41)	3.0	nd	91	23
			18.6–19.6	4.54	4.00	62	0.8	(0.6)	6.1	nd	36	13
RUFARM07	39.5199	-75.2034	0–1	6.27	5.56	37	4.4	(0.8)	3.2	0.4	368	72
			19.8–20.55	5.43	5.02	43	0.9	1.0	1.2	nd	(12)	(9)

Table 23. pH, electrical conductivity,and concentrations of nutrients and inorganic ions measured in sediment samples collected from selected plots at the Rutgers Agricultural Research and Extension Center, Upper Deerfield, New Jersey, 2007.—Continued

[Results in parentheses ( ) are below method detection limits and are estimates. dd, decimal degrees; ft bls, feet below land surface; $CaCl_2$, calcium chloride; µS/cm, microsiemens per centimeter at 25 degrees Celsius; g/kg, grams per kilogram; mg/kg N, milligrams per kilogram as nitrogen; mg/kg, milligrams per kilogram; 1 N HCl, 1 normal hydrochloric acid; nd, not detected; --, no data]

Core name	Latitude (dd)	Longitude (dd)	Interval (ft bls)	Sodium (mg/kg)	Potassium (mg/kg)	Aluminum (mg/kg)	Phosphorus, Mehlich-III extractable (mg/kg)	Phosphorus, 1 N HCl extractable (mg/kg)	Total phosphorus (mg/kg)	Total sulfate (mg/kg)	Sulfate, water extractable (mg/kg)	Chloride, water extractable (mg/kg)
RUFARM01	39.5166	-75.2035	0–1	(3)	102	(19)	256	418	653	12	7	13
			20–20.8	(3)	25	(17)	3.5	--	122	95	39	8
			24.9–25.8	nd	20	(5.4)	3.7	--	142	85	41	7
			30.1–31.1	(7)	(11)	(3.5)	2.04	--	31	35	12	29
RUFARM02	39.5265	-75.1987	0–1	(6)	49	nd	86.8	169	424	11	12	10
			9.1–10.1	nd	(7)	(19)	2.6	--	38	105	45	8
			11.9–12.9	nd	(3)	(10)	2.7	--	33.8	69	29	7
			16.6–17.6	nd	(4)	(3)	(1.2)	--	22	39	17	8.4
RUFARM03	39.5275	-75.2002	0–1	nd	78	nd	45	94	348	21	24	35
			20–21	nd	(3)	(9.4)	(1.44)	--	21	12	(1.9)	7.8
			24.1–25.1	nd	(4)	(9.6)	(1.09)	--	15.2	36	4.7	9.8
RUFARM04	39.5238	-75.1990	0–1	(7)	112	nd	251	404	636	7.7	7.8	22
			6–6.85	nd	42	(0.7)	2.5	--	133	160	52	11
			10.8–11.8	(0.4)	33	52	(0.6)	--	44	135	49	9
			14.5–15.5	(1)	30	57	(1.5)	--	35	75	44	5
RUFARM05	39.5261	-75.1975	0–1	(0.2)	93	nd	146	253	523	12	15	15
			8.0–9.0	nd	19	(17)	4.1	--	66	98	43	7
			9.7–10.7	nd	25	(12)	4.9	--	57	77	33	7
			13.5–14.5	(2)	40	(9.2)	4.8	--	72	62	30	1.1
RUFARM06	39.5281	-75.1986	0–1	nd	89	nd	70.7	126	380	11	13	26
			10.0–11.0	(7)	32	(21)	2.88	--	292	300	108	11
			13.35–14.35	(2)	16	(18)	6.8	--	189	116	60	2.7
			18.6–19.6	(4)	22	71	(1.9)	--	30.0	34	29	1.5
RUFARM07	39.5199	-75.2034	0–1	nd	42	nd	79	131	364	10.4	8.6	7.8
			19.8–20.55	(3)	19	nd	9	--	256	91	54	5.8

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