

Prepared in cooperation with the Saline Valley Conservancy District

# **Groundwater Quality at the Saline Valley Conservancy District Well Field, Gallatin County, Illinois**

Data Series 1009



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By Magdalena Gorczynska and Robert T. Kay

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

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U.S. Geological Survey, Reston, Virginia: 2016

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Suggested citation:

Gorczyńska, Magdalena, and Kay, R.T., 2016, Groundwater quality at the Saline Valley Conservancy District well field, Gallatin County, Illinois: U.S. Geological Survey Data Series 1009, 13 p., <http://dx.doi.org/10.3133/ds1009>.

ISSN 2327-638X (online)

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## Conversion Factors, Datum, and Abbreviations

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

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

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

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

Abbreviated water-quality units used in this report: Concentrations of most chemical constituents in water are given in micrograms per liter ( $\mu\text{g/L}$ ) and milligrams per liter ( $\text{mg/L}$ ). Micrograms per liter are considered equivalents to parts per billion and the reported concentrations. Milligrams per liter are considered equivalents to parts per million and the reported concentrations.

Radiometric measurements of water are given in picocuries per liter ( $\text{pCi/L}$ ).

Specific conductance (SC) of water is given in microsiemens per centimeter at 25 degrees Celsius ( $\mu\text{S/cm}$  at 25 °C).

pH of water is given in standard units.

$\delta$  (delta), as used in this report, refers to the stable isotope ratio  $\delta x = [(R_x/R_{STD}) - 1] \times 1,000$ , where  $R_x$  and  $R_{STD}$  are the  $^2\text{H}/^1\text{H}$ ,  $^{34}\text{S}/^{32}\text{S}$ ,  $^{13}\text{C}/^{12}\text{C}$ , or  $^{18}\text{O}/^{16}\text{O}$  values of the sample and reference standard. The value of  $\delta$  is generally expressed in parts per thousand (‰, or per mil). A positive  $\delta$  value means that the sample contains more of the heavy isotope than the standard; a negative  $\delta$  value means that the sample contains less of the heavy isotope than the standard.

Per mil, as used in this report, is equivalent to parts per thousand.

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## Abstract

The Saline Valley Conservancy District (SVCD) operates wells that supply water to most of the water users in Saline and Gallatin Counties, Illinois. The SVCD wells draw water from a shallow sand and gravel aquifer located in close proximity to an abandoned underground coal mine, several abandoned oil wells, and at least one operational oil well. The aquifer that yields water to the SVCD wells overlies the New Albany Shale, which may be subjected to shale-gas exploration by use of hydraulic fracturing. The SVCD has sought technical assistance from the U.S. Geological Survey to characterize baseline water quality at the SVCD well field so that future changes in water quality (if any) and the cause of those changes (including mine leachate and hydraulic fracturing) can be identified.

## Introduction

Wells operated by the Saline Valley Conservancy District (SVCD) provide water to 16 municipalities and water districts in Saline and Gallatin Counties, Illinois. The SVCD wells draw water from a shallow sand and gravel aquifer located in a buried bedrock valley (fig. 1; table 1). The SVCD wells are in close proximity to an abandoned underground coal mine (<http://isgs.illinois.edu/research/coal/maps/county/gallatin>, accessed June 10, 2015), several abandoned oil wells, and at least one operational oil well (<http://maps.isgs.illinois.edu/iloil/>, accessed June 10, 2015).

Infiltration of surface water containing mine leachate discharged from a series of slurry ponds resulted in water-quality degradation at well SVCD5 (now abandoned) located south of a tributary to Cypress Ditch (fig. 1). Infiltration was exacerbated by pumping at well SVCD5 and the thin surficial silt and clay deposits near the ditch (Cox, 2013). Monitoring wells in the vicinity of the mine are sampled on a periodic basis by the former operator of the mine to characterize the nature and extent of leachate impacts on groundwater quality so that the potential for impacts to the SVCD wells can be assessed on an ongoing basis.

The aquifer that yields water to the SVCD wells overlies the New Albany Shale, which may be subjected to shale-gas exploration by use of hydraulic fracturing (Hasenmueller and Comer, 1994). Drilling processes and waste-disposal practices related to production of shale gas have the potential to contaminate groundwater through the release of hazardous chemicals used in the hydraulic fracturing process from pre-use storage reservoirs or during fluid injection. Hydraulic fracturing also has the potential to alter groundwater flow in such a way as to mobilize constituents (including methane, chloride, and radium) often present at high concentrations in deep, gas-producing, bedrock formations to shallow groundwater (Myers, 2012).

The SVCD has sought technical assistance from the U.S. Geological Survey (USGS) to sample selected wells for a variety of constituents. These data will characterize baseline water quality at the SVCD well field and will provide some indication of the spatial and temporal variation in water quality. These data can be used to identify future changes in water quality (if any) as well as the cause of those changes (including mine leachate and hydraulic fracturing).

Although not included in this report, the USGS also compiled the water-quality data obtained from the ongoing periodic sampling of the monitoring wells in the vicinity of the coal mine that was performed by the former mine operator. These data can be obtained from the SVCD.

## Purpose and Scope

This report presents the water-quality data obtained from USGS sampling of the six functional SVCD wells on June 1, 2015, and from SVCD well 4 on February 23, 2016.

## Methods of Sample Collection and Analysis

Samples from SVCD wells 1, 2, 4, 6, 7, and 8 were collected by the USGS on June 1, 2015. A sample and duplicate sample from SVCD well 4 were collected by the USGS on February 23, 2016. Water samples were collected, preserved, stored, and transported in accordance with USGS standard methods (U.S. Geological Survey, variously dated).

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pH, temperature, and specific conductance were measured in the field. Temperature was determined to have been affected by atmospheric temperature and is not presented. All samples were analyzed by USGS laboratories or by laboratories under contract to the USGS.

### Groundwater-Quality Data

Periodic sampling of raw water from each of the SVCD wells was performed by the Illinois Environmental Protection Agency (IEPA) to ensure that this water does not contain excessive concentrations of potentially toxic constituents (Anthony Dulka, Illinois Environmental Protection Agency, written commun., 2012). Samples were collected by the IEPA from well SVCD1 in June, October, and December 1984 and

March 1985; wells SCVD2 and SVCD3 in December 1986; and wells SVCD4, SVCD6, SVCD7, and SVCD8 in May 2012. Although these samples were not collected or analyzed by the USGS, the sample results are presented in appendix 1 to provide all of the water-quality data from the SVCD wells. The IEPA samples were collected in accordance with IEPA standard operating procedures (Illinois Environmental Protection Agency, 2012).

Results of the analysis of samples collected on June 1, 2015, by the USGS from SVCD wells 1, 2, 4, 6, 7, and 8 are presented in table 2. Results of the analysis of the sample and the duplicate sample collected on February 23, 2016, by the USGS from SVCD well 4, as well as the relative percent difference between these samples, are presented in table 3. Well SVCD3 was not operational during the sampling events and was not sampled.

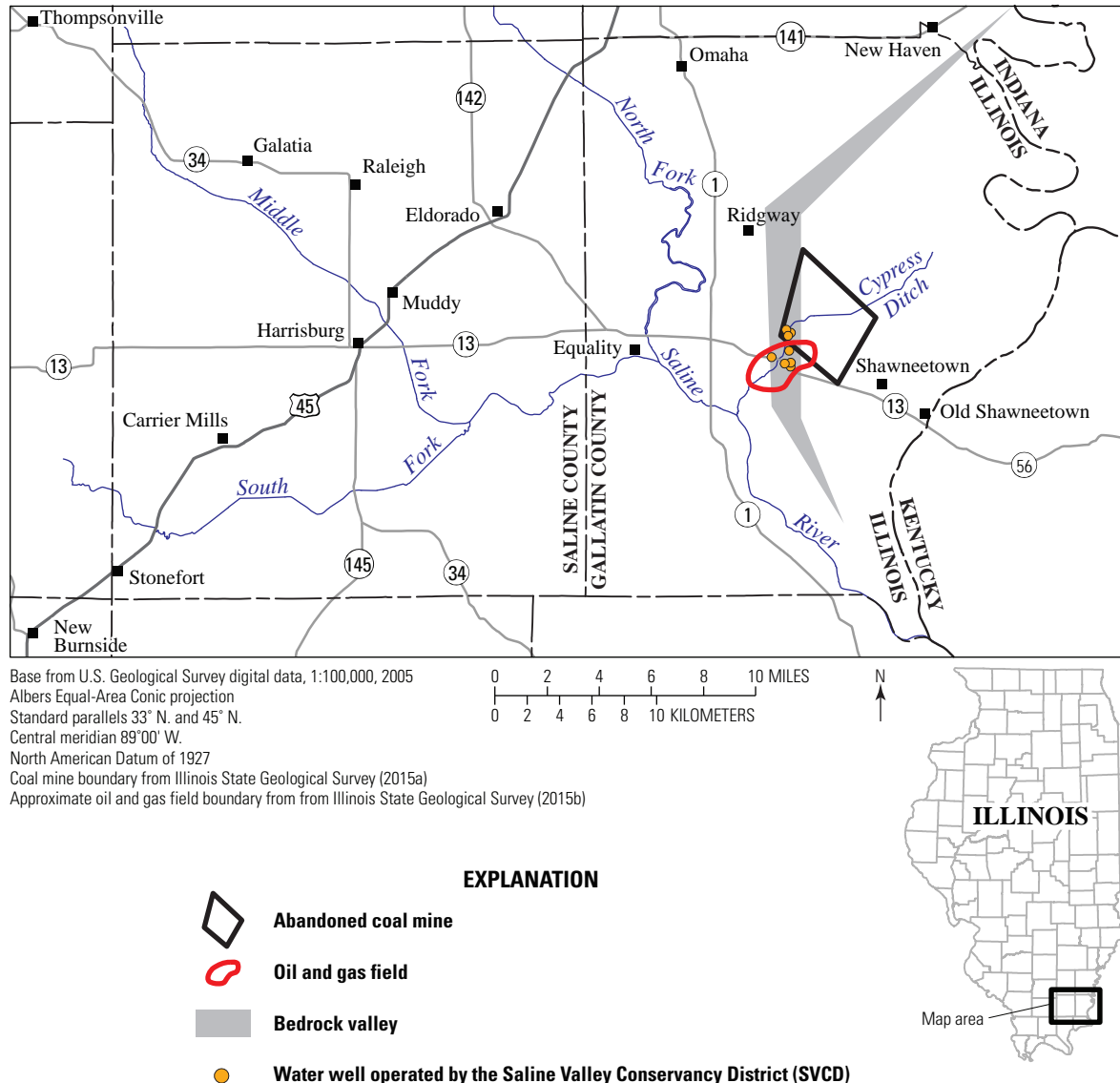


Figure 1. Selected features in Saline and Gallatin Counties, Illinois.



**Table 1.** Summary information for Saline Valley Conservancy District (SVCD) wells, Gallatin County, Illinois.

[NAVD 88, North American Vertical Datum of 1988]

Well	Elevation of land surface (NAVD 88)	Elevation of screen interval (NAVD 88)	Unit monitored
SVCD1	363	228–278	Sand and gravel.
SVCD2	360	225–275	Sand and gravel.
SVCD3	360	225–275	Sand and gravel.
SVCD4	365	241–291	Sand and gravel.
SVCD6	356	230–280	Sand and gravel.
SVCD7	361	231–281	Sand and gravel.
SVCD8	355	235–285	Sand and gravel.

**Table 2.** Results of U. S. Geological Survey analysis of samples collected from Saline Valley Conservancy District (SVCD) wells, Gallatin County, Illinois, June 1, 2015.

[SU, standard units;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter; mg/L, milligrams per liter;  $\text{CaCO}_3$ , calcium carbonate;  $\mu\text{g}/\text{L}$ , micrograms per liter; <, less than; E, value exceeds calibration range, estimated value;  $^{\circ}\text{C}$ , degrees Celsius; pCi/L, picocuries per liter;  $\delta$ , del notation;  $^{18}\text{O}$ , oxygen-18; D, deuterium;  $^{34}\text{S}$ , sulfur-34; --, insufficient sample volume for analysis;  $^{13}\text{C}$ , carbon-13]

Character or constituent	Well name					
	SVCD1	SVCD2	SVCD4	SVCD6	SVCD7	SVCD8
pH, field (SU)	7.07	7.18	7.21	7.22	7.17	7.21
Specific conductance, field ( $\mu\text{S}/\text{cm}$ )	674	677	672	739	619	698
Alkalinity, lab (mg/L as $\text{CaCO}_3$ )	300	322	340	395	330	380
Aluminum ( $\mu\text{g}/\text{L}$ )	<3	<3	<3	<3	<3	<3
Antimony ( $\mu\text{g}/\text{L}$ )	<0.03	0.035	<0.03	<0.03	0.04	<0.03
Arsenic ( $\mu\text{g}/\text{L}$ )	7	4.1	39	6.9	10	7.7
Barium ( $\mu\text{g}/\text{L}$ )	51	42	61.5	64	70	67
Beryllium ( $\mu\text{g}/\text{L}$ )	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Boron ( $\mu\text{g}/\text{L}$ )	12.5	15	39	24	16	18
Bromide (mg/L)	<0.03	<0.03	<0.03	0.4	0.03	<0.03
Cadmium ( $\mu\text{g}/\text{L}$ )	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Calcium (mg/L)	100	100	82	95.5	84	93.5
Chloride (mg/L)	11	11	5.3	9.3	6.3	7.3
Chromium ( $\mu\text{g}/\text{L}$ )	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Cobalt ( $\mu\text{g}/\text{L}$ )	0.635	0.32	0.74	0.17	0.37	0.11
Copper ( $\mu\text{g}/\text{L}$ )	<0.8	<0.8	<0.8	<0.8	<0.8	1.2
Fluoride (mg/L)	0.15	0.18	0.25	0.25	0.19E	0.20E
Iron ( $\mu\text{g}/\text{L}$ )	3,100	2,900	2,700	1,750	2,800	1,700
Lead ( $\mu\text{g}/\text{L}$ )	0.052	0.094	0.11	0.14	0.2	<0.08

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**Table 2.** Results of U. S. Geological Survey analysis of samples collected from Saline Valley Conservancy District (SVCD) wells, Gallatin County, Illinois, June 1, 2015.—Continued

[SU, standard units;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter; mg/L, milligrams per liter;  $\text{CaCO}_3$ , calcium carbonate;  $\mu\text{g}/\text{L}$ , micrograms per liter; <, less than; E, value exceeds calibration range, estimated value;  $^\circ\text{C}$ , degrees Celsius; pCi/L, picocuries per liter;  $\delta$ , del notation;  $^{18}\text{O}$ , oxygen-18; D, deuterium;  $^{34}\text{S}$ , sulfur-34; --, insufficient sample volume for analysis;  $^{13}\text{C}$ , carbon-13]

Character or constituent	Well name					
	SVCD1	SVCD2	SVCD4	SVCD6	SVCD7	SVCD8
Lithium ( $\mu\text{g}/\text{L}$ )	2.4	2.5	2.0	0.73	2.4	1.5
Magnesium (mg/L)	33	32	37	39	33	37
Manganese ( $\mu\text{g}/\text{L}$ )	155	125	110	85	170	86
Molybdenum ( $\mu\text{g}/\text{L}$ )	1.1	1.6	9	5.1	3.5	4.5
Nickel ( $\mu\text{g}/\text{L}$ )	1.2	1.1	1.1	0.89	0.8	0.72
Potassium (mg/L)	0.87	0.81	0.93	1.1	0.74	0.88
Residue, 180 $^\circ\text{C}$ (mg/L)	410	410	370	415	350	400
Selenium ( $\mu\text{g}/\text{L}$ )	0.36	1.2	<0.05	<0.05	<0.05	<0.05
Silica (mg/L)	22	21	17.5	20	21	21
Silver ( $\mu\text{g}/\text{L}$ )	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Sodium (mg/L)	8.3	8.1	17	16.5	8.2	13.5
Specific conductance, laboratory ( $\mu\text{S}/\text{cm}$ )	670	675	670	740	620	700
Strontium ( $\mu\text{g}/\text{L}$ )	115	110	270	240	175	192
Sulfate (mg/L)	45	46	18	13.5	11	16
Uranium ( $\mu\text{g}/\text{L}$ )	0.85	0.62	0.13	0.335	0.11	0.19
Zinc ( $\mu\text{g}/\text{L}$ )	<2	5.35	<2	3.4	3.3	2.1
Radium-224 (pCi/L)	0.20	0.24	0.56	0.29	<0.24	<0.27
Radium-226 (pCi/L)	0.14	0.076	0.080	0.24	0.175	0.25
$\delta^{18}\text{O}$ Water (per mil)	-6.36	-6.34	-6.39	-5.99	-6.46	-6.25
$\delta\text{D}$ Water (per mil)	-37.87	-38.01	-38.36	-36.69	-38.53	-38.08
$\delta^{34}\text{S}$ Sulfate (per mil)	-13.52	-11.64	-5.94	2.66	-0.16	-13.38
$\delta^{18}\text{O}$ Sulfate (per mil)	0.28	1.84	4.88	8.09	11.49	5.29
Methane (mg/L)	0.0093	0.02	0.60	0.31	0.15	0.21
Ethane (mg/L)	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Propane (mg/L)	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
$\delta\text{D}$ Methane (per mil)	--	--	-183	-170	--	-169
$\delta^{13}\text{C}$ Methane (per mil)	--	--	-72.4	-75.8	-69.9	-44.9

**Table 3.** Results of U. S. Geological Survey analysis of samples collected from Saline Valley Conservancy District (SVCD) well 4, Gallatin County, Illinois, February 23, 2016.

[Dup, duplicate sample; SU, standard units;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter;  $\text{mg}/\text{L}$ , milligrams per liter;  $\text{CaCO}_3$ , calcium carbonate;  $\mu\text{g}/\text{L}$ , micrograms per liter; <, less than; na, not analyzed;  $^{\circ}\text{C}$ , degrees Celsius;  $\text{pCi}/\text{L}$ , picocuries per liter;  $\delta$ , del notation;  $^{18}\text{O}$ , oxygen-18; D, deuterium;  $^{34}\text{S}$ , sulfur-34;  $^{13}\text{C}$ , carbon-13]

Character or constituent	Well name		Relative percent difference
	SVCD4	SVCD4 Dup	
pH, field (SU)	7.52	7.52	0.0
Specific conductance, field ( $\mu\text{S}/\text{cm}$ )	670	670	0.0
Alkalinity, lab ( $\text{mg}/\text{L}$ as $\text{CaCO}_3$ )	367	367	0.0
Aluminum ( $\mu\text{g}/\text{L}$ )	5.2	7.2	-8.1
Antimony ( $\mu\text{g}/\text{L}$ )	<0.027	<0.027	na
Arsenic ( $\mu\text{g}/\text{L}$ )	37	37	0.0
Barium ( $\mu\text{g}/\text{L}$ )	60	59	0.42
Beryllium ( $\mu\text{g}/\text{L}$ )	<0.02	<0.02	na
Boron ( $\mu\text{g}/\text{L}$ )	48	51	-1.5
Bromide ( $\text{mg}/\text{L}$ )	0.026	0.026	0.0
Cadmium ( $\mu\text{g}/\text{L}$ )	<0.03	<0.03	na
Calcium ( $\text{mg}/\text{L}$ )	78	78	0.0
Chloride ( $\text{mg}/\text{L}$ )	5.5	5.5	0.0
Chromium ( $\mu\text{g}/\text{L}$ )	<0.3	<0.3	na
Cobalt ( $\mu\text{g}/\text{L}$ )	0.65	0.64	0.39
Copper ( $\mu\text{g}/\text{L}$ )	<0.8	0.86	na
Fluoride ( $\text{mg}/\text{L}$ )	0.25	0.25	0.0
Iron ( $\mu\text{g}/\text{L}$ )	2,610	2,620	-0.10
Lead ( $\mu\text{g}/\text{L}$ )	0.042	0.046	-2.3
Lithium ( $\mu\text{g}/\text{L}$ )	2.1	3.0	-8.8
Magnesium ( $\text{mg}/\text{L}$ )	37	37	0.0
Manganese ( $\mu\text{g}/\text{L}$ )	116	116	0.0
Molybdenum ( $\mu\text{g}/\text{L}$ )	8.5	8.4	0.30
Nickel ( $\mu\text{g}/\text{L}$ )	0.62	1.8	-24
Potassium ( $\text{mg}/\text{L}$ )	0.94	0.96	-0.52
Residue, 180 $^{\circ}\text{C}$ ( $\text{mg}/\text{L}$ )	390	382	0.52
Selenium ( $\mu\text{g}/\text{L}$ )	<0.05	<0.05	na
Silica ( $\text{mg}/\text{L}$ )	17	17	0.0
Silver ( $\mu\text{g}/\text{L}$ )	<0.02	<0.02	na
Sodium ( $\text{mg}/\text{L}$ )	16	16	0.0
Specific conductance, laboratory ( $\mu\text{S}/\text{cm}$ )	670	672	-0.07
Strontium ( $\mu\text{g}/\text{L}$ )	268	265	0.28

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**Table 3.** Results of U. S. Geological Survey analysis of samples collected from Saline Valley Conservancy District (SVCD) well 4, Gallatin County, Illinois, February 23, 2016.—Continued

[Dup, duplicate sample; SU, standard units;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter;  $\text{mg}/\text{L}$ , milligrams per liter;  $\text{CaCO}_3$ , calcium carbonate;  $\mu\text{g}/\text{L}$ , micrograms per liter; <, less than; na, not analyzed;  $^\circ\text{C}$ , degrees Celsius;  $\text{pCi}/\text{L}$ , picocuries per liter;  $\delta$ , del notation;  $^{18}\text{O}$ , oxygen-18; D, deuterium;  $^{34}\text{S}$ , sulfur-34;  $^{13}\text{C}$ , carbon-13]

Character or constituent	Well name		Relative percent difference
	SVCD4	SVCD4 Dup	
Sulfate (mg/L)	20	20	0.0
Uranium ( $\mu\text{g}/\text{L}$ )	0.13	0.13	0.0
Zinc ( $\mu\text{g}/\text{L}$ )	<2	<2	na
Radium-224 (pCi/L)	<0.17	<0.17	na
Radium-226 (pCi/L)	0.16	0.16	0.0
$\delta^{18}\text{O}$ Water (per mil)	-6.37	-6.39	-0.08
$\delta\text{D}$ Water (per mil)	-38.24	-38.24	0.0
$\delta^{34}\text{S}$ Sulfate (per mil)	-6.72	-6.75	-0.11
$\delta^{18}\text{O}$ Sulfate (per mil)	3.81	3.91	-0.65
Methane (mg/L)	0.60	0.59	0.42
Ethane (mg/L)	<0.0002	<0.002	na
Propane (mg/L)	<0.0002	<0.0002	na
$\delta\text{D}$ Methane (per mil)	-161.9	-162.4	-0.08
$\delta^{13}\text{C}$ Methane (per mil)	-79.8	-79.8	0.0

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**Appendix 1. Results of Analysis of Water Samples Collected by the Illinois Environmental Protection Agency from Saline Valley Conservancy District Wells, Gallatin County, Illinois**

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**Table 1–1.** Results of Illinois Environmental Protection Agency analysis of water samples collected from Saline Valley Conservancy District well 1. This well is Illinois Environmental Protection Agency well WL71300.

[°C, degrees Celsius; SU, standard units;  $\mu\text{mhos/cm}$ , micromhos per centimeter;  $\mu\text{g/L}$ , micrograms per liter; <, less than; mg/L, milligrams per liter; --, no data]

Analyte	Sampling date			
	6/13/1984	10/10/1984	12/20/1984	3/25/1985
Temperature, field (°C)	15	15	14	16
pH, field (SU)	7.1	7.0	7.1	7.3
Conductivity, field ( $\mu\text{mhos/cm}$ )	540	530	545	515
Turbidity, field ( $\mu\text{g/L}$ )	5	<1	<1	10
Alkalinity, lab, total (mg/L)	282	--	276	278
Aluminum ( $\mu\text{g/L}$ )	<1	<1	61	<1
Arsenic ( $\mu\text{g/L}$ )	7	7	7	6
Barium (mg/L)	40	43	39	35
Beryllium, total ( $\mu\text{g/L}$ )	<1	<1	<1	<1
Boron, total (mg/L)	<1	<1	<1	<1
Cadmium ( $\mu\text{g/L}$ )	4	<1	<1	4
Calcium (mg/L)	73	71	78	77
Chloride (mg/L)	5.7	6.0	7.2	7.5
Chromium ( $\mu\text{g/L}$ )	<1	<1	<1	6
Cobalt, total ( $\mu\text{g/L}$ )	<1	<1	<1	6
Copper, free ( $\mu\text{g/L}$ )	<1	<1	<1	<1
Cyanide (mg/L)	<1	<1	<1	<1
Fluoride (mg/L)	0.16	0.15	0.17	0.15
Iron ( $\mu\text{g/L}$ )	2,117	2,104	2,212	1,847
Lead ( $\mu\text{g/L}$ )	<1	<1	<1	<1
Magnesium (mg/L)	28	28	29	28
Manganese ( $\mu\text{g/L}$ )	136	127	137	115
Mercury ( $\mu\text{g/L}$ )	<1	<1	<1	<1
Nitrate (mg/L)	<1	<1	<1	<1
Nitrogen-Ammonia as (N) (mg/L)	<1	<1	<1	<1
Phosphate, total (mg/L)	0.13	0.14	0.15	0.16
Potassium (mg/L)	0.63	0.67	0.72	0.74
Selenium ( $\mu\text{g/L}$ )	<1	<1	<1	<1
Silica (mg/L)	20	19	20	22
Silver ( $\mu\text{g/L}$ )	<1	<1	<1	6
Sodium (mg/L)	7.10	7.10	6.80	6.50
Strontium ( $\mu\text{g/L}$ )	95	103	93	89
Sulfate (mg/L)	33	27	28	27
Vanadium, total ( $\mu\text{g/L}$ )	<1	<1	<1	<1
Zinc ( $\mu\text{g/L}$ )	<1	<1	<1	<1
Phenols ( $\mu\text{g/L}$ )	<1	<1	<1	<1
Bromodichloromethane ( $\mu\text{g/L}$ )	--	--	--	<1

**Table 1-1.** Results of Illinois Environmental Protection Agency analysis of water samples collected from Saline Valley Conservancy District well 1. This well is Illinois Environmental Protection Agency well WL71300.—Continued[°C, degrees Celsius; SU, standard units;  $\mu\text{mhos/cm}$ , micromhos per centimeter;  $\mu\text{g/L}$ , micrograms per liter; <, less than;  $\text{mg/L}$ , milligrams per liter; --, no data]

Analyte	Sampling date			
	6/13/1984	10/10/1984	12/20/1984	3/25/1985
Carbon Tetrachloride ( $\mu\text{g/L}$ )	--	--	--	<1
1,2-Dichloroethane ( $\mu\text{g/L}$ )	--	--	--	<1
Bromoform ( $\mu\text{g/L}$ )	--	--	--	<1
Chloroform ( $\mu\text{g/L}$ )	--	--	--	<1
Trichloroethylene ( $\mu\text{g/L}$ )	--	--	--	<1
Toluene ( $\mu\text{g/L}$ )	--	--	--	<1
Benzene ( $\mu\text{g/L}$ )	--	--	--	<1
Chlorobenzene ( $\mu\text{g/L}$ )	--	--	--	<1
Ethylbenzene ( $\mu\text{g/L}$ )	--	--	--	<1
Dichloromethane ( $\mu\text{g/L}$ )	--	--	--	<1
Tetrachloroethylene ( $\mu\text{g/L}$ )	--	--	--	<1
1,1-Dichloroethane ( $\mu\text{g/L}$ )	--	--	--	<1
1,1-Dichloroethylene ( $\mu\text{g/L}$ )	--	--	--	<1
1,1,1-Trichloroethane ( $\mu\text{g/L}$ )	--	--	--	<1
Dibromochloromethane ( $\mu\text{g/L}$ )	--	--	--	<1
Endrin ( $\mu\text{g/L}$ )	--	--	--	<1
Ethion ( $\mu\text{g/L}$ )	--	--	--	<1
Toxaphene ( $\mu\text{g/L}$ )	--	--	--	<1
Heptachlor ( $\mu\text{g/L}$ )	--	--	--	<1
Heptachlor Epoxide ( $\mu\text{g/L}$ )	--	--	--	<1
Terbufos ( $\mu\text{g/L}$ )	--	--	--	<1
Malathion ( $\mu\text{g/L}$ )	--	--	--	<1
Ortho-Para DDE ( $\mu\text{g/L}$ )	--	--	--	<1
2,4-D ( $\mu\text{g/L}$ )	--	--	--	<1
Fonofos ( $\mu\text{g/L}$ )	--	--	--	<1
Methoxychlor ( $\mu\text{g/L}$ )	--	--	--	<1
Aldrin ( $\mu\text{g/L}$ )	--	--	--	<1
2,4,5-TP ( $\mu\text{g/L}$ )	--	--	--	<1
BHC-Gamma ( $\mu\text{g/L}$ )	--	--	--	<1
Diflubenzuron ( $\mu\text{g/L}$ )	--	--	--	<1
Para-Para DDE ( $\mu\text{g/L}$ )	--	--	--	<1
Ortho-Para DDD ( $\mu\text{g/L}$ )	--	--	--	<1
Para-Para DDD ( $\mu\text{g/L}$ )	--	--	--	<1
Ortho-Para DDT ( $\mu\text{g/L}$ )	--	--	--	<1
Para-Para DDT ( $\mu\text{g/L}$ )	--	--	--	<1
Thimet ( $\mu\text{g/L}$ )	--	--	--	<1
Dieldrin ( $\mu\text{g/L}$ )	--	--	--	<1
Spectracide ( $\mu\text{g/L}$ )	--	--	--	<1

**10 Groundwater Quality at the Saline Valley Conservancy District Well Field, Gallatin County, Illinois**

**Table 1–2.** Results of Illinois Environmental Protection Agency (IEPA) analysis of water samples collected from Saline Valley Conservancy District well 2 (SVCD2) and well 3 (SVCD3). Well 2 is IEPA well WL71301. Well 3 is IEPA well WL71302.

[°C, degrees Celsius; SU, standard units; µmhos/cm, micromhos per centimeter; µg/L, micrograms per liter; <, less than; mg/L, milligrams per liter]

Analyte	SVCD2	SVCD3	Analyte	SVCD2	SVCD3
	12/18/1986	12/18/1986		12/18/1986	12/18/1986
Temperature, field (°C)	15	16	Potassium (mg/L)	<1	0.41
pH, field (SU)	7.2	7.1	Selenium (µg/L)	<1	<1
Conductivity, field (µmhos/cm)	450	490	Silica (mg/L)	20	21
Turbidity, field (µg/L)	<1	<1	Silver (µg/L)	<1	<1
Aluminum (µg/L)	<1	<1	Sodium (mg/L)	5.4	7.1
Arsenic (µg/L)	3	6	Strontium (µg/L)	74	84
Barium (mg/L)	30	39	Sulfate (mg/L)	25	28
Beryllium, total (µg/L)	<1	<1	Vanadium, total (µg/L)	<1	<1
Boron, total (mg/L)	<1	<1	Zinc (µg/L)	<1	<1
Cadmium (µg/L)	<1	<1	Phenols (µg/L)	<1	<1
Calcium (mg/L)	71	78	Bromodichloromethane (µg/L)	<1	<1
Chloride (mg/L)	4.6	8.2	Carbon Tetrachloride (µg/L)	<1	<1
Chromium (µg/L)	<1	<1	1,2-Dichloroethane (µg/L)	<1	<1
Cobalt, total (µg/L)	<1	<1	Bromoform (µg/L)	<1	<1
Copper, free (µg/L)	<1	<1	Chloroform (µg/L)	<1	<1
Cyanide (mg/L)	<1	<1	Trichloroethylene (µg/L)	<1	<1
Fluoride (mg/L)	0.22	0.18	Toluene (µg/L)	<1	<1
Iron (µg/L)	2,298	2,363	Benzene (µg/L)	<1	<1
Lead (µg/L)	<1	5	Chlorobenzene (µg/L)	<1	<1
Magnesium (mg/L)	25	28	Ethylbenzene (µg/L)	<1	<1
Manganese (µg/L)	80	117	Dichloromethane (µg/L)	<1	<1
Mercury (µg/L)	<1	<1	Tetrachloroethylene (µg/L)	<1	<1
Nitrogen-Ammonia as (N) (mg/L)	<1	<1	1,1-Dichloroethane (µg/L)	<1	<1
Nitrate (mg/L)	0.13	<1	1,1-Dichloroethylene (µg/L)	<1	<1
Phosphate, total (mg/L)	0.12	0.14	1,1,1-Trichloroethane (µg/L)	<1	<1
			Dibromochloromethane (µg/L)	<1	<1



**Table 1-3.** Results of Illinois Environmental Protection Agency (IEPA) analysis of water samples collected from Saline Valley Conservancy District well 4 (SVCD4), well 6 (SVCD6), well 7 (SVCD7), and well 8 (SVCD8). Well 4 is IEPA well WL00728. Well 6 is IEPA well WL01331. Well 7 is IEPA well WL01510. Well 8 is IEPA well WL01511.

[°C, degrees Celsius; SU, standard units;  $\mu\text{mhos/cm}$ , micromhos per centimeter; mg/L, milligrams per liter;  $\mu\text{g/L}$ , micrograms per liter; <, less than;  $\text{CaCO}_3$ , calcium carbonate]

Analyte	SVCD4	SVCD6	SVCD7	SVCD8
	5/31/2012	5/31/2012	5/31/2012	5/31/2012
Temperature, field (°C)	15	15	16	15
pH, field (SU)	7.04	6.95	6.96	6.87
Conductivity, field ( $\mu\text{mhos/cm}$ )	659	730	624	667
Alkalinity, total, lab (mg/L)	355	400	340	375
Aluminum ( $\mu\text{g/L}$ )	<100	<100	<100	<100
Antimony, total ( $\mu\text{g/L}$ )	<2	<2	<2	<2
Arsenic ( $\mu\text{g/L}$ )	57	6.4	8.1	6.2
Barium (mg/L)	59	64	74	69
Beryllium, total ( $\mu\text{g/L}$ )	<1	<1	<1	<1
Boron, total ( $\mu\text{g/L}$ )	54	35	33	37
Cadmium ( $\mu\text{g/L}$ )	<3	<3	<3	<3
Calcium (mg/L)	76.4	92.3	80	86.3
Chloride (mg/L)	5	8	4.6	3.2
Chromium ( $\mu\text{g/L}$ )	<5	<5	<5	<5
Cobalt, total ( $\mu\text{g/L}$ )	<10	<10	<10	<10
Copper, free ( $\mu\text{g/L}$ )	<100	<100	<100	<100
Cyanide (mg/L)	<0.2	<0.2	<0.2	<0.2
Fluoride (mg/L)	0.21	0.21	0.18	0.19
Hardness (mg/L as $\text{CaCO}_3$ )	34.9	40.1	34.2	37.3
Iron ( $\mu\text{g/L}$ )	3,090	1,780	2,910	1,690
Lead ( $\mu\text{g/L}$ )	<5	<5	<5	<5
Magnesium (mg/L)	38.5	41.5	34.6	38.2
Manganese ( $\mu\text{g/L}$ )	122	84	163	79
Mercury ( $\mu\text{g/L}$ )	<0.06	<0.06	<0.06	<0.06
Molybdenum ( $\mu\text{g/L}$ )	<20	<20	<20	<20
Nickel ( $\mu\text{g/L}$ )	<25	<25	<25	<25
Nitrate (mg/L)	<0.1	<0.1	<0.1	<0.1
Nitrogen-Ammonia as (N) (mg/L)	0.86	0.58	0.73	0.76
Phosphorous, total (mg/L)	0.14	0.11	0.15	0.09
Potassium (mg/L)	<1.4	<1.4	<1.4	<1.4
Selenium ( $\mu\text{g/L}$ )	<2	<2	<2	<2
Silica (mg/L)	19.6	23	22.5	24.1
Silver ( $\mu\text{g/L}$ )	<10	<10	<10	<10
Sodium (mg/L)	18	17	8.9	14.5
Strontium ( $\mu\text{g/L}$ )	282	243	187	190
Sulfate (mg/L)	29	30	27	27
Thallium ( $\mu\text{g/L}$ )	<2	<2	<2	<2

**12 Groundwater Quality at the Saline Valley Conservancy District Well Field, Gallatin County, Illinois**

**Table 1-3.** Results of Illinois Environmental Protection Agency (IEPA) analysis of water samples collected from Saline Valley Conservancy District well 4 (SVCD4), well 6 (SVCD6), well 7 (SVCD7), and well 8 (SVCD8). Well 4 is IEPA well WL00728. Well 6 is IEPA well WL01331. Well 7 is IEPA well WL01510. Well 8 is IEPA well WL01511.—Continued

[°C, degrees Celsius; SU, standard units; µmhos/cm, micromhos per centimeter; mg/L, milligrams per liter; µg/L, micrograms per liter; <, less than; CaCO<sub>3</sub>, calcium carbonate]

Analyte	SVCD4	SVCD6	SVCD7	SVCD8
	5/31/2012	5/31/2012	5/31/2012	5/31/2012
Total dissolved solids (mg/L)	388	446	402	218
Vanadium, total (µg/L)	<5	<5	<5	<5
Zinc (µg/L)	<100	<100	<100	<100
Phenols (µg/L)	<10	<10	<10	<10
1,2,4-Trichlorobenzene (µg/L)	<0.5	<0.5	<0.5	<0.5
Carbon Tetrachloride (µg/L)	<0.5	<0.5	<0.5	<0.5
1,2-Dichloropropane (µg/L)	<0.5	<0.5	<0.5	<0.5
1,2-Dichloroethane (µg/L)	<0.5	<0.5	<0.5	<0.5
Trichloroethylene (µg/L)	<0.5	<0.5	<0.5	<0.5
Toluene (µg/L)	<0.5	<0.5	<0.5	<0.5
Benzene (µg/L)	<0.5	<0.5	<0.5	<0.5
Chlorobenzene (µg/L)	<0.5	<0.5	<0.5	<0.5
Xylenes, total (µg/L)	<0.5	<0.5	<0.5	<0.5
Ethylbenzene (µg/L)	<0.5	<0.5	<0.5	<0.5
Dichloromethane (µg/L)	<0.5	<0.5	<0.5	<0.5
Tetrachloroethylene (µg/L)	<0.5	<0.5	<0.5	<0.5
1,1,2-Trichloroethane (µg/L)	<0.5	<0.5	<0.5	<0.5
Vinyl chloride (µg/L)	<0.5	<0.5	<0.5	<0.5
Cis-1,2-Dichloroethylene (µg/L)	<0.5	<0.5	<0.5	<0.5
Trans-1,2-Dichloroethylene (µg/L)	<0.5	<0.5	<0.5	<0.5
Hexachlorobenzene (µg/L)	<0.1	<0.1	<0.1	<0.1
1,1,1-Trichloroethane (µg/L)	<0.5	<0.5	<0.5	<0.5
Styrene (µg/L)	<0.5	<0.5	<0.5	<0.5
1,1-Dichloroethylene (µg/L)	<0.5	<0.5	<0.5	<0.5
Methyl tert-butyl ether (µg/L)	<0.5	<0.5	<0.5	<0.5
o-Dichlorobenzene (µg/L)	<0.5	<0.5	<0.5	<0.5
p-Dichlorobenzene (µg/L)	<0.5	<0.5	<0.5	<0.5
Pentachlorophenol (µg/L)	<0.4	<0.4	<0.4	<0.4
Benzo(a)pyrene (µg/L)	<0.1	<0.1	<0.1	<0.1
Acifluorfen (µg/L)	<0.5	<0.5	<0.5	<0.5
Chlordane (µg/L)	<0.2	<0.2	<0.2	<0.2
Heptachlor epoxide (µg/L)	<0.02	<0.02	<0.02	<0.02
Trifluralin (µg/L)	<0.05	<0.05	<0.05	<0.05
Cyanazine (µg/L)	<0.5	<0.5	<0.5	<0.5
Lasso (µg/L)	<0.2	<0.2	<0.2	<0.2
Atrazine (µg/L)	<0.3	<0.3	<0.3	<0.3
Metolachlor (µg/L)	<0.25	<0.25	<0.25	<0.25
Hexachlorocyclopentadiene (µg/L)	<0.5	<0.5	<0.5	<0.5
Dinoseb (µg/L)	<1	<1	<1	<1

**Table 1-3.** Results of Illinois Environmental Protection Agency (IEPA) analysis of water samples collected from Saline Valley Conservancy District well 4 (SVCD4), well 6 (SVCD6), well 7 (SVCD7), and well 8 (SVCD8). Well 4 is IEPA well WL00728. Well 6 is IEPA well WL01331. Well 7 is IEPA well WL01510. Well 8 is IEPA well WL01511.—Continued

[°C, degrees Celsius; SU, standard units;  $\mu\text{mhos/cm}$ , micromhos per centimeter; mg/L, milligrams per liter;  $\mu\text{g/L}$ , micrograms per liter; <, less than;  $\text{CaCO}_3$ , calcium carbonate]

Analyte	SVCD4	SVCD6	SVCD7	SVCD8
	5/31/2012	5/31/2012	5/31/2012	5/31/2012
Di(2-ethylhexyl)phthalate ( $\mu\text{g/L}$ )	<1.8	<1.8	<1.8	<1.8
Simazine ( $\mu\text{g/L}$ )	<0.35	<0.35	<0.35	<0.35
Propachlor ( $\mu\text{g/L}$ )	<0.5	<0.5	<0.5	<0.5
Di(2-ethylhexyl) adipate ( $\mu\text{g/L}$ )	<0.6	<0.6	<0.6	<0.6
Dalapon ( $\mu\text{g/L}$ )	<5	<5	<5	<5
Acetochlor ( $\mu\text{g/L}$ )	<1	<1	<1	<1
Toxaphene ( $\mu\text{g/L}$ )	<1	<1	<1	<1
Methoxychlor ( $\mu\text{g/L}$ )	<0.1	<0.1	<0.1	<0.1
BHC-gamma ( $\mu\text{g/L}$ )	<0.02	<0.02	<0.02	<0.02
Endrin ( $\mu\text{g/L}$ )	<0.10	<0.1	<0.1	<0.1
Picloram ( $\mu\text{g/L}$ )	<1	<1	<1	<1
2,2,3,3,4,4,6-Heptachlorobiphenyl ( $\mu\text{g/L}$ )	<1	<1	<1	<1
Metribuzin ( $\mu\text{g/L}$ )	<0.1	<0.1	<0.1	<0.1
Dicamba ( $\mu\text{g/L}$ )	<0.25	<0.25	<0.25	<0.25
Total Polychlorinated Biphenyls ( $\mu\text{g/L}$ )	<0.40	<0.40	<0.4	<0.4
2,4-D ( $\mu\text{g/L}$ )	<1	<1	<1	<1
Aldrin ( $\mu\text{g/L}$ )	<0.05	<0.05	<0.05	<0.05
2,4,5-TP ( $\mu\text{g/L}$ )	<1	<1	<1	<1
Bromacil ( $\mu\text{g/L}$ )	<1	<1	<1	<1
Dieldrin ( $\mu\text{g/L}$ )	<0.05	<0.5	<0.5	<0.5

Publishing support provided by:  
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