Effects of Highway-Deicer Application on Ground-Water Quality in a Part of the Calumet Aquifer, Northwestern Indiana

By Lee R. Watson, E. Randall Bayless, Paul M. Buszka, and
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U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 01–4260

Prepared in cooperation with the
INDIANA DEPARTMENT OF TRANSPORTATION

Indianapolis, Indiana
2002

U.S. DEPARTMENT OF THE INTERIOR
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CONTENTS

FIGURES

TABLES

CONVERSION FACTORS, VERTICAL DATUM, AND ABBREVIATIONS

Multiply	By	To obtain
inch (in.)	2.54	centimeter
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
square mile (mi^2)	259.0	hectare
square mile (mi^2)	2.590	square kilometer
gallon (gal)	3.785	liter
gallon (gal)	0.003785	cubic meter
gallon per minute (gal/min)	0.06309	liter per second
foot per day (ft/d)	0.3048	meter per day
foot per mile (ft/mi)	0.1894	meter per kilometer

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

$$°F = (1.8 \times °C) + 32$$

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Altitude, as used in this report, refers to distance above or below sea level.

Hydraulic conductivity: The standard unit for hydraulic conductivity is foot per day.

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 either in milligrams per liter (mg/L) or micrograms per liter (μg/L). Abbreviated water-quality units used in this report: Chemical concentrations and water temperature are given in metric units. Milligrams per liter is a unit expressing the concentration of chemical constituents in solution as weight (milligrams) of solute per unit volume (liter) of water. One thousand micrograms per liter is equivalent to one milligram per liter. For concentrations less than 7,000 mg/L, the numerical value is the same as for concentrations in parts per million.

Concentrations of chemical constituents related to aquifer sediment are given in milliequivalents per 100 grams of aquifer sediment (meq/100 g). Cation exchange capacity is also reported in these units. A milliequivalent is defined as a weight of a chemical substance, divided by the formula weight of its composition elements and the assumed charge of the species. For example, calcium and magnesium have assumed charges of 2 and sodium and potassium have assumed charges of 1. Concentrations in solution saturation extracts are reported as milligrams of a constituent per liter of water used to perform the extraction from aquifer sediment (mg/L).

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Abstract

The effects of highway-deicer application on ground-water quality were studied at a site in northwestern Indiana using a variety of geochemical indicators. Site characteristics such as high snowfall rates; large quantities of applied deicers; presence of a high-traffic highway; a homogeneous, permeable, and unconfined aquifer; a shallow water table; a known ground-water-flow direction; and minimal potential for other sources of chloride and sodium to complicate source interpretation were used to select a study area where ground water was likely to be affected by deicer application. Forty-three monitoring wells were installed in an unconfined sand aquifer (the Calumet aquifer) near Beverly Shores in northwestern Indiana. Wells were installed along two transects that approximately paralleled ground-water flow in the Calumet aquifer and crossed US–12. US–12 is a highway that receives Indiana's highest level of maintenance to maintain safe driving conditions. Ground-water quality and water-level data were collected from the monitoring wells, and precipitation and salt-application data were compiled from 1994 through 1997.

The water-quality data indicated that chloride was the most easily traced indicator of highway deicers in ground water. Concentration ratios of chloride to iodide and chloride to bromide and Stiff diagrams of major element concentrations indicated that the principal source of chloride and sodium in ground water from the uppermost one-third to one-half of the Calumet aquifer and downgradient from US–12 was from a halite highway-deicer source. Borehole logs of relative electromagnetic conductivity defined a distinct plume of deicer-affected water in the uppermost 8 feet of aquifer at about 9 feet horizontally from the paved roadway edge and a zone of higher conductivity than background in the lower one-third of the aquifer. Chloride and sodium in the deep parts of the aquifer originated from natural sources.

Chloride and sodium from highway deicers were present in the aquifer throughout the year. The highest concentrations of chloride and sodium in ground water were determined in samples collected during the spring and summer from wells open to the water table within about 9 feet of the highway. Chloride concentrations in ground water that were attributable to highway deicers also were found in tested wells about 400 feet downgradient from US–12 during the fall and winter and at greater depths than in wells closer to US–12.

Chloride concentrations exceeded the U.S. Environmental Protection Agency's (USEPA) secondary maximum contaminant level of 250 milligrams per liter for drinking water at seven wells downgradient from the highway during late winter, spring, and summer samplings. The chloride standard was exceeded only in water from wells with total depths that are less than about 10 feet below land surface. Sodium concentrations in water periodically exceeded the USEPA drinking-water equivalency level of 20 milligrams per liter in both the uppermost (deicer

affected) and lower one-thirds of the aquifer. Sodium concentrations in ground water downgradient from US–12 and in the upper 5 feet of the aquifer also occasionally exceeded drinking-water standards for sodium (160 milligrams per liter) as set by the State of Florida and a standard for taste (200 milligrams per liter) as set by the World Health Organization.

Dispersion was identified by analysis of aquifer-test data, isotopic dating of ground water, and water-quality data to be the process most responsible for reducing concentrations of highway deicers in the aquifer. Chemical analyses of the sand composing the aquifer indicated that cation exchange decreased the mass of deicer-related sodium in ground water, although the sand has a limited capacity to sustain the process.

Automated daily measurements of specific conductance, correlated to chloride concentrations, indicated that some deicer is retained in the aquifer near the highway throughout the entire year and acts as a continuous chloride source for ground water. Peak concentrations of deicer-related constituents occasionally were detected by the daily, automated measurements of specific conductance that were made between the monthly samplings of ground water. Data analysis indicated that more frequent sampling than monthly intervals would be necessary if maximum chloride concentrations were to be measured.

Some deicer may be retained in the aquifer and unsaturated zone between annual salt-application periods. Chloride concentrations at wells 1-DG-WT and 2-DG-WT remained greater than background through much or all of the year. The estimated masses of chloride transported in ground water past 2-DG in 1995 and 1996 were either slightly greater than (1995) or less than (1996) the masses of chloride applied to US–12 during the study.

INTRODUCTION

The use of deicer chemicals is an important highway-safety practice used throughout Indiana and North America to keep driving surfaces free of ice and snow. The practice of applying highway-deicer chemicals has increased greatly since the 1950’s (Calabrese and Tuthil, 1978). The primary deicer chemicals used are sodium chloride, known by the mineral name halite (Gales and VanderMuelen, 1992, p. 136), and calcium chloride. Deicers typically work by dissolving in water, increasing the water’s salinity, and decreasing the freezing temperature of the water-deicer solution. The saline water and salt melt through the ice and snow on the highway and break the ice-to-road and snow-to-road bonds. As traffic breaks up the ice and snow, the resulting slurry flows, is plowed, or is splashed off the highway and onto adjacent soil. Infiltration of the saline water into soil and runoff into surface water by way of lined and unlined ditches occurs principally after thaws. If the surficial geology is permeable sand and gravel, the chemicals in highway runoff can infiltrate to the ground-water system and eventually affect nearby surface-water and ground-water quality.

Chloride and sodium concentrations in drinking water are regulated by the U.S. Environmental Protection Agency (USEPA) and other agencies and organizations under a variety of standards and guidelines as shown in table 1. The Indiana Department of Environmental Management regulates chloride concentrations in drinking water at the USEPA secondary maximum contaminant level but does not regulate sodium concentrations in water. Studies of ground-water contamination from deicer chemicals in Massachusetts and Ohio indicate needs for more data to evaluate (1) how deicing practices affect ground-water quality, (2) how to identify reliable indicators of saline water sources, and (3) how to establish baseline data to monitor deicer-affected changes in ground-water quality over time (Church, 1996; Jones and Sroka, 1997).

In Indiana, data on chloride and sodium concentrations in ground water near salted highways are scarce. These data are needed particularly for parts of the State such as northwestern Indiana that receive a considerable amount of snow and frequent deicer treatments to maintain safe driving conditions. By this study, the U.S. Geological Survey (USGS), in cooperation with the Indiana Department of Transportation (INDOT), establishes baseline information about the effects of deicers at a single area of northwestern Indiana. The study area specifically was selected because available information about deicer application, hydrogeology, and climatic factors indicated a potential for measurable effects on ground-water quality.

Table 1. Selected water-quality standards and guidelines for chloride and sodium in drinking water

[mg/L, milligrams per liter]

Regulated constituent	Agency or organization	Regulated concentration	Type of regulation
Chloride	U.S. Environmental Protection Agency	250 mg/L	Secondary maximum contaminant level[a]
Sodium	U.S. Environmental Protection Agency	20 mg/L	Drinking-water equivalency level[b]
	Massachusetts Department of Environmental Protection	20 mg/L	Drinking-water guideline[b,c]
	State of Maine, Department of Public Health	20 mg/L	Drinking-water standard[b,d]
	Florida Department of Environmental Protection	160 mg/L	Drinking-water standard[e]
	World Health Organization, United Nations	200 mg/L	Taste standard[f]
	Ontario Ministry of the Environment	200 mg/L	Taste standard[f]
	British Columbia, Safe Drinking Water Regulation	200 mg/L	Additional chemical standard (taste) [f]

[a]The Secondary Maximum Contaminant Level (SMCL) is a concentration level established by the U.S. Environmental Protection Agency (1992) to protect qualities of water such as taste and potential for pipe corrosion.

[b]The U.S. Environmental Protection Agency also has established a drinking-water equivalency level (DWEL) of 20 mg/L of sodium to protect the health of persons with hypertensive disorders (U.S. Environmental Protection Agency, 1998). Hypertensive disorders are diseases that cause difficulty in regulating body fluid volume or affect people who are on sodium-limited diets. Adverse health effects may be anticipated with sodium concentrations greater than 20 mg/L, however, for persons whose total sodium intake is restricted to 500 mg/d (National Research Council, 1977, p. 402).

[c]Massachusetts Department of Environmental Protection, Office of Research and Standards (2000).

[d]Maine Department of Public Health (2001).

[e]The Florida regulation was established to protect individuals who are susceptible to sodium sensitive hypertension or diseases that cause difficulty in regulating body fluid volume (Florida Department of Environmental Protection, 2000).

[f]These jurisdictions have established standards based primarily on taste or corrosion considerations (World Health Organization, 1993; Ontario Ministry of the Environment, 2000; Queen’s Printer, Province of British Columbia, 2001).

Background

The effects of highway deicers on lakes, streams, ground water, flora, and fauna have been studied since the 1950’s; in North America, studies have been done in southeastern Canada and in the Northeastern and upper Midwestern United States (D’Itri, 1992, p. iii). Close to the highways where deicers are applied, concentrations of chloride and sodium in ground water may substantially exceed background concentrations in ground water. Projections for urbanized watersheds of Toronto, Ontario, Canada, indicate that chloride and sodium concentrations in ground-water discharge to streams will ultimately exceed Ontario regulatory standards for drinking water (Howard and others, 1993).

The USGS has participated in cooperative studies of highway-deicer effects on ground-water quality in Ohio and Massachusetts with the respective State transportation agencies. In Ohio, eight sites were selected to represent different settings with respect to the amount of snowfall, deicer-application rates, and aquifer vulnerability (Jones and Sroka, 1997). At the five sites that received frequent snows and deicer application, downgradient concentrations of chloride in the water were from 2 to 72 times greater than the mean background concentrations (3 to 32 mg/L). In Massachusetts, a study indicated that constructed highway-drainage systems are effective in controlling contamination of ground water by highway deicers in runoff (Church, 1996). In that study, lined highway-drainage systems were more effective in controlling ground-water contamination than unlined drainage systems.

Ground-water studies in Indiana and adjacent areas of Illinois occasionally have identified concentrations of sodium and chloride at greater than background levels in shallow ground water that were attributed potentially to road-deicer application. Seven of the 10 largest sodium concentrations (those greater than or equal to 18 mg/L) and chloride concentrations (those greater than or equal to 34 mg/L) in water from the St. Joseph aquifer system in northern Indiana were from wells in mixed or urban land-use groups (Fenelon and others, 1995, p. 32 and 47). The source of the sodium and chloride was attributed primarily to salts used for highway deicing and water softening (Fenelon and others, 1995, p. 32). Water from two wells in the Calumet aquifer at the Indiana Dunes National Lakeshore (IDNL) had substantial amounts of sodium (250 and 620 mg/L) and chloride (710 and 820 mg/L) (Shedlock and others, 1994, p. 64). The authors attributed the origin of those concentrations primarily to application of highway deicers or upward leakage of brackish water from a bedrock formation. Water from several shallow wells that were near interstate highways about 5 miles west of the Indiana border with Illinois had sodium and chloride as the dominant ion pair among major ions (Duwelius and others, 1996, p. 24 and 30). These data indicate the potential for highway deicers to affect ground-water quality along northern Indiana highways and the potential for other sources of chloride and sodium to complicate source interpretation.

Wilcox (1986) measured the effects of an uncovered highway-deicer storage pile on an adjacent bog at the IDNL. The highway-deicer storage pile was established in 1963. By the late 1960's, tamarack trees in the bog were dying and being replaced by cattails and other salt-tolerant vegetation. Runoff from the storage pile and from the adjacent highway was identified as causing the die-off. The highway-deicer storage pile was covered with a domed enclosure in 1972, which reduced the concentration of highway deicers in the runoff. Deicer storage at the site ceased in 1981; however, deicer-laden runoff from the highway still affected the flora of the bog. Modifications were made to the highway drainage system to divert most highway runoff away from the bog. Reductions in the contribution of highway-deicer components to water in the bog indicate that regrowth of resident bog flora possibly could occur.

Purpose and Scope

This report describes a 1994–97 study of the effects of highway-deicer chemicals on ground-water quality in a part of the Calumet aquifer, a surficial sand aquifer in northwestern Indiana. The report (1) describes the presence and concentrations of deicer-related solutes in shallow ground water adjacent to a highway, (2) determines suitable chemical indicators and parameters to identify deicer-affected water quality, (3) evaluates hydrogeologic processes that affect migration of deicer-related solutes, and (4) evaluates the mass of deicer transport and retention of deicer in the aquifer between application seasons. The investigation focused on one area of northwestern Indiana, the part of the State that applies the largest quantities of deicer chemicals to roads. Information describing the study area, data-collection and analysis methods, and the results of these analyses are included in this report.

Selection and Description of the Study Area

The study area was in Porter County near the town of Beverly Shores in northwestern Indiana (fig. 1). The southern shore of Lake Michigan is about 2 mi north of the study area. This area was selected because it provided a situation where the effects of highway-deicing practices on ground-water quality were likely to be observed. Site-selection criteria included high snowfall rates to create potential for deicer application, presence of a high-traffic highway that receives winter maintenance, absence of interference from other potential sources of chloride and sodium, and a homogeneous and permeable unconfined aquifer with a shallow water table and known regional ground-water-flow directions.

Climate

The climate in Indiana is midwestern continental with four distinct seasons. Seasons range from hot, humid summers to cold, wet winters. In the study area, the mean daily minimum temperature is in January and is 16^{o}F (–8.9° C; Lou Brennan, National Park Service, Indiana Dunes National Lakeshore, written commun., 2001). The mean daily maximum temperature is in July and is 83° F (28.3° C).

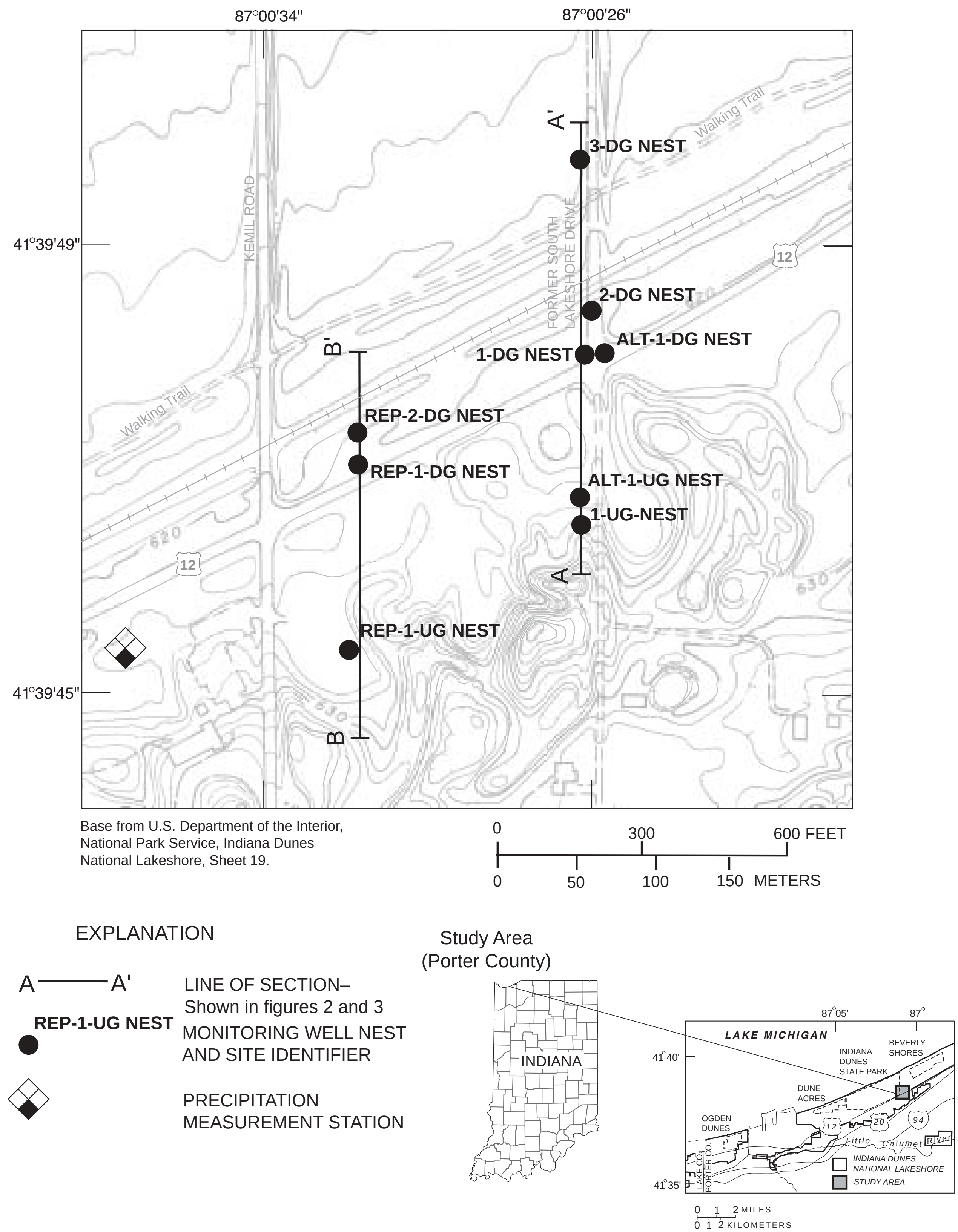


Figure 1. Location of study area, lines of section, monitoring well nests, and precipitation measurement station in northwestern Indiana at Indiana Dunes National Lakeshore near Beverly Shores.

Lake Michigan affects the climate of the study area (Schall, 1966, p. 166); air temperature extremes are moderated by the proximity to Lake Michigan. Mean annual snowfall for the study area is about 45.9 in./yr (Lou Brennan, National Park Service, Indiana Dunes National Lakeshore, written commun., 2001) compared with about 43.8 in./yr in the southern part of Porter County (National Oceanic and Atmospheric Administration, Midwestern Regional Climatic Center, 2001). Average precipitation in the study area is about 37 in./yr (Lou Brennan, National Park Service, Indiana Dunes National Lakeshore, written commun., 2001).

The heaviest snowfalls in Indiana occur in the northern part of the State, near and east of the southern tip of Lake Michigan, chiefly because of the "lake effect." Lake-effect snow is produced during the fall and winter when cold, arctic air masses move across a relatively warm body of water, such as Lake Michigan (Niziol, 2001). Moist, heated air from the warm lake rises into the cold, arctic air where it then cools and condenses into snow clouds. The prevailing wind direction through the depth of the snow clouds determines where the snow will fall. The study area was typically in the path of lake-effect snows and, therefore, would have a good potential for high snowfall rates during the study.

Land Use Characteristics

U.S. Highway 12 (US–12) is a major route that passes through the area of lake-effect snowfall. The two-lane highway is heavily traveled by steel-mill traffic between Michigan and northwestern Indiana and commuter traffic between the South Bend, Indiana, and the Gary, Indiana–Chicago, Illinois, metropolitan areas. US–12 also is a popular route for vehicle traffic around the southern tip of Lake Michigan. Because of the traffic load, INDOT has designated this segment of US–12 as a Class "A" highway requiring their highest level of maintenance to maintain safe driving conditions. The absence of roadside ditches and other diversions to surface water and the relatively flat topography promote rapid infiltration of highway runoff and snowmelt in the study area.

The segment of US–12 that passes through the IDNL has the fewest potential sources of chloride and sodium that could interfere with deicer detection in ground water, as compared with other segments of the highway. For example, domestic wastewater from septic systems can be a source of some of the same water-quality constituents that are attributed to highway-deicer chemicals, principally from urine, washing products, and water treatment (sodium-chloride-softened water) (National Research Council, 1977, p. 400–401). There is a seasonal-use residence with a septic system about 600 ft south of the upgradient well nest installed for this study. However, the residence was used about 6 months of the year and was not along the principal direction of ground-water flow that passes through the study site.

There were no other known sources of water-quality constituents that might be misidentified as deicer compounds in the study area. Interviews with railroad representatives verified that the railroad tracks north of US–12 (fig. 1) were not used to haul halite or other deicer-related chemicals. US–20 is 4,000 ft upgradient from the study area and was maintained with the same deicers that were applied to US–12. During this study, it was shown by water quality in upgradient monitoring wells and by isotopically determined ground-water recharge dates that upgradient deicer application had no effect on ground-water-quality observations made in the study area.

Physiographic and Hydrogeologic Characteristics

The route of US–12 follows the Calumet Lacustrine Plain physiographic unit described by Schneider (1966). The Calumet Lacustrine Plain is a former lakebed of glacial and postglacial age upon which have been deposited numerous beach ridges that represent successive strandlines of the former glacial Lake Chicago and Lake Michigan. Land-surface altitudes in the Calumet Lacustrine Plain range from about 580 to 640 ft above sea level (Schneider, 1966).

The study area was in an interdunal area between the Calumet dune-beach complex to the south and the Holocene Tolleston dune-beach complexes to the north (H.A. Lindgren, 1994). Many interdunal areas in the IDNL are occupied by wetlands. A wetland was about 350 feet downgradient from and north of US–12 in the study area.

A relatively permeable, unconfined aquifer was selected for study because it was expected to be vulnerable to contamination by highway deicers. An unconfined aquifer that is homogeneous would facilitate tracking of transported deicers through the ground-water system. Previous studies of the Calumet aquifer along US–12 indicated that it is principally a homogeneous, permeable, fine sand of dune and beach origin (Hartke and others, 1975; Shedlock and others, 1994). The Calumet aquifer near the study area consists of eolian and coastal-derived sands (Thompson, 1987). The sands are very well graded and composed of quartz (Petty and Jackson, 1966) with 10–15 percent potassium feldspar (Willman, 1942) and some heavy mineralization (Pettijohn, 1931).

Drilling records for wells within 200 ft of the study area indicated that the Calumet aquifer was unconfined; no low-permeability units were present except at the base of the aquifer. About 80 ft of a relatively impermeable confining unit composed of glacial-lacustrine clays and ablation tills underlies the Calumet aquifer (Shedlock and others, 1994, fig. 22, p. 52; Thompson, 1987; Brown and Thompson, 1995). The clay-rich unit is underlain immediately by the basal sand aquifer of Shedlock and others (1994, fig. 22, p. 52), a glacial-lacustrine sand interbedded with layers of silt and clay. The basal sand aquifer is about 70 to 75 ft thick near the study area and is underlain by Devonian system shale.

Monitoring well data from Shedlock and others (1994) indicated areas along US–12 where the depth to water generally was less than 10 ft. Ground-water recharge from highway runoff was anticipated to occur most rapidly at a site with a relatively shallow water table and an unconfined aquifer. Regional ground-water flow was northward towards Lake Michigan (Shedlock and others, 1994). In some areas of the IDNL, local ground-water flow deviates from this regional direction, as affected by creeks, ditches, wetlands, ponds, ground-water pumping, and local variations in geology (Shedlock and others, 1994); these effects were not present in the study area.

Acknowledgments

The USGS is grateful for the cooperation provided by the National Park Service; the Indiana Department of Transportation; and the Town of Beverly Shores, Indiana, in conducting this study. The National Park Service and the Town of Beverly Shores provided permission to install and access hydrologic monitoring instruments on their property for data collection. The National Park Service staff provided daily service of the wet-precipitation gage at the Indiana Dunes National Lakeshore Visitor Center. The Indiana Department of Transportation compiled highway-deicer application records and provided valued advice and logistics related to well location and sampling design.

METHODS OF STUDY

The following narrative describes the methods used to collect and analyze deicer application, hydrologic and water-quality data for this study. Methods used to collect hydrologic and water-quality data during this study were performed according to USGS standards and protocols. Other methods, such as those used to analyze aquifer sediment chemistry, were applied according to referenced literature.

Deicer-Application Record

Information describing deicers applied to US–12 was supplied to the USGS by the INDOT. Rock salt (halite) was the only deicer applied to US–12 in the study area from 1994 through 1997. Halite is about 98 percent pure sodium chloride. Sand also was applied to the road in a variety of recorded mixtures with halite. The main trace impurities in halite are sulfate, calcium, potassium, magnesium, and fluoride (Granato, 1996). Other constituents, such as bromide and iodide, are present in very small amounts. Application of highway deicers was done with spreader trucks. The INDOT recorded the masses of sand and halite deicer loaded into each truck that traversed the study area and the number of passes the truck made along each road mile.

The INDOT commonly uses liquid calcium chloride in combination with granular halite when temperatures are below about 20^{o}F. Calcium chloride was not applied to US–12 at the site during the study period (James Kaur, Indiana Department of Transportation, oral commun., 1997).

Well Installation and Development

Before instrumenting the study site, a single temporary monitoring well was installed in 1993 to complement two wells already present. Ground-water altitudes were measured, and the general direction of ground-water flow at that time was determined, by triangulating between the three measurements, to be approximately perpendicular to the highway.

Forty-three monitoring wells were installed from May 1994 through November 1994 at seven sites on two parallel transects, labeled A–A' and B–B' (table 2, figs. 1–3). Monitoring wells were assigned identifiers according to their position on a section and their relative depth in the aquifer. The identifier abbreviations UG and DG indicate upgradient and downgradient from US–12. The number preceding the identifier abbreviation indicates the position along the section. For example, site 3-DG was the third well site downgradient from the highway. The number following the identifier abbreviation indicates the relative depth in the aquifer. Level 5 wells were screened near, but below, the water table; level 3 wells were screened at about the middle of the aquifer, and level 1 wells were screened at the base of the aquifer. Level WT wells were screened through or within 1 ft of the water table.

Wells with identifier abbreviations ALT and REP (alternate and replicate) were installed to examine the variability in water-quality measurements. Monitoring wells with the ALT designation were installed to provide data to evaluate the variability in water quality between proximal wells. The purpose of the wells with the REP designation (section B–B') was to determine if deicer-affected groundwater quality varied along the highway.

Sections A–A' and B–B' cross the highway and were slightly offset from the direction of ground-water flow because of drilling-rig access limitations. Each transect had at least one site south of and upgradient from US–12 (one site at 1-UG and ALT-1-UG, and one at REP-1-UG) with wells that described background water quality, and two or more sites positioned at varying distances downgradient from the highway (sites 1-DG and ALT-1-DG, REP-1-DG, 2-DG, REP-2-DG, and 3-DG). Sites 1-DG, ALT-1-DG, and REP-1-DG were about 9 ft off the paved roadway edge, the closest distance that safely could be sampled without a lane closure. Sites 2-DG and REP-2-DG were about 106 ft off the paved roadway edge and were as far as possible from the roadway without encroaching on adjacent railroad right-of-way. Site 3-DG was about 396 ft off a paved former roadway edge along the only raised area of the wetland north of the railroad that was not subject to ponding. The 396-ft distance was selected as representing 1 year's traveltime at a typical ground-water flow rate of 1 ft/d. The upgradient sites (1-UG, ALT-1-UG, and REP-1-UG) were just off an unsalted public road or parking lot area. All monitoring wells were completed and screened within the aquifer.

The monitoring wells were installed by the USGS using a hollow-stem auger system (table 2). Wells at each site were drilled about 3 ft apart. Specifications were the same for all wells. All well screens and casings were constructed from flush-joint, 2-in.-inside-diameter, polyvinyl chloride (PVC) components. Well screens were slotted with 0.010-in. openings and were 5 ft long for the WT wells and 1 ft long for all other wells. The augers, soil-sampling equipment, and well components were steam cleaned before use, following procedures described by Aller and others (1991). Water used during well installation was potable and was obtained from a nearby municipal water supply.

The annular space surrounding the monitoring well screens was filled by collapse of natural material. Bentonite grout was used to fill the annular space from approximately 5 ft above the top of the screen to within 5 ft of land surface. The annular space from the top of the grout to the land surface was filled with concrete. The three downgradient WT wells did not have grout seals because the top of the screen was within 1 to 7 ft of the land surface. A locking, steel well protector was set into a 6-in.-thick concrete pad at land surface. Flush-to-the-ground protector pipes were used for wells installed at the 1-DG, ALT-1-DG, and REP-1-DG well nests to prevent creating a traffic hazard.

Wells were developed by overpumping to obtain a hydraulic connection between the well and the aquifer sediment and to ensure that the water used during well installation was removed from the aquifer before water-quality sampling. The volume of water produced from each well during development was at least 10 times that used during well drilling. Most wells sustained a pumping rate of 3.5 to 5 gal/min. Some WT and level 5 wells only produced about 1 gal/min because of a lack of drawdown capacity; the wells were installed at too shallow a depth to produce more water. Well development was completed at least 4 weeks before the initial water-quality sampling.

Table 2. Selected characteristics of monitoring wells along U.S. Highway 12 at Indiana Dunes National Lakeshore near Beverly Shores, Indiana

[USGS, U.S. Geological Survey; well depths, casing heights, and screen lengths are in feet; altitudes and intervals are in feet above sea level]

Well name	USGS station identification number	Land-surface altitude	Total depth from measuring point	Casing height above ground	Measuring point altitude[1]	Well-screen length	Screened interval
1-UG-1	413946087002601	628.20	41.45	2.69	630.89	0.67	589.99–590.66
1-UG-2	413946087002602	627.94	33.15	2.75	630.69	.67	598.09–598.76
1-UG-3	413946087002603	627.86	26.38	2.61	630.47	.67	604.64–605.31
1-UG-4	413946087002604	627.83	19.37	2.79	630.62	.67	611.80–612.47
1-UG-5	413946087002605	628.09	13.37	2.59	630.68	.67	617.86–618.53
1-UG-WT	413946087002606	628.20	15.34	3.20	631.40	4.67	616.61–621.28
ALT-1-UG-1	413947087002601	625.84	38.83	3.48	629.32	.67	591.04–591.71
ALT-1-UG-2	413947087002602	625.69	31.35	3.36	629.05	.67	598.25–598.92
ALT-1-UG-3	413947087002603	625.73	25.30	3.17	628.90	.67	604.15–604.82
ALT-1-UG-4	413947087002604	625.66	18.30	2.90	628.56	.67	610.81–611.48
ALT-1-UG-5	413947087002605	625.65	12.83	3.09	628.74	.67	616.46–617.13
ALT-1-UG-WT	413947087002606	625.73	15.34	3.18	628.91	4.67	614.12–618.79
1-DG-1	413950087002601	620.65	30.10	-.29	620.36	.67	590.81–591.48
1-DG-2	413950087002602	620.61	25.38	-.27	620.34	.67	595.51–596.18
1-DG-3	413950087002603	620.53	20.37	-.34	620.19	.67	600.37–601.04
1-DG-4	413950087002604	620.58	15.27	-.25	620.33	.67	605.61–606.28
1-DG-5	413950087002605	620.67	8.34	-.48	620.19	.67	612.40–613.07
1-DG-WT	413950087002606	620.58	6.33	-.28	620.30	4.67	614.52–619.19
ALT-1-DG-1	413950087002501	620.54	30.08	-0.26	620.28	0.67	590.75–591.42
ALT-1-DG-2	413950087002502	620.64	25.43	-0.26	620.38	0.67	595.50–596.17
ALT-1-DG-3	413950087002503	620.72	19.80	-.33	620.39	.67	601.14–601.81
ALT-1-DG-4	413950087002504	620.59	14.89	-.30	620.29	.67	605.95–606.62
ALT-1-DG-5	413950087002505	620.53	9.39	-.33	620.20	.67	611.36–612.03
ALT-1-DG-WT	413950087002506	620.70	6.16	-.28	620.42	4.67	614.81–619.48
2-DG-1	413951087002601	619.71	33.15	2.50	622.21	.67	589.61–590.28
2-DG-2	413951087002602	619.69	28.38	2.76	622.45	.67	594.62–595.29
2-DG-3	413951087002603	619.74	23.29	2.82	622.56	.67	599.82–600.49
2-DG-4	413951087002604	620.01	18.33	2.84	622.85	.67	605.07–605.74
2-DG-5	413951087002605	620.08	10.33	2.00	622.08	.67	612.30–612.97
2-DG-WT	413951087002606	619.62	8.76	2.86	622.48	4.67	614.27–618.94
3-DG-1	413953087002601	614.19	27.42	2.93	617.12	.67	590.25–590.92
3-DG-2	413953087002602	614.43	24.37	2.58	617.01	.67	593.19–593.86
3-DG-3	413953087002603	614.46	19.36	3.06	617.52	.67	598.71–599.38
3-DG-4	413953087002604	614.56	14.33	3.17	617.73	.67	603.95–604.62
3-DG-5	413953087002605	614.30	7.29	3.50	617.80	.67	611.06–611.73
3-DG-WT	413953087002606	614.71	9.32	2.51	617.22	4.67	608.45–613.12
REP-1-UG-3	413943087003202	623.50	22.14	2.22	625.72	.67	604.13–604.80
REP-1-UG-5	413943087003203	623.51	10.09	3.50	627.01	.67	617.47–618.14
REP-1-UG-WT	413943087003201	623.39	12.39	2.44	625.83	4.67	613.99–618.66
REP-1-DG-3	413947087003201	620.62	20.23	-.40	620.22	.67	600.54–601.21
REP-1-DG-5	413947087003202	620.69	8.31	-.26	620.43	.67	612.67–613.34
REP-2-DG-3	413948087003201	619.31	23.42	3.09	622.40	.67	599.53–600.20
REP-2-DG-5	413948087003202	619.41	10.37	2.90	622.31	.67	612.49–613.16

[1]The measuring point is a mark on the top of the casing of the monitoring well.

Falling-Head and Rising-Head Aquifer Tests

Falling-head and rising-head aquifer tests (slug tests) were done to estimate horizontal hydraulic conductivity of the Calumet aquifer. These tests were done instead of pumping-based aquifer tests so as not to substantially alter the flow system and distribution of any deicer-affected water in the aquifer. The tests were done at well sites 1-UG, ALT-1-UG, 1-DG, 2-DG, and 3-DG by using a solid plastic cylinder (slug) to displace water and a submersible pressure transducer with data logger to measure and record changes in water level. Sixty slug tests were completed during December 1996. Slug-test data were analyzed using the Bouwer and Rice analytical method (Bouwer, 1989; Bouwer and Rice, 1976).

To complete a slug test, the well cap was removed and the water level in the well was allowed to equilibrate with atmospheric pressure. The depth to the water level in the well was measured. A submersible pressure transducer was installed near the bottom of the well and monitored until the water level stabilized. The test then was initialized in the data logger and data collection was started. The slug was lowered smoothly and rapidly into the well to cause the water level to rise quickly (falling-head test). Data acquisition through the logger continued until the water level had stabilized at the pretest or static level, and data collection was ended. A rising-head test generally was completed in the same well following the falling-head test by withdrawing the slug from below the water level in the well. To preserve the integrity of the wells for water-quality sampling, the pressure transducer and the slug were cleaned before testing each well, using the protocol described later in this report for cleaning the water-quality sampling equipment.

Natural Gamma and Electromagnetic-Induction Borehole Logs

Borehole logs to measure natural gamma activity and electromagnetic-induction conductivity were completed in the deepest wells at sites 1-UG, 1-DG, 2-DG, and 3-DG. The methods used for the logging were the same as those described by Risch and Robinson (2001).

Borehole logs of electromagnetic conductivity measure the capacity of the aquifer sediments and ground water near a well to conduct electricity. The electromagnetic conductivity is related directly to the concentration of dissolved solids in the ground water and the content of clay in the aquifer sediment (Keys, 1990, p. 66). Because the Calumet aquifer is composed chiefly of sand, the electromagnetic-conductivity probe can be used to investigate vertical differences in the dissolved-solids concentration of ground water.

Negative values occasionally were recorded during the logging because the calibration temperature departed substantially from the ground-water temperature. After consultation with staff of Mt. Sopris Instrument Company (Jim Lococo, oral commun., 1997), a constant value was added to all data from logs with negative values to convert them to non-negative or “relative” values. Analysis of differences in the relative electromagnetic-conductivity values is used only to indicate relative differences in water salinity with depth at each of the downgradient sites.

Ground-Water-Quality Sampling and Analyses

During the study, 1,052 water-quality samples were collected on a monthly basis from December 1994 through June 1997. All monthly samples were laboratory analyzed for concentrations of chloride and measured onsite for specific conductance, dissolved oxygen, pH, and water temperature. Additional samples were collected quarterly and analyzed for concentrations of major ions and some trace elements (table 3). Some adjustments were made to the frequency of sample collection and the schedule of analyses for individual samples as the project progressed and the understanding of the hydrologic system evolved. The USGS National Water Quality Laboratory (NWQL) in Arvada, Colo., did water-quality analyses using methods consistent with those in Fishman and Friedman (1989). Alkalinity was determined onsite in a mobile laboratory for quarterly water samples by incremental titration of an unfiltered sample with sulfuric acid (Wilde and others, 1998).

Before sampling, the depth to water was measured in each well by using an electric tape. A submersible, positive-displacement pump, constructed of polytetrafluoroethylene and stainless-steel components, was used to purge and sample the wells. The pump intake was set at the top of the well screen

Table 3. Analytical constituents and properties, methods of analysis, and reporting limits for samples collected during 1994–97 from monitoring wells at Indiana Dunes National Lakeshore near Beverly Shores, Indiana

$CaCO_3$, calcium carbonate; USGS, U.S. Geological Survey, National Water Quality Laboratory, Arvada, Colorado; mg/L, milligram per liter; IC, ion chromatography; ICP, inductively coupled plasma; ISE, ion selective electrode; µg/L, microgram per liter, N, nitrogen; std. unit, standard unit; AA, atomic absorption spectrometry; SiO_2, silicon dioxide; µS/cm, microsiemens per centimeter; °C, degrees Celsius]

Constituent or property	Category	Analytical method	Laboratory	Reporting limits
Alkalinity as $CaCO_3$	Physical property	titration	field, USGS	1.0 mg/L
Bicarbonate	Anion	titration	field	1.0 mg/L
Bromide	Anion, trace element	IC	USGS	0.01 mg/L
Calcium	Cation	ICP	USGS	0.1 mg/L
Chloride	Anion	IC	USGS	0.1 mg/L
Dissolved oxygen	Characteristic	polarographic, membrane	field	0.1 mg/L
Dissolved solids	Physical property	gravimetric	USGS	1.0 mg/L
Fluoride	Anion	ISE-automated	USGS	0.1 mg/L
Iron	Metal	ICP	USGS	1.0 µg/L
		atomic absorption	USGS	10 µg/L
Iodide	Anion, trace element	IC	USGS	0.001 mg/L
Magnesium	Cation	ICP	USGS	0.1 mg/L
Manganese	Metal	ICP	USGS	3 or 1 µg/L
		atomic absorption	USGS	10 µg/L
Nitrate plus nitrite as N	Anion	colorimetric	USGS	0.02 mg/L
pH	Characteristic	electrometric	field	0.02 std. unit
Potassium	Cation	AA	USGS	0.1 mg/L
Silica as SiO_2	Metal	ICP	USGS	0.1 mg/L
Sodium	Cation	AA	USGS	0.1 mg/L
Specific conductance	Characteristic	electrometric	field	1.0 µS/cm
Sulfate	Anion	IC	USGS	0.1 mg/L
Water temperature	Characteristic	thermistor	field	0.1°C

during all purging and sampling. The discharge was routed through a flow-through chamber of a multiparameter water-quality meter to measure pH, specific conductance, dissolved oxygen, and water temperature.

A volume of water no less than three times the volume standing in the well was purged before sampling. After the three bore volumes of water were purged, pumping continued until consecutive measurements of pH, specific conductance, dissolved oxygen, and water temperature in the flow-through chamber had stabilized (Wood, 1976). The multiparameter water-quality meter was calibrated on a daily basis by using standard solutions and local atmospheric conditions. Most of the wells sustained a purge rate of 0.5 gal/min; however, the WT and level 5 wells were purged at 0.25 gal/min because of limited drawdown capacity. Well 1-UG-5 had very little capacity and was purged and sampled at a much reduced rate by using a peristaltic pump. To minimize the possibility of affecting nearby wells, purged water was discharged about 50 ft from the sampled well and perpendicular to the monitoring-well transects. When onsite measurements had stabilized, the flow-through chamber was disconnected and samples were collected. Before sampling the next well, the pumping equipment was rinsed internally and externally with deionized water.

Quality-Assurance Data

Quality-assurance data were collected to identify systematic problems associated with (1) collection and preservation of environmental samples, (2) laboratory and(or) field determination of chemical concentrations or water-quality characteristics, and (3) decontamination of sampling equipment. Quality-assurance samples included sequential duplicates and equipment blanks.

Sequential duplicates were two samples collected in close succession from the same well using the same equipment and methods. Sequential duplicates were used to assess the reproducibility of sample-collection procedures and water-quality analyses. A sequential duplicate sample was collected from every tenth well sampled. Sequential duplicates were submitted to the NWQL with environmental samples for identical analyses.

The log-percent difference (LPD) was computed to measure the relative difference (precision) between the environmental sample (S) and the sequential duplicate (D); LPD is defined as 100 ln (S/D) (Tornqvist and others, 1985). The LPD, unlike the conventional relative percent difference, is symmetric; the LPD between two concentrations is the same absolute value regardless of whether S or D is used as the point of comparison. The magnitude of the LPD is about equal to the average of the absolute deviation of the two possible traditional percent differences between two numbers.

Equipment blanks were used to determine if cleaning procedures successfully remove detectable concentrations of water-quality constituents from the pump and hoses. Two equipment blanks were collected during each monthly sampling from 1995 through 1997. Equipment blanks were collected after sampling wells that commonly produced water with the highest chloride concentrations; these wells were expected to pose the greatest potential for carryover contamination if equipment cleaning was inadequate. Equipment blanks were collected after decontamination by pumping deionized water through the pump and hoses and collecting and preserving a portion of the water for chemical analysis. Equipment blanks were analyzed for many of the same constituents and properties as the environmental samples.

Wells also were sampled in random order to eliminate systematic errors (such as changes in equipment or sampler performance during sampling) that could be attributed to routine well-visitation schedules. A random-number generator was used before each sampling event to determine the order of well sampling.

Ground-Water Isotope Sampling and Analyses

Ground-water samples were collected in August 1997 from 10 wells and analyzed for concentrations of tritium and tritiogenic helium. Tritium (hydrogen-3) and tritiogenic helium (helium-3) have been used in numerous studies to improve interpretations of site hydrology (Clark and Fritz, 1997; Plummer and others, 1993). The samples were collected, preserved, and analyzed according to methods described in U.S. Geological Survey National Water Quality Laboratory Technical Memorandum 97.04S (1997).

Tritium occurs naturally in ground water in small concentrations because of cosmic ray spallation. Substantial quantities of tritium were introduced artificially into the atmosphere by the testing of thermonuclear bomb devices during 1952–80 (Clark and Fritz, 1997). The peak years of bomb-related tritium in precipitation were 1963–64; since that time, tritium concentrations in precipitation have declined to near pre-1952 levels. Clark and Fritz (1997) proposed a qualitative method to estimate the date that a parcel of water recharged an aquifer (“ground-water age”) based on the tritium concentration and certain assumptions; this method was used to estimate the recharge dates for samples collected in the study area.

A more precise method for estimating ground-water age is by use of tritiogenic helium. Tritiogenic helium is a radiogenic degradation product of tritium (Schlosser and others, 1988). By measuring the concentrations of tritium, tritiogenic helium, and other related compounds, and by implementing relevant correction factors, a more precise ground-water age can be estimated. Tritiogenic helium is most useful for determining ground-water ages that are younger than 1970 and is less accurate for ground-water ages older than 1970 because of the potential for dispersive mixing with older water. The analytical uncertainty of tritiogenic-helium age dates typically is $\pm$ 0.5 year, although dispersive mixing can create larger uncertainties. Tritiogenic helium ages were calculated for seven ground-water samples. Of 10 ground-water samples, ages could not be interpreted in 3 because atmospheric gases contaminated the samples (table 4).

Aquifer-Sediment Sampling and Analyses

Six samples of Calumet aquifer sediment were extracted from selected depths in continuous cores collected at well sites 1-DG and 3-DG. The samples represent aquifer-sediment chemistry below the water

Table 4. Recharge dates for ground water inferred from tritium and tritium-helium methods at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, August 1997

[--, no measurement because of laboratory or sampling error; He, helium]

Well name	Tritium, in tritium units	Recharge date inferred from the tritium concentration, by year[1]	Corrected helium age, in years	Recharge date inferred from helium age, by year	Laboratory comments
ALT-1-UG-1	0.01 ± 0.10	Prior to 1952	100 ± 240	1887	Low tritium. High mineralogic helium.
ALT-1-UG-4	36 ± 1.5	Significant fraction from 1960 to 1980	--	--	Tritium value questionable.
ALT-1-UG-5	10 ± 0.20	1987–97	–2.1 ± 0.19	1997	δ^3He approximates equilibrium. Young water.
1-DG-1	0.19 ± 0.10	Prior to 1952	71 ± 9.8	1926	Low tritium. High mineralogic helium.
1-DG-4	10 ± 0.22	1987–97	6.9 ± 0.17	1990	Sample may be fractionated.
1-DG-5	9.4 ± 0.19	1987–97	--	--	No comment.
2-DG-5	10 ± 0.21	1987–97	--	--	No comment.
3-DG-1	0.16 ± 0.10	Prior to 1952	67 ± 11	1930	Low tritium. High mineralogic helium.
3-DG-4	10 ± 0.2	1987–97	9.1 ± 0.2	1988	No comment.
3-DG-WT	10 ± 0.21	1987–97	1.9 ± 0.17	1997	Young water. Uncorrected age used.

[1]Clark and Fritz, 1997.

table (well site 1-DG at 3 ft and well site 3-DG at 7 ft), from the middle of the aquifer (well site 1-DG at 15 ft and well site 3-DG at 13 and 15 ft) and from the base of the aquifer (well site 1-DG at 29 ft). Samples of aquifer sediment were submitted to an NWQL contract laboratory for measurements of cation-exchange capacity (Method 5A1b; U.S. Department of Agriculture, 1996), corrected exchangeable bases (Method 5B1b; U.S. Department of Agriculture, 1996), saturation paste and saturation extract (Methods 8A and 8A3; U.S. Department of Agriculture, 1996) with ion chromatographic analysis of anions (Method 300; U.S. Environmental Protection Agency, 1993) and inductively coupled plasma-atomic emission spectrometry analysis of cations (Method 200.7; U.S. Environmental Protection Agency, 1994). Duplicate analyses were done on each sample for quality assurance.

The cation exchange capacity (CEC) describes the capability of a soil or aquifer sediment to retain or release cations (U.S. Department of Agriculture, 1954); a cation is a positively charged ion such as sodium (Freeze and Cherry, 1979). Alternately, the CEC also is defined as the total number of negatively charged sites in a material where reversible sorption and desorption can occur (Hem, 1989). For this study area, the CEC was examined as an indicator of the capability of the aquifer to exchange ions, such as deicer-related sodium in ground water for calcium and magnesium sorbed onto aquifer sediment. The extent to which the cation exchange process occurs depends on various factors including the CEC of the aquifer sediment, the aqueous cation concentrations, the chemical properties of the exchangeable cations, and the ground-water pH and residence time (Freeze and Cherry, 1979).

Ancillary Measurements

Precipitation was measured using a standard 8-in., nonrecording precipitation station (fig. 1). The station was serviced and maintained by the staff of the Visitor's Center at the IDNL. Precipitation was recorded daily.

Three wells at site 2-DG were instrumented with sensors to make automated measurements of specific conductance. Data were recorded hourly and reported as a daily average. Wells 2-DG-4 and 2-DG-5 were instrumented with temperature-compensating specific-conductance probes. Well 2-DG-WT was instrumented with a submersible pressure transducer to measure water level and a temperature-compensating specific-conductance probe.

Air temperatures reported by this study were compiled from 1994–97 data collected from a measurement station at the IDNL Park Headquarters, about 2.5 miles west of the study area (Lou Brennan, National Park Service, written commun., 1997).

Statistical and Graphical Analysis of Water-Quality Data

Statistical compilations and analyses were completed for selected water-quality data using the S-Plus 2000 statistical software package (Mathsoft, Inc., 1999). Summary statistics were computed for the water-quality data: the minimum, median, maximum, and the first and third quartile values. Statistics were computed for each constituent or water-quality property at a well if five or more measurements were made.

Median and quartile statistics were not computed for iron and manganese. The reporting limits for iron and manganese changed during the study; two reporting limits were used for iron (1 microgram per liter [μg/L] and 10 μg/L) and three reporting limits were used for manganese (1 μg/L, 3 μg/L, and 10 μg/L). Because median values could not be determined precisely for iron and manganese, median and quartile statistics were not computed for those constituents and only minimum and maximum values were reported. Otherwise, if two or more samples from a well had iron or manganese concentrations that were less than (<) two different method reporting limits, the smaller of the two reporting limits was used to define the minimum value. For example, if five samples from a well were analyzed for iron and two of the samples had reported iron concentrations of <10 μg/L and <1 μg/L, the minimum value of iron reported for that well was <1 μg/L.

Box-and-whisker plots also were made for chloride data by using statistics determined with the S-Plus software. Box-and-whisker plots show the statistical variability within the data set of a single water-quality constituent or property by plotting the data distribution according to the 25th, 50th (median), and 75th percentiles as a box and the distribution of data outside the box as either whiskers or outliers. Box-and-whisker plots were made for chloride data because the monthly analyses provided more than 10 values for the statistical computations.

Vertically oriented scatterplots, similar to the box-and-whisker plots, were constructed to portray the distribution of sodium concentrations at each well. Each well had nine or fewer sodium analyses—a number that was not sufficient to construct box-and-whisker plots.

Contoured concentration data were used to show the two-dimensional distribution of chloride along section A–A', inferred from data collected on a single date. Because chloride is a product of halite dissolution and generally is nonreactive in sorption or mineral precipitation-dissolution reactions (Richter and Kreitler, 1991), it was used in contour plots to indicate the distribution of deicer compounds in ground water.

Linear regression relations of chloride concentrations and field measurements of specific conductance were developed for data from wells 2-DG-4, 2-DG-5, and 2-DG-WT. The automated, daily specific-conductance values measured in the three wells were used as input to the regression equations to create a record of estimated chloride concentrations at each well. The linear regression equations had the form

$$\text{Chloride (estimated, in mg/L)} = a \times (\text{Specific conductance, in } \mu\text{S/cm}) + b, \qquad (1)$$

where

a = the slope of the linear regression relation, and
b = the value of chloride when specific conductance equals zero.

Specific-conductance data from monthly water sampling and linear interpolation techniques were used to estimate specific-conductance data during periods of missing automated specific-conductance record when a probe or data logger did not function.

Using Chloride-to-Halide Ratios to Evaluate Chloride Sources

Ratios of aqueous concentrations of chloride (Cl) to bromide (Br) and Cl to iodide (I) (the ratios hereinafter referred to as Cl/Br and Cl/I) were used to evaluate the source of chloride in ground water. The source of chloride in a water sample may be inferred by the similarity of the Cl/Br and Cl/I ratios and the chloride concentration in a sample to ideal mixtures of (1) background water quality and (2) halite brine, deicer-affected water, or other saline water

(Whittemore and Pollock, 1979; Howard and Beck, 1993; Jones and Sroka, 1997). Cl/Br ratios were calculated for 29 water-quality samples collected during December 1994 and March–April 1995 that contained measurable concentrations of chloride and bromide. Cl/I ratios were computed for data from all quarterly samples collected during the study. Mixing curves were drawn for background ground water and several possible saline-water sources on the basis of their Cl/Br and Cl/I ratios and chloride concentrations. The chemical similarity of water samples from the down-gradient wells and one or both of the ideal mixtures was used to infer the source of chloride in that sample.

Field investigations have shown that certain ranges of Cl/Br ratios can be used to indicate various sources of chloride in ground water (table 5; Davis and others, 1998; Vengosh and Pankratov, 1998). The conservative nature of chloride and bromide and to a lesser extent iodide, makes the Cl/Br and Cl/I ratios well suited for tracing solute sources (Richter and Kreitler, 1991). Conservative constituents are affected only by dispersion and diffusion and not other geochemical processes. Bromide and iodide are incorporated into halite in trace proportions that are less than 30 times and 600 times, respectively, the proportion of chloride in halite (Holser, 1979, p. 298–299). The largest Cl/Br and Cl/I ratios have been interpreted to indicate that ground water has been affected by highway deicers or halite brines (table 5; Davis and others, 1998; Vengosh and Pankratov, 1998; Whittemore and Pollock, 1979; Knuth and others, 1990; Howard and Beck, 1986; Risch and Robinson, 2001). Saltwater intrusion and brine contamination from generally deep aquifers also can increase chloride concentrations in ground water. The Cl/Br and Cl/I ratios from these sources generally are less than values measured in deicer-affected ground water (Richter and Kreitler, 1991; Whittemore, 1988; Keller, 1983).

Table 5. Potential sources of chloride and associated ratios of chloride to bromide (Cl/Br) and chloride to iodide (Cl/I)

[--, no values cited; >, greater than]

Potential chloride source	Ranges of weight ratios (milligrams/milligrams)	
	Chloride/ Bromide	Chloride/ Iodide
Atmospheric deposition	[1]50–150	--
Urban runoff, summer	[1]10–100	--
Uncontaminated ground water	[1]100–200 [2]173–293	--
Domestic sewage	[1]300–600 [2]150–540	--
Formation brine, Devonian system, Muscatatuck Group	[3]146–292	--
Halite-dissolution brines	[1]1,000–10,000 [2]>600 [4]2,410–5,830 [5]3,620–9,560	[5]1,020,000–1,691,000
Halite road-deicer salts	[6]8,320–8,440	[7]1,543,000–1,582,000
Deicer-affected ground water, Indiana	[8]3,570–11,200	[8]184,000–516,000

Sources of data for this table:
[1]Davis and others (1998).
[2]Vengosh and Pankratov (1998).
[3]Keller (1983).
[4]Dutton (1989).
[5]Whittemore and Pollock (1979).
[6]Knuth and others (1990).
[7]Howard and Beck (1986).
[8]Risch and Robinson (2001).

Because of the potential for deep-aquifer chloride sources to affect local ground water (Shedlock and others, 1994, p. 64), brine analyses from the local bedrock, the Devonian series Muscatatuck Group (Keller, 1983), were used to compute Cl/Br ratios and compare deep-aquifer brine with shallow ground water. No local analyses of iodide were available for deep-aquifer brine to compute Cl/I ratios. Bromide and iodide can be added to solution through the decomposition of organic matter and the leaching of soluble minerals, such as from carbonate deposits enriched in bromide (Whittemore, 1988).

The ideal mixing curves to define the zones of mixing between background water and water affected by (1) halite brine, (2) road deicer, or (3) formation brine were constructed using the equation (Whittemore, 1988)

$$C\,(mix) = C\,(l) \times V + C\,(2) \times (1 - V), \tag{2}$$

where

C (mix) = concentration of trace species or chloride in the ideal mixture;
C (1) = concentration of trace species or chloride in background water with small chloride concentrations;
C (2) = concentration of trace species or chloride in water with larger chloride concentrations (deicer-affected water, halite brine, or deep-aquifer brine); and

V = volumetric fraction in ideal mixture of water with small chloride concentrations.

The zone of mixing was defined as the area between the upper and lower curves on each graph. Ratios of Cl/Br or Cl/I and chloride concentrations in ground water from the study area were plotted on the graph with the zones of mixing. Where the Cl/I weight ratios and chloride concentrations in a sample coincided with a zone of mixing, the source of the chloride was defined as the source or sources used to define the zone of mixing. For example, a sample that plots inside the zone of mixing between water with small chloride concentrations and halite brine is classified as obtaining its chloride from a brine formed by halite dissolution.

Lower and upper limits for ideal mixing curves were defined using analyses of background (upgradient) water reported in this study and published data on chloride sources with iodide and bromide determinations (halite brine, Kansas: Whittemore and Pollock, 1979; deicer-affected water: Howard and Beck, 1986 [Ontario, Canada, source, Cl/I data only] and Risch and Robinson, 2001 [Indiana source]; and Keller, 1983 [formation brine, Devonian system, Muscatatuck Group]). When the concentrations of Br and I were less than their reporting limits of <0.01 mg/L for Br and <0.001 mg/L for I, ratios were computed but were not used to define background water or to plot on mixing curves. The Cl/Br and Cl/I ratios commonly were reported as minimum values and were described as "not less than" a computed value.

EVALUATION OF QUALITY-ASSURANCE DATA

Results of water-quality analyses for environmental samples and sequential duplicates were compared for four constituents—chloride, sodium, iodide, and bromide (table 10). These constituent concentrations were considered most critical to evaluating water-quality effects of road-deicer application for two reasons: (1) An assessment of the reproducibility of chloride and sodium concentrations was needed to limit the potential for false positives—nonreproducible, large concentrations that exceed a drinking-water standard, and false negatives—nonreproducible, small concentrations that would indicate no effect on water quality. (2) Accurate, reproducible concentrations of iodide were needed to assess the potential disproportionate effect of small variations in iodide concentrations on Cl/I ratios and assessment of potential chloride sources in water. Iodide concentrations in ground water sampled during this study ranged from <0.001 to 0.01 mg/L for all but a few samples (tables 11 and 12).

Large concentrations of chloride determined in environmental samples were reproduced by analysis of the sequential duplicate samples. The LPD's for 103 comparisons of chloride concentrations between environmental and sequential duplicate samples were less than 5 percent for about 75 percent of the comparisons (table 10). All comparisons with LPD values greater than 10 percent had chloride concentrations less than or equal to 11 mg/L, much less than the USEPA Secondary Maximum Contaminant Level (SMCL) of 250 mg/L for chloride. In addition, LPD values were less than 5 percent for the four comparisons where chloride concentrations were greater than or equal to 200 mg/L. The data indicated no false positive chloride detections; detections of chloride concentrations greater than 11 mg/L were reproducible within 10 percent in sequential samples. The data also indicated no occurrence of false negatives; the differences in chloride concentrations between sequential duplicate samples at small concentrations were not sufficient to exceed a water-quality standard or indicate a difference in chloride source.

Large concentrations of sodium determined in environmental samples were reproduced by analysis of the sequential duplicate samples in all but one case. The LPD's for 29 comparisons of sodium concentrations between environmental and sequential duplicate samples were less than 5 percent for 75 percent of the comparisons (table 10). All but one comparison with LPD values greater than 5 percent had sodium concentrations less than or equal to 5 mg/L, or one-fourth of the USEPA drinking-water equivalency level (DWEL) of 20 mg/L. However, the only comparison with sodium concentrations of 100 mg/L or more had an LPD of 18.2 percent. This result indicates that analytical problems or variability in sodium concentrations in ground water can occur. The data indicate the need to reproduce analyses for sodium and other concentrations that may exceed water-quality standards. No false negatives were identified in the data; the differences in sodium concentrations between sequential duplicate samples at small concentrations were not sufficient to exceed a water-quality standard, as listed in table 1.

Although one sample had an LPD of 51.1 percent, the relative accuracy of the other iodide determinations indicated that ratios computed with these values typically would be reliable to evaluate chloride source. The LPD's for 22 comparisons of iodide concentrations between environmental and sequential duplicate samples were 15.4 percent or less for 75 percent of the comparisons (table 10). Three comparisons could not be computed because one of the paired samples had iodide concentrations less than the method reporting limit. Iodide concentrations ranged from 0.003 to 0.007 mg/L for the seven comparisons with non-zero LPD values.

LPD values for two of three comparisons with reported bromide concentrations in sequential duplicate samples were 0 and 19.4 percent (table 10). One comparison could not be computed because both samples had bromide concentrations less than the 0.01-mg/L reporting limit.

Summary statistics for water-quality analyses of equipment-blank samples indicated that equipment cleaning procedures between samplings were sufficient to eliminate carryover of contaminants from one environmental sample into the next (table 6). The maximum specific-conductance values in 31 equipment blanks and chloride concentrations in 34 equipment blanks were similar to the range of those values in the most dilute background samples from upgradient wells. The values and concentrations were not sufficiently large to substantially affect the concentrations of chloride, sodium, or other constituents in environmental samples.

Table 6. Summary statistics for water-quality analyses and specific-conductance measurements of equipment-blank samples collected during sampling at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1995–97, and of deionized water in 1995

[µS/cm, microsiemens per centimeter; mg/L, milligrams per liter, --, insufficient number of data to compute statistics; <, less than; N.A., not analyzed; $CaCO_3$, calcium carbonate]

Statistic	Water-quality parameter or constituent						
	Specific conductance (µS/cm)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
Maximum	54	0.73	0.1	1.4	<0.1	2.3	0.1
75th percentile	27.5	--	--	--	--	.3	--
Median	13	.15	<.1	<.2	<.1	.15	<.1
25th percentile	2	--	--	--	--	<.1	--
Minimum	1	<.1	<.1	<.1	<.1	<.1	<.1
Number of analyses	31	8	8	8	8	34	8
Deionized water, sampled 06/20/95	N.A.	.05	<.01	<.2	<.1	<.1	<.1

Statistic	Water-quality parameter or constituent						
	Alkalinity (mg/L as $CaCO_3$)	Fluoride (mg/L)	Silica (mg/L as SiO_2)	Iron (µg/L)	Manganese (µg/L)	Bromide (mg/L)	Iodide (mg/L)
Maximum	<1	<0.1	0.2	20	<10	<0.01	0.001
75th percentile	--	--	--	--	--	--	--
Median	--	<.1	<.1	<10	<1	--	<.001
25th percentile	--	--	--	--	--	--	--
Minimum	<1	<.1	<.1	<1	<1	<.01	<.001
Number of analyses	2	8	8	5	5	2	8
Deionized water, sampled 06/20/95	N.A.	<.1	<.01	3	<1	N.A	N.A

Four of the eight equipment-blank samples contained 0.001 mg/L of iodide. It is not known whether this iodide concentration was present in the deionized water used for the cleaning or whether some other source existed. The lack of other potential interfering constituents in the deionized water indicate that iodide contribution to the sample from the deionized water was less likely as a potential source. The frequency of iodide concentrations in the data that were <0.001 mg/L (table 6) indicate that the sampling procedures were capable of producing representative samples with concentrations near the method reporting limit if sufficient ground water flowed through the pump during purging. The results indicate a need for caution when interpreting Cl/I ratios computed using iodide concentrations at the reporting limit.

HYDROGEOLOGY OF THE STUDY AREA

The Calumet aquifer ranges from about 30 to 50 ft thick at the study area (figs. 2 and 3). Visual examination of drill cuttings and split-barrel core samples indicated that the Calumet aquifer in the study area consists of a very uniform, fine sand. Fine to medium sand was reported from 8 to 10 ft below land surface at site 3-DG. Some highway-building materials were mixed with surficial sands within the first 2 ft below land surface at site 1-DG. Dark organic matter was reported at the edge of a wetland forest from land surface to a depth of about 3.5 ft at site 3-DG.

Except near land surface, borehole geophysical logs of natural gamma radiation showed uniform distributions of gamma-emitting minerals (chiefly clay minerals and albitic feldspars) at all sites. Gamma measurements ranged from about 30 to 50 counts per second throughout the aquifer and were typical for a dune sand aquifer in northwestern Indiana (fig. 4; Brown and Thompson, 1995).

The logs of natural gamma radiation indicated slightly more clay content in the 5 ft of material near land surface at 1-DG-1 and 2-DG-1 and from about 622 to 625 ft above sea level at 1-UG-1. The larger clay content was not noted in the driller’s logs and may result from the well grouting materials. Drilling records indicate that during installation of 1-UG-1, a relatively large subsurface void was created near land surface and extensive grouting was required; the result of that activity was most likely the cause of the larger gamma counts at that site and at 1-DG-1 and 2-DG-1. The near-surface deposits of dark organic matter at site 3-DG that were noted in the drilling records do not appear in the natural gamma logs because of their lack of clay minerals.

Ground water generally flows north-northwestward from the dune ridge in the southern part of the study area (fig. 5). The water table generally was highest in the late spring and lowest in late fall. Hydraulic gradients at the water table between wells 1-DG-WT and 3-DG-WT were relatively flat, ranging from 0.0062 ft/ft in November 1995 to 0.0124 ft/ft in June 1996. The steepest gradients along this section were noted during the June measurements for each of the 3 years of monitoring (1995–97).

The most hydraulically conductive parts of the Calumet aquifer were at shallow depth close to US–12 (well 1-DG-5) and at intermediate depth farther downgradient from US–12 (wells 2-DG-4, 2-DG-3, 3-DG-4, and 3-DG-3; fig. 6). Values of horizontal hydraulic conductivity calculated from the slug tests ranged from 7.69 to 46.2 ft/d (table 13). The mean horizontal hydraulic conductivity for all tests was 25.3 ft/d. The mean horizontal hydraulic conductivity was 19.7 ft/d for level 1 wells, 22.6 ft/d for level 2 wells, 36.3 ft/d for level 3 wells, 33.5 ft/d for level 4 wells, 25.2 ft/d for level 5 wells, and 10.9 ft/d for water-table wells. The values of horizontal hydraulic conductivity ranged from 18.4 to 22.6 ft/d in level 1 wells, 18.2 to 27.8 ft/d in level 2 wells, 30.9 to 45.6 ft/d in level 3 wells, 26.9 to 43 ft/d in level 4 wells, 7.8 to 39.9 ft/d in level 5 wells, and 8.2 to 13.6 ft/d in water-table wells. Relatively lower hydraulic conductivity values were calculated for the water-table wells because of the limited saturated thickness of these wells and the presence of organic matter at 3-DG-WT.

The average ground-water velocities through section A–A' were computed and compared to water-quality data to qualify the extent that deicer-related compounds were being affected by hydrodynamic dispersion and chemical retardation. The average linear velocity of ground water at the level 4 depth ranged from 0.57 to 1.28 ft/d and averaged 1.02 ft/d (table 14). Average linear ground-water velocity was computed using the method described in Freeze and Cherry (1979), using an assumed porosity of 0.3. The time required for ground water to flow from 1-DG to 3-DG at the level 4 depth ranged from 250 days to 2.47 years and averaged 1.09 years. The average linear

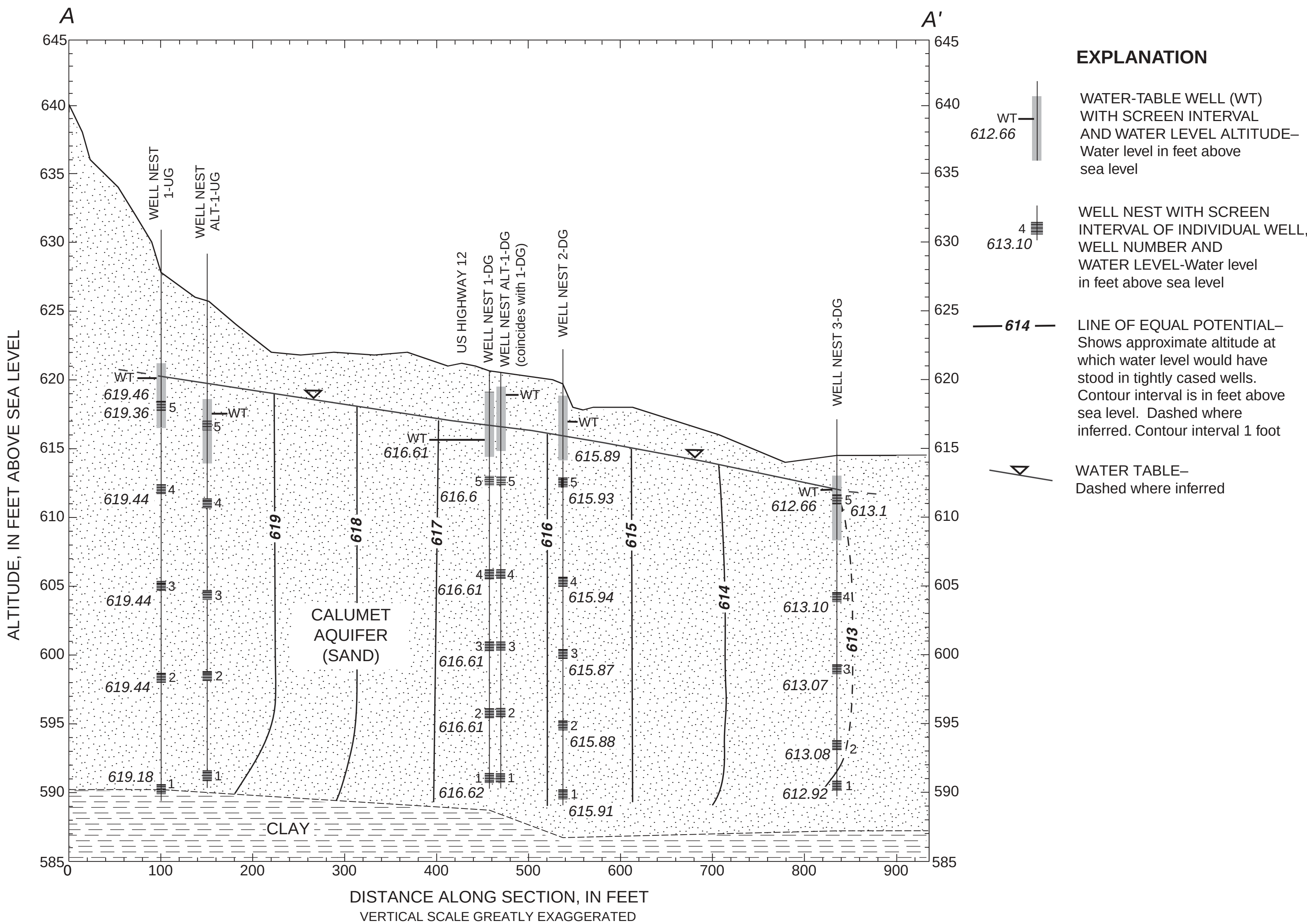


Figure 2. Hydrogeologic section showing well nests in the Calumet aquifer and the potentiometric surface along section A-A' at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, June 26–28, 1995 (trace of section shown in figure 1).

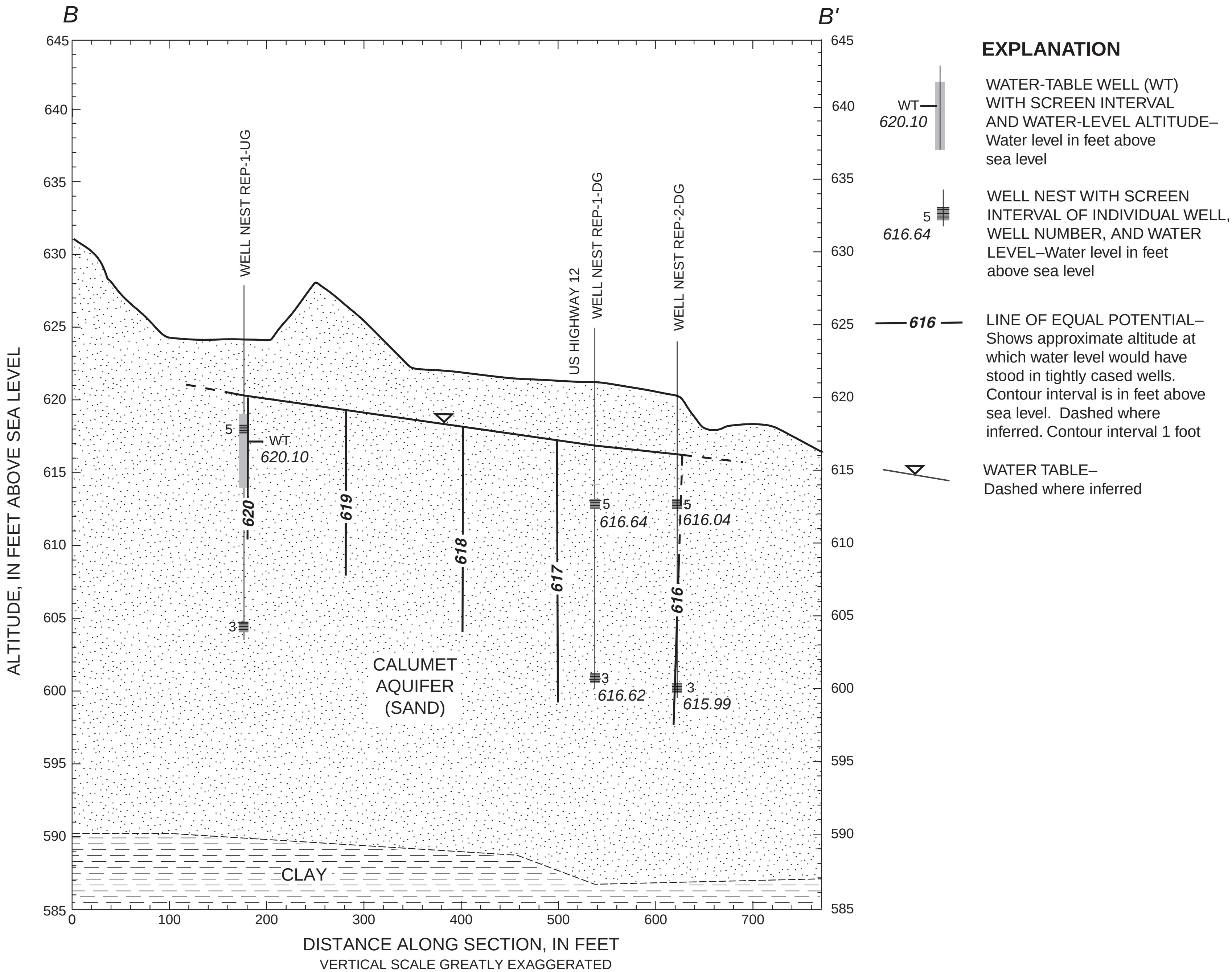
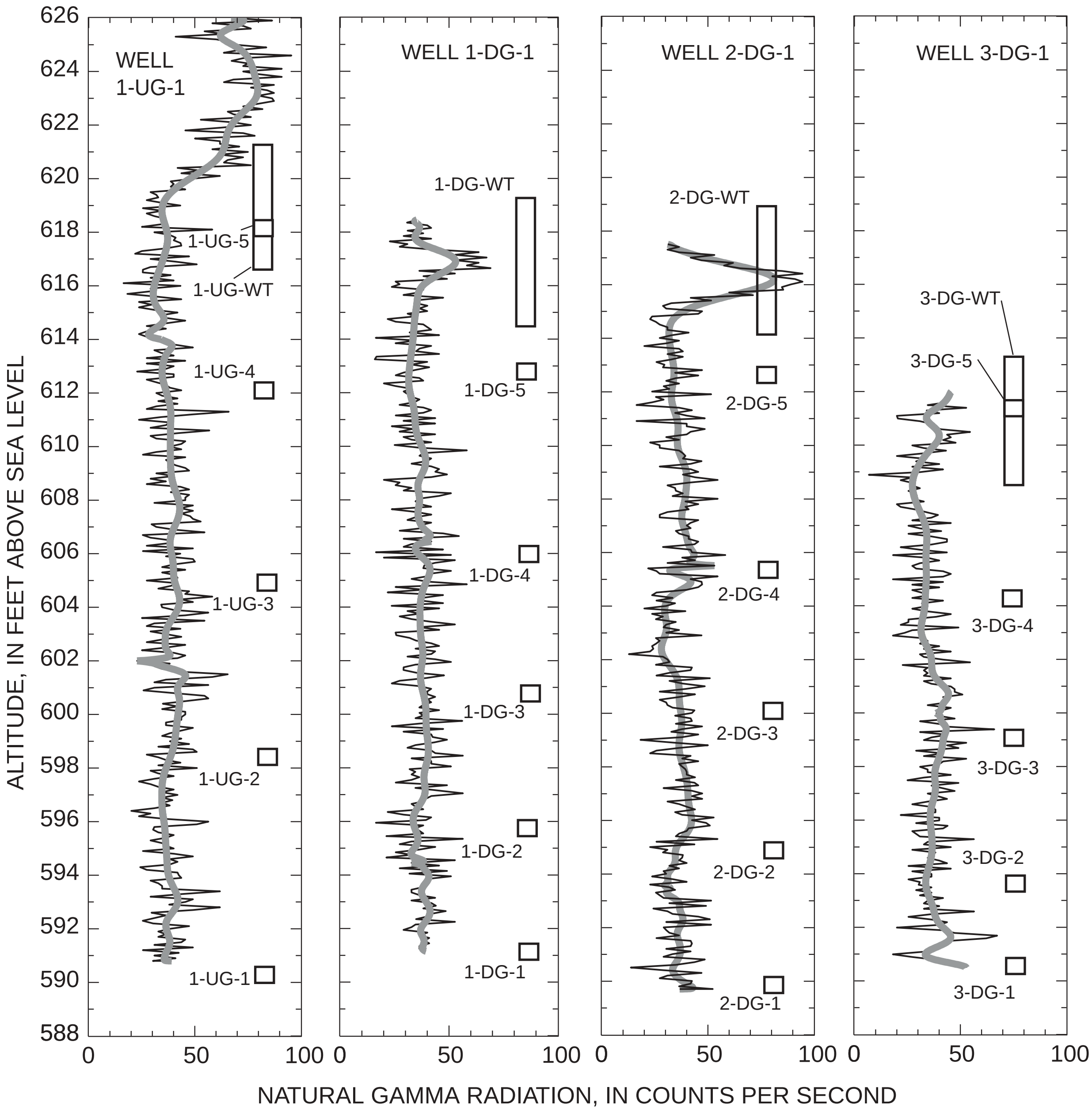


Figure 3. Hydrogeologic section showing well nests in the Calumet aquifer and the potentiometric surface along section B-B' at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, June 26–28, 1995 (trace of section shown in figure 1).



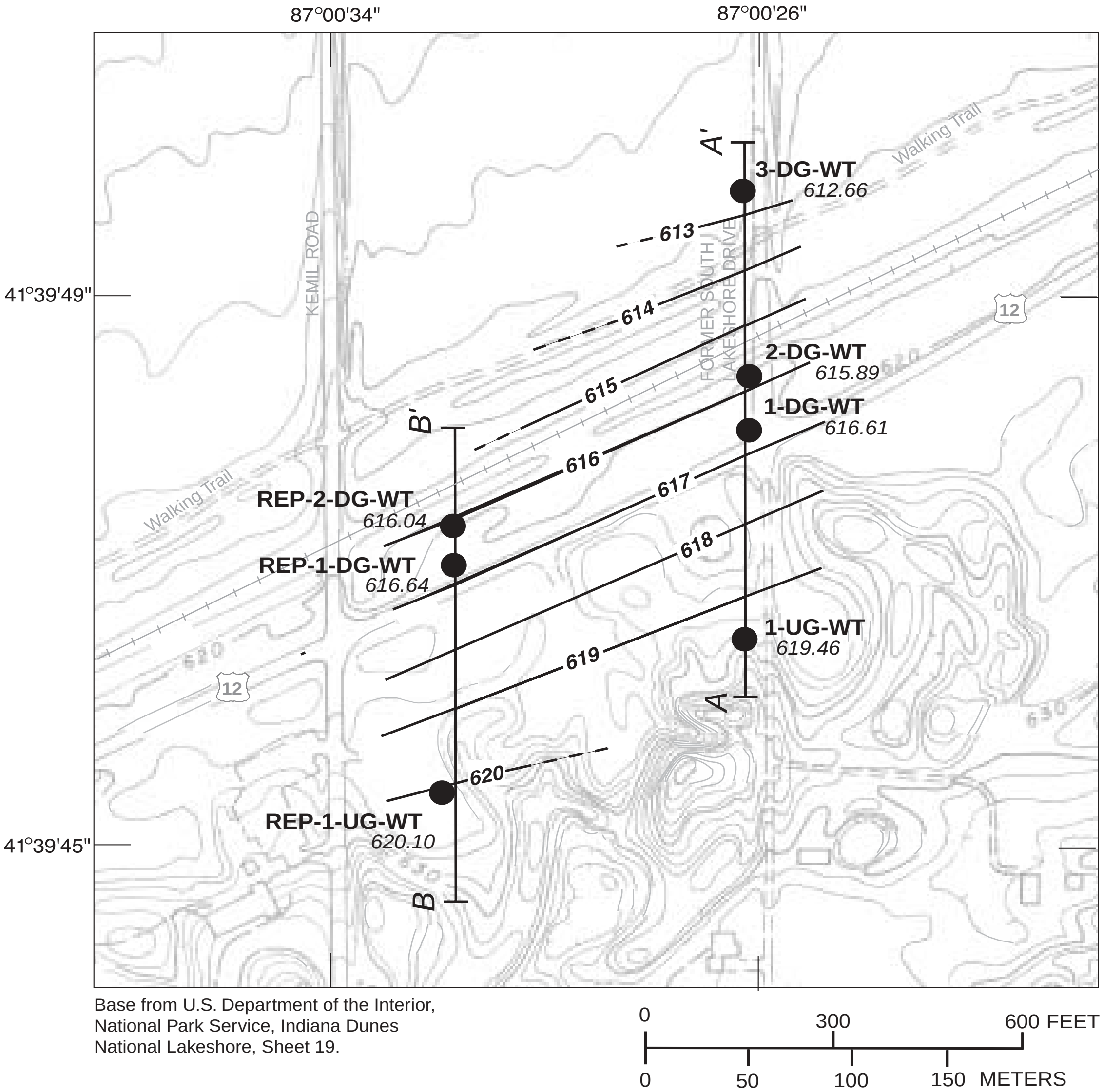
EXPLANATION

WELL NAME AND WELL SCREEN INTERVAL

NATURAL GAMMA RADIATION, FROM LOG DATA—Shown as thin black line

NATURAL GAMMA RADIATION, SMOOTHED DATA USING SPLINE FUNCTION—Shown as thick grey line

Figure 4. Natural gamma logs in monitoring wells along hydrogeologic section A-A' at Indiana Dunes National Lakeshore near Beverly Shores, Indiana.



EXPLANATION

—614—	WATER-TABLE CONTOUR–Shows approximate altitude of the water table in the Calumet aquifer. Contour interval is in feet above sea level. Dashed where inferred. Contour interval 1 foot
A ⊢—⊣ A'	LINE OF SECTION–Shown in figures 2 and 3
● 1-UG-WT 619.46	MONITORING WELL NEST, SITE IDENTIFIER AND WATER-LEVEL ALTITUDE–Shows water-level in feet above sea level, measured in shallowest well at nest

Figure 5. Altitude of the water table in the Calumet aquifer at the study area, June 26–28, 1995, Indiana Dunes National Lakeshore Near Beverly Shores, Indiana.

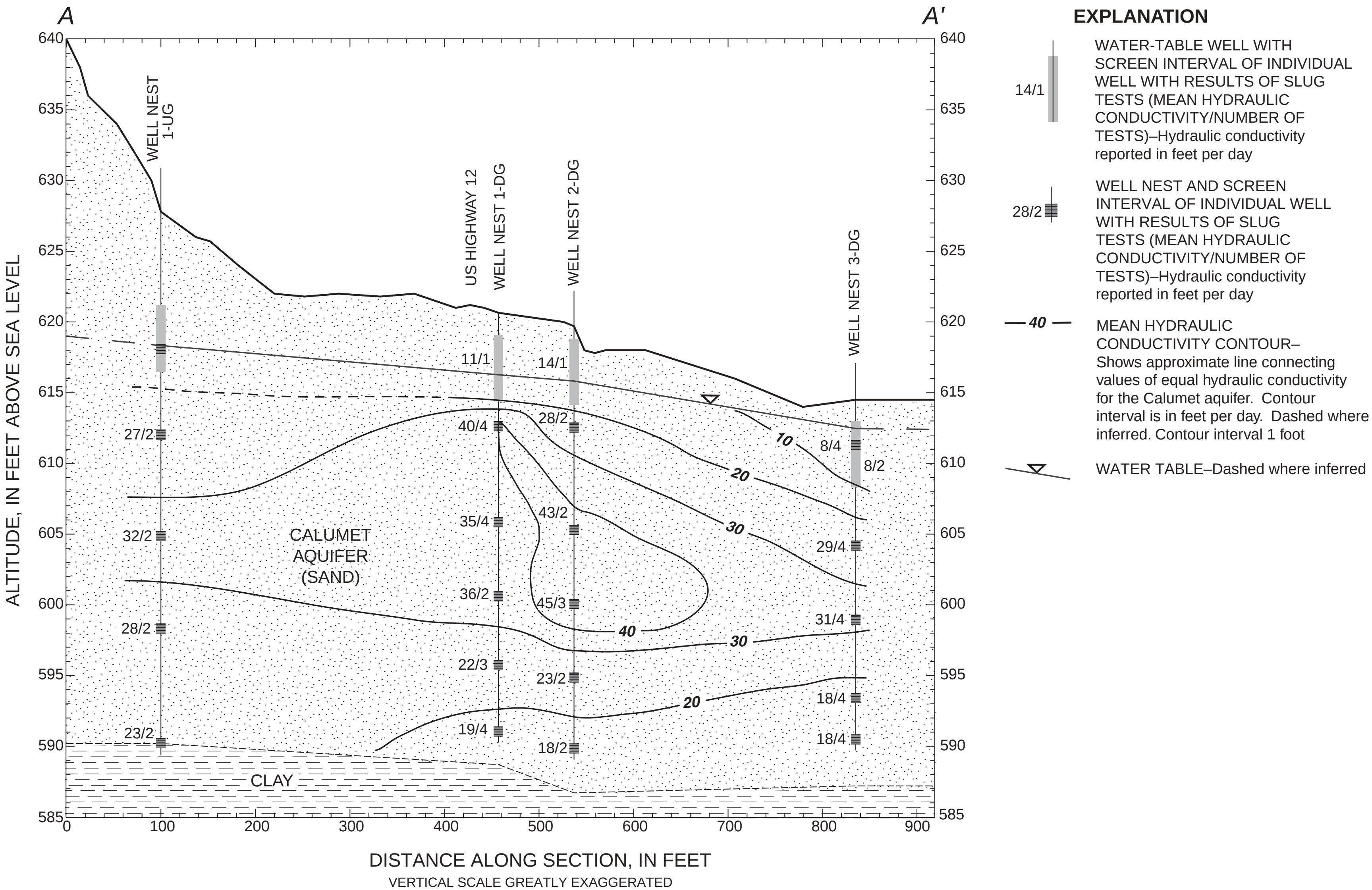


Figure 6. Hydrogeologic section A-A' showing the estimated distribution of hydraulic conductivity in the Calumet aquifer at Indiana Dunes National Lakeshore near Beverly Shores, Indiana (trace of section shown in figure 1).

velocity of ground water at the level 5 depth ranged from 0.15 to 1.53 ft/d and averaged 0.77 ft/d. The time required for ground water to flow from 1-DG to 3-DG at the level 5 depth ranged from 265 days to 7.46 years and averaged 1.44 years. The average linear velocity of ground water at the WT level ranged from 0.16 to 0.58 ft/d and averaged 0.37 ft/d. The time required for ground water to flow from 1-DG to 3-DG at the WT level ranged from 1.91 to 6.77 years and averaged 2.98 years. The slug-test measurements in partially submerged screens of the WT wells may bias the computed hydraulic conductivity at those depths to lower than actual values.

Vertical gradients at the water table generally were downward between wells 1-DG-WT and 1-DG-5. Out of 29 vertical gradients, 23 were downward, 5 were zero and 1 was positive. The gradient between these wells ranged from –0.097 ft/ft in January 1996 (downward) to 0.014 ft/ft (upward) in August 1995. These gradients indicated the potential for deicer-affected water from US–12 to flow deeper in the Calumet aquifer nearest the highway. By contrast, gradients between the water table and level 5 wells at the 2-DG and 3-DG sites were upward in all but one measurement. The gradients between wells 2-DG-WT and 2-DG-5 ranged from –1.467 ft/ft (downward) in September 1996 to 0.591 ft/ft (upward) in February 1996. The gradients between wells 3-DG-WT and 3-DG-5 ranged from 0.003 ft/ft (upward) in February 1995 to 0.263 ft/ft in May 1995. The upward gradients at the 2-DG and 3-DG sites indicate that the wetland near 3-DG is a discharge area for ground water.

Deeper in the Calumet aquifer than described in the previous paragraph, vertical gradients were more variable. Most notably, vertical gradients also were downward for the majority of measurements between wells 2-DG-3 and 2-DG-4, 3-DG-4 and 3-DG-3, 3-DG-3 and 3-DG-2, and 3-DG-2 and 3-DG-1. Vertical gradients either varied between upward and downward values (such as between wells 2-DG-2 and 2-DG-3) or were mostly upward at all other wells. In more than 90 percent of the cases, vertical gradients were 10 percent or less than the horizontal hydraulic gradients reported in table 14.

Results of ground-water dating by tritium and tritiogenic helium methods indicated that water in the upper part of the Calumet aquifer represented the most recent recharge and was the most vulnerable to deicer-related contamination (fig. 7). Water from wells 1-UG-5 and 3-DG-5 had estimated age dates of 1997, the same year the samples were collected. Water from wells 1-DG-4 and 3-DG-4 indicated average ages of recharge that were from 7 to 9 years older than samples from the level 5 wells. Vertical gradients along section A–A', however, were small (fig. 2). Larger values of hydraulic conductivity in the middle of the Calumet aquifer (fig. 6) indicate that recharge from the water table may mix with water from older, upgradient recharge sources in the middle of the Calumet aquifer. Water samples collected from the level 1 wells, at the base of the Calumet aquifer, all had tritium and tritiogenic-helium age dates that indicated pre-1952 recharge. This older water at the base of the Calumet aquifer probably represents recharge from upgradient sources or upward discharge of ground water by flow through the confining unit and was, therefore, not vulnerable to deicer contamination from US–12.

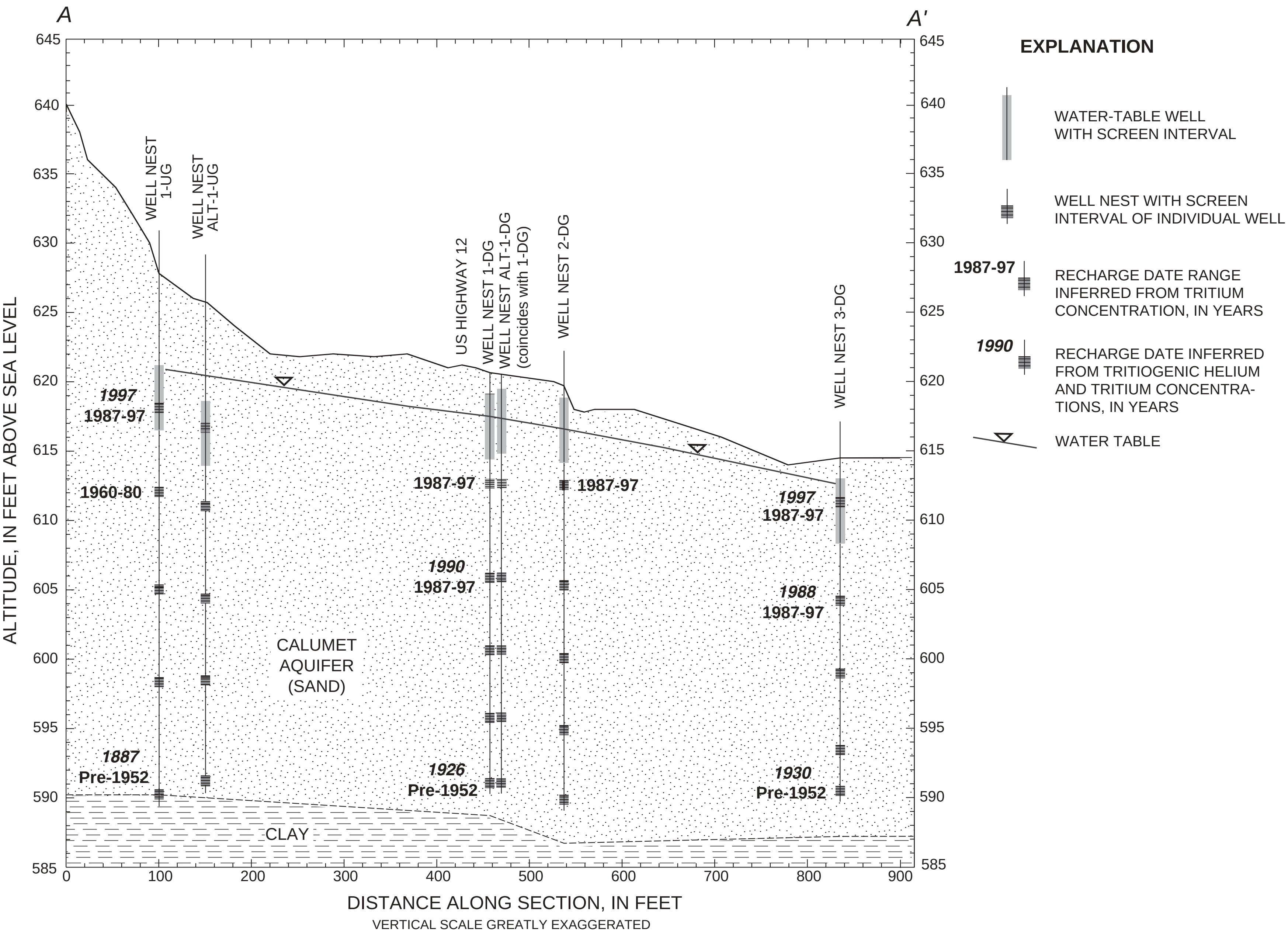


Figure 7. Hydrogeologic section A-A' showing ground-water recharge dates inferred from tritium and tritiogenic helium concentrations, Indiana Dunes National Lakeshore near Beverly Shores, Indiana, August 1997 (trace of section shown in figure 1).

EFFECTS OF HIGHWAY-DEICER APPLICATION ON GROUND-WATER QUALITY IN A PART OF THE CALUMET AQUIFER

From January 1994 through March 1997 and during the deicer-application seasons, the rate of deicer application, as halite, to US–12 ranged from 87 to 4,850 pounds per road mile per day on days when deicer was applied (table 7). Total amounts applied during the deicer application seasons (November through March) were 43,176 pounds per road mile per year (lb/mi/yr) in 1993–94, 15,169 lb/mi/yr in 1994–95, 39,324 lb/mi/yr in 1995–96, and 36,886 lb/mi/yr in 1996–97. No deicer was applied in other months.

The effects of highway deicers on ground-water quality in the Calumet aquifer at the study area were interpreted from the distribution of chloride, sodium, and other chemical constituents and water properties. Distinct trends were observed that indicated the spatial and seasonal patterns in the distribution of deicer compounds. Results of aquifer tests, average linear ground-water-flow velocity calculations, and isotope and solid-phase analyses also were used to interpret the distribution of deicer-affected water.

Indicators of Deicer-Affected Water Quality

The best indicators of deicer-affected water quality for this study were concentrations of chloride and sodium and ratios of Cl/Br and Cl/I. The largest concentrations of chloride and sodium in ground water were in samples from shallow wells 1-DG-WT and ALT-1-DG-WT, which were closest to US–12, the source of the deicer (figs. 8–11 and table 15). Chloride/halide ratio data verified information about the exclusive use of halite deicers on US–12 during the study. Cl/Br and Cl/I ratios from the shallowest wells that were closest to the road plotted within the zones of mixing of upgradient ground water and halite-dissolution brines and deicer-affected water (figs. 12–14). In addition, five of the samples with the largest concentrations of chloride from wells 1-DG-WT and ALT-1-DG-WT had Cl/I ratios that plotted in or near the region of figure 13 that was defined as a hypothetical mixture of background water quality with halite-dissolution brine. The deicer-affected water described by Risch and Robinson (2001) derived its salinity from leaching of sodium-chloride salt and calcium-chloride solution. The similarity of the Cl/I data from wells 1-DG-WT and ALT-1-DG-WT to a mixture with halite brine also verified the INDOT report that halite deicer was used exclusively along US–12 during the project. No water samples produced results that plotted in the zone of mixing with Devonian-system brine; therefore, the brine was not likely a source of chloride to shallow ground water.

Nitrate and Cl/Br data indicated that domestic wastewater was not a source of chloride to ground water in the study area. Nitrate concentrations in water collected from wells along section A–A' in December 1994 ranged from <0.05 to 0.06 mg/L as nitrogen (N) in upgradient wells, from <0.05 to 0.24 mg/L as N in level 1 through level 5 wells downgradient from US–12, and from 0.36 to 1.1 mg/L as N in WT level wells downgradient from US–12 (table 11). The nitrate concentrations in all wells were within ranges assumed to represent nitrate from natural background conditions (less than 0.2 mg/L as N) or in the lower one-third of a transitional range that may or may not represent human influence (0.21 to 3.0 mg/L as N; Madison and Brunett, 1984, p. 95). The well with the largest nitrate concentration (1-DG-WT, 1.1 mg/L as N) also had a Cl/Br ratio of >3,600 that indicated a mixture with deicer-affected water.

Spatial and Temporal Variability of Deicer-Affected Ground-Water Quality

Contoured chloride concentrations along hydrogeologic section A–A' (figs. 15–18) for four sets of monthly samples illustrate: (1) the annual initial condition before the onset of deicer application (fig. 15), (2) initial detection of deicer-affected water during the time of active deicer application (fig. 16), (3) development of a plume of deicer-affected water during the late-winter thaw (fig. 17), and (4) annual migration of deicer away from US–12 and past the farthest downgradient site (3-DG), a distance of 396 ft (fig. 18). The initial condition in November also represents the extent of annual recovery of water quality from the previous year's deicer application. Deicer-affected water occupied the upper 13–15 ft of the Calumet aquifer at site 3-DG by June 1997 (fig. 18). Chloride concentrations that exceed 250 mg/L, the USEPA SMCL for drinking water, also had reached about 220 ft downgradient from US–12 by July 1997. The migration of a chloride plume through the

Table 7. Deicer-application rates along U.S. Highway 12 at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1993–97

[mm/dd/yy, month/day/year; Deicer application data compiled by Indiana Department of Transportation (James Kaur, Indiana Department of Transportation, LaPorte Subdistrict, written commun., 1997)]

Date of application during winter of 1993–94	Deicer application (pounds per mile)	Date of application during winter of 1994–95	Deicer application (pounds per mile)	Date of application during winter of 1995–96	Deicer application (pounds per mile)	Date of application during winter of 1996–97	Deicer application (pounds per mile)
01/03/94	433	12/07/94	173	11/11/95	693	11/21/96	866
01/04/94	433	12/31/94	260	11/12/95	693	11/28/96	346
01/05/94	1,559	01/01/95	866	11/16/95	346	12/01/96	693
01/07/94	693	01/02/95	346	11/21/95	260	12/05/96	476
01/08/94	1,299	01/03/95	866	12/08/95	866	12/08/96	520
01/10/94	2,425	01/04/95	952	12/09/95	1,386	12/17/96	693
01/11/94	693	01/06/95	3,291	12/11/95	606	12/19/96	433
01/12/94	260	01/07/95	953	12/12/95	1,299	12/20/96	693
01/14/94	3,118	01/10/95	953	12/13/95	1,472	12/26/96	1,905
01/15/94	2,945	01/21/95	346	12/20/95	693	01/06/97	173
01/17/94	4,850	01/22/95	693	12/21/95	780	01/09/97	4,158
01/18/94	87	01/23/95	953	12/26/95	1,039	01/11/97	1,213
01/19/94	1,732	01/27/95	866	12/27/95	2,425	01/12/97	953
01/20/94	2,102	01/28/95	693	12/28/95	780	01/13/97	173
01/25/94	2,252	02/04/95	260	12/30/95	346	01/15/97	2,598
01/26/94	1,535	02/05/95	1,472	12/31/95	780	01/16/97	2,938
01/27/94	4,504	02/06/95	346	01/04/96	953	01/17/97	346
01/28/94	1,039	02/21/95	173	01/05/96	520	01/18/97	1,213
01/29/94	303	03/02/95	173	01/06/96	693	01/19/97	866
01/30/94	563	03/05/95	173	01/09/96	173	01/23/97	433
01/31/94	606	03/07/95	188	01/11/96	4,504	01/24/97	693
02/02/94	173	03/09/95	173	01/12/96	1,386	01/25/97	779
02/03/94	433			01/19/96	606	01/26/97	2,979
02/04/94	1,213			01/24/96	1,161	01/27/97	1,039
02/07/94	130			01/29/96	2,253	01/28/97	2,339
02/08/94	2,339			01/30/96	1,039	01/30/97	1,039
02/09/94	1,516			01/31/96	243	02/11/97	693
02/10/94	822			02/12/96	243	02/12/97	1,213
02/12/94	953			02/17/96	1,039	02/16/97	1,379
02/22/94	693			02/19/96	693	02/17/97	866
02/24/94	866			03/02/96	693	02/19/97	620
02/25/94	347			03/06/96	4,331	02/21/97	346
02/28/94	260			03/07/96	3,291	02/22/97	866
				03/08/96	1,039	03/14/97	346
Seasonal total (pounds per mile)	**43,176**		**15,169**		**39,324**		**36,886**
Seasonal total (kilograms per kilometer)	**31,512**		**11,070**		**28,700**		**26,921**

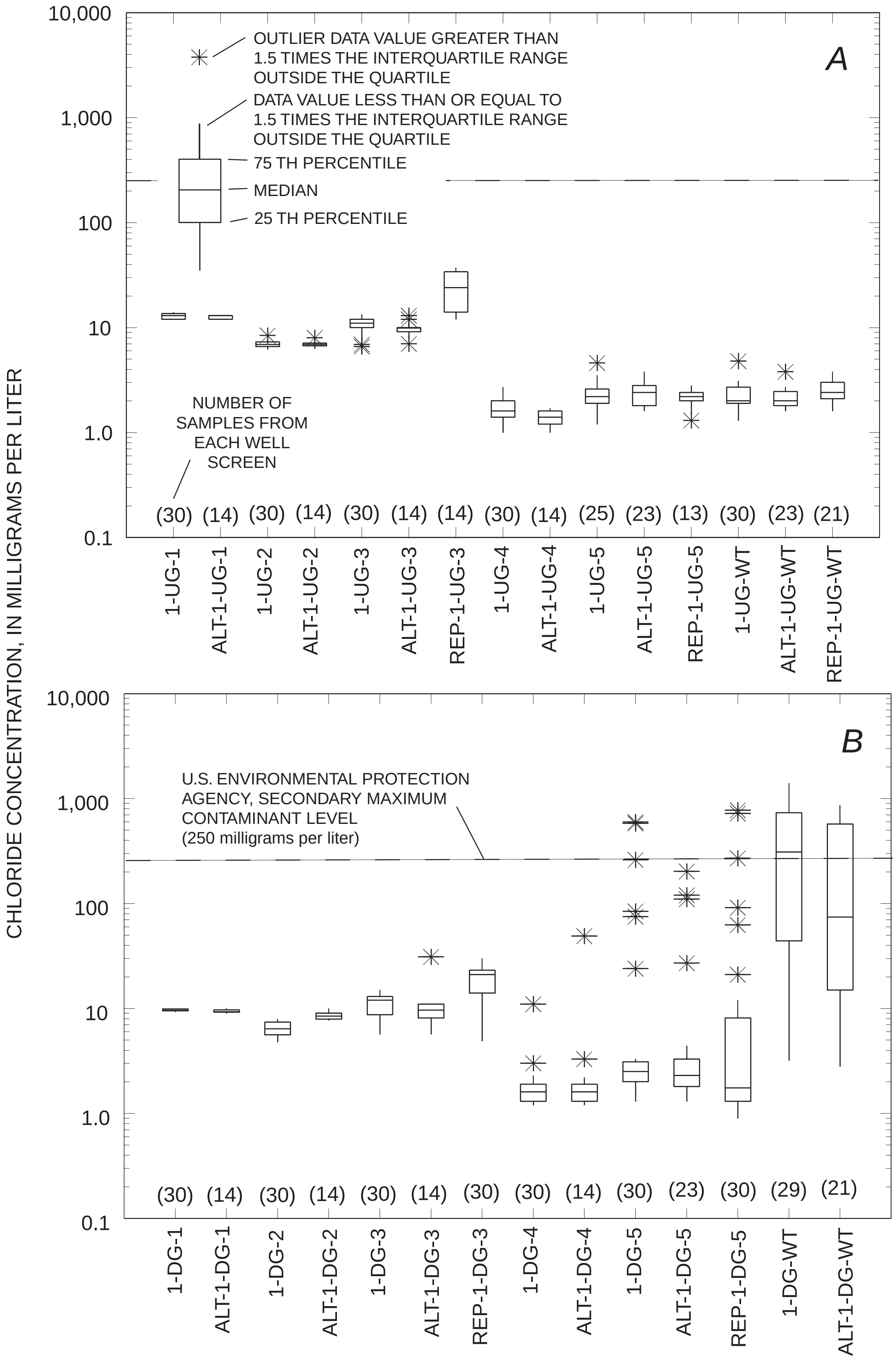


Figure 8. Box-and-whisker plots of chloride concentrations in ground water at (*A*) well nests 1-UG, ALT-1-UG, and REP-1-UG and (*B*) well nests 1-DG, ALT-1-DG, and REP-1-DG at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97.

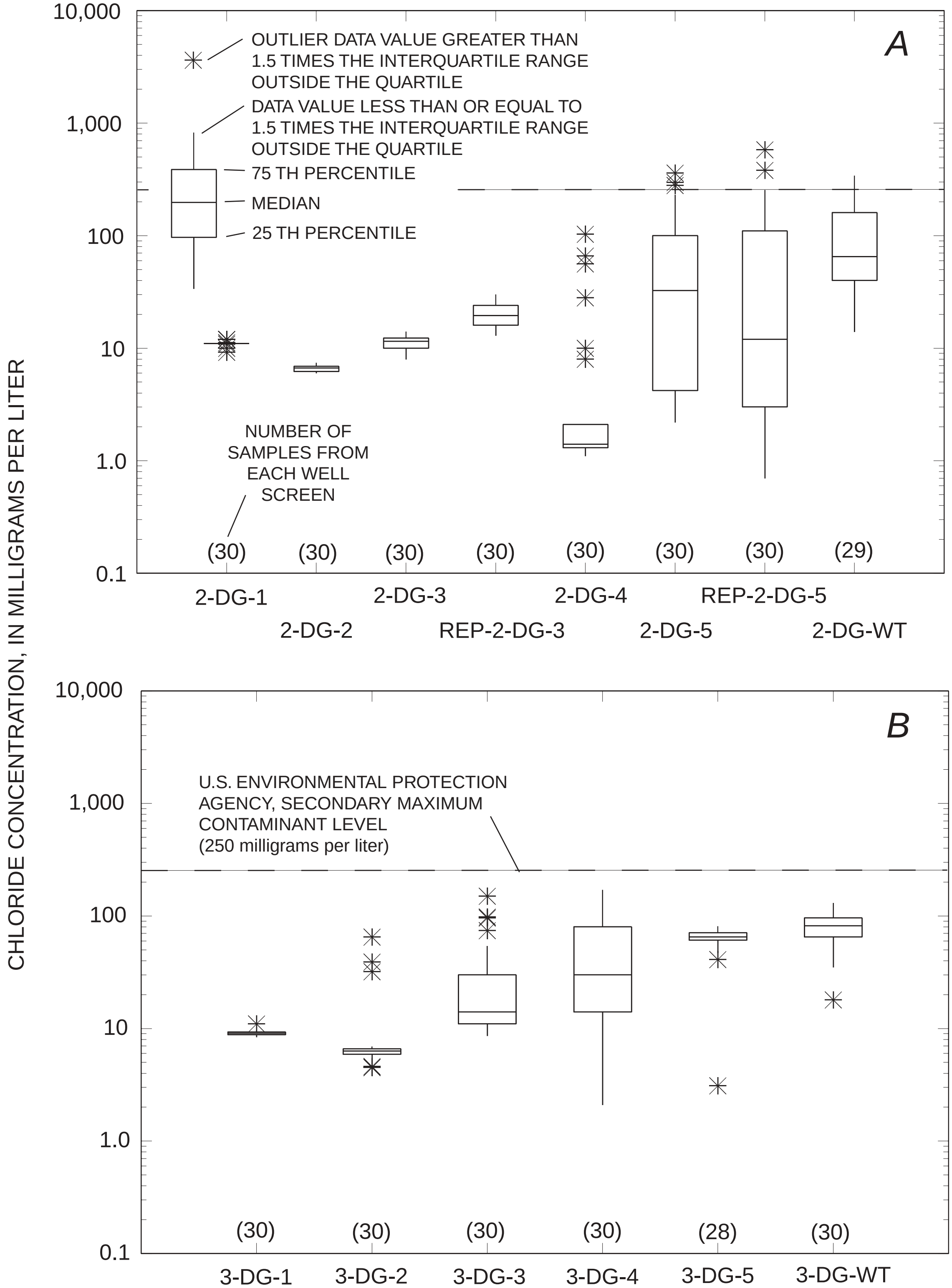


Figure 9. Box-and-whisker plots of chloride concentrations in ground water at (*A*) well nests 2-DG and REP-2-DG, and (*B*) well nest 3-DG at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97.

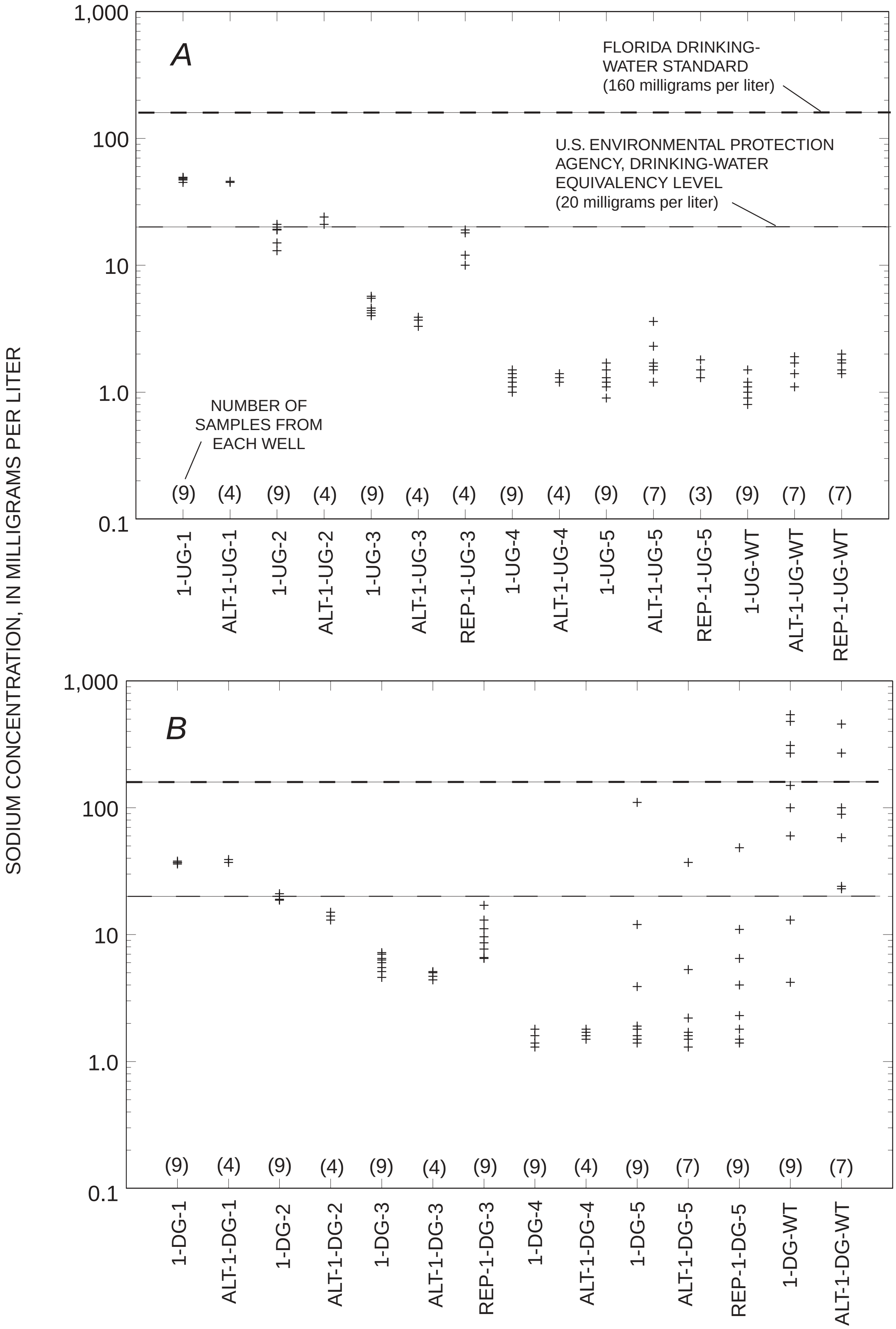


Figure 10. Scatterplots of sodium concentrations in ground water at (*A*) well nests 1-UG, ALT-1-UG, and REP-1-UG and (*B*) well nests 1-DG, ALT-1-DG, and REP-1-DG at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97.

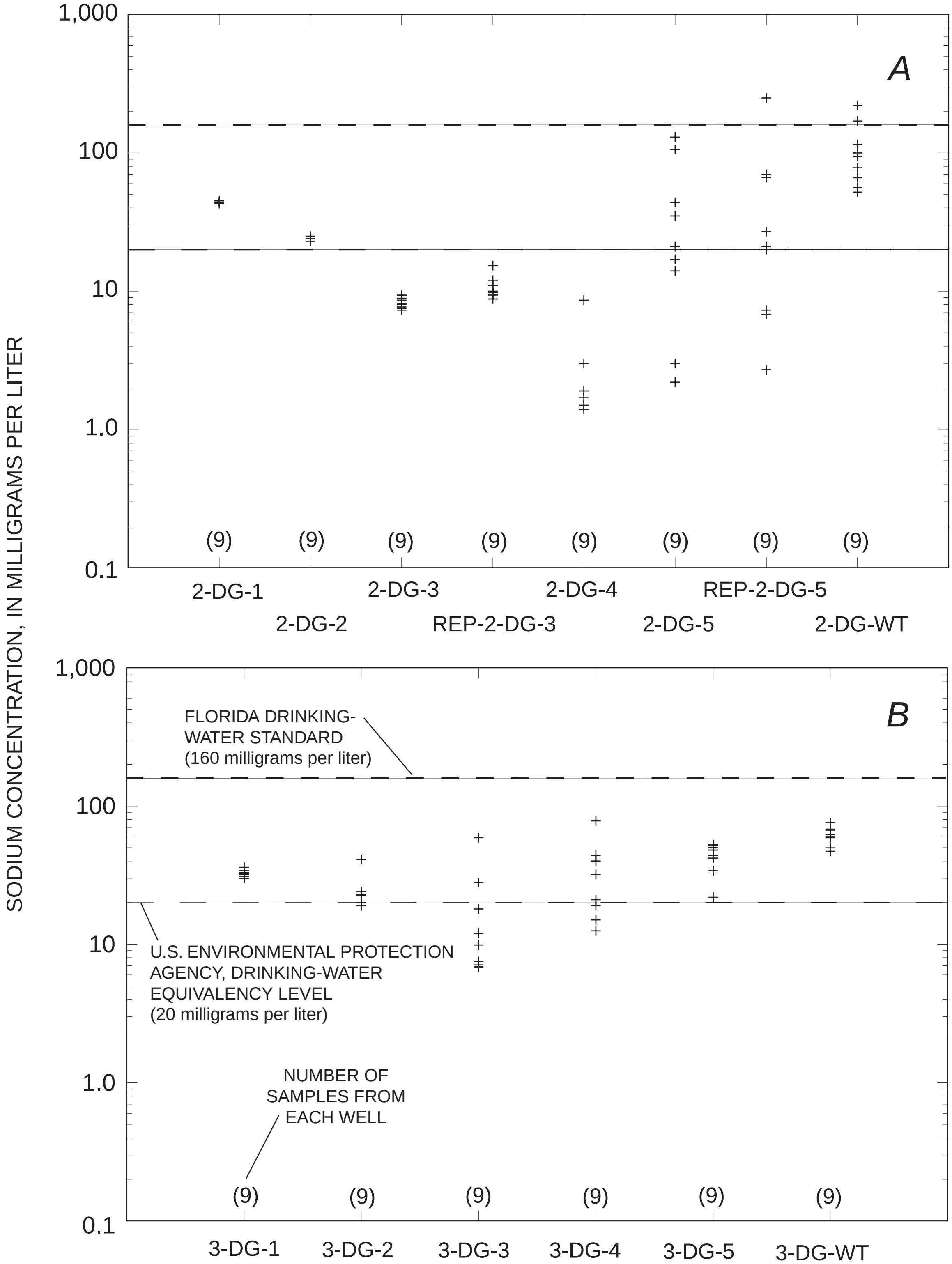


Figure 11. Scatterplots of sodium concentrations in ground water at (*A*) well nests 2-DG and REP-2-DG, and (*B*) well nest 3-DG at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97.

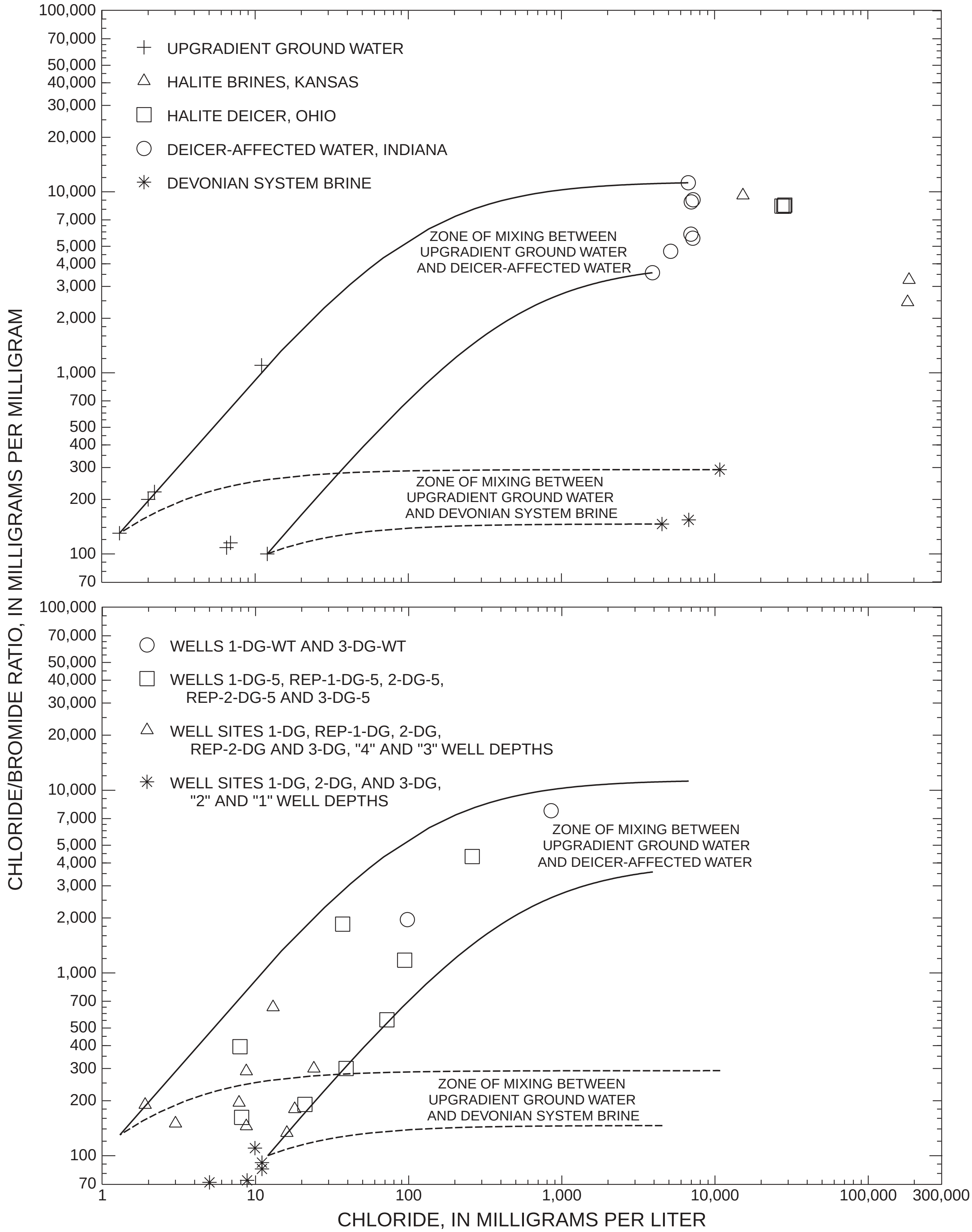


Figure 12. Curves defining zones of mixing between compositions of deicer-affected water, Devonian system brine, and upgradient ground-water quality plotted with 1994–95 chloride/bromide ratios and chloride concentrations for water from downgradient wells, Indiana Dunes National Lakeshore near Beverly Shores, Indiana (brine analyses referenced in table 5).

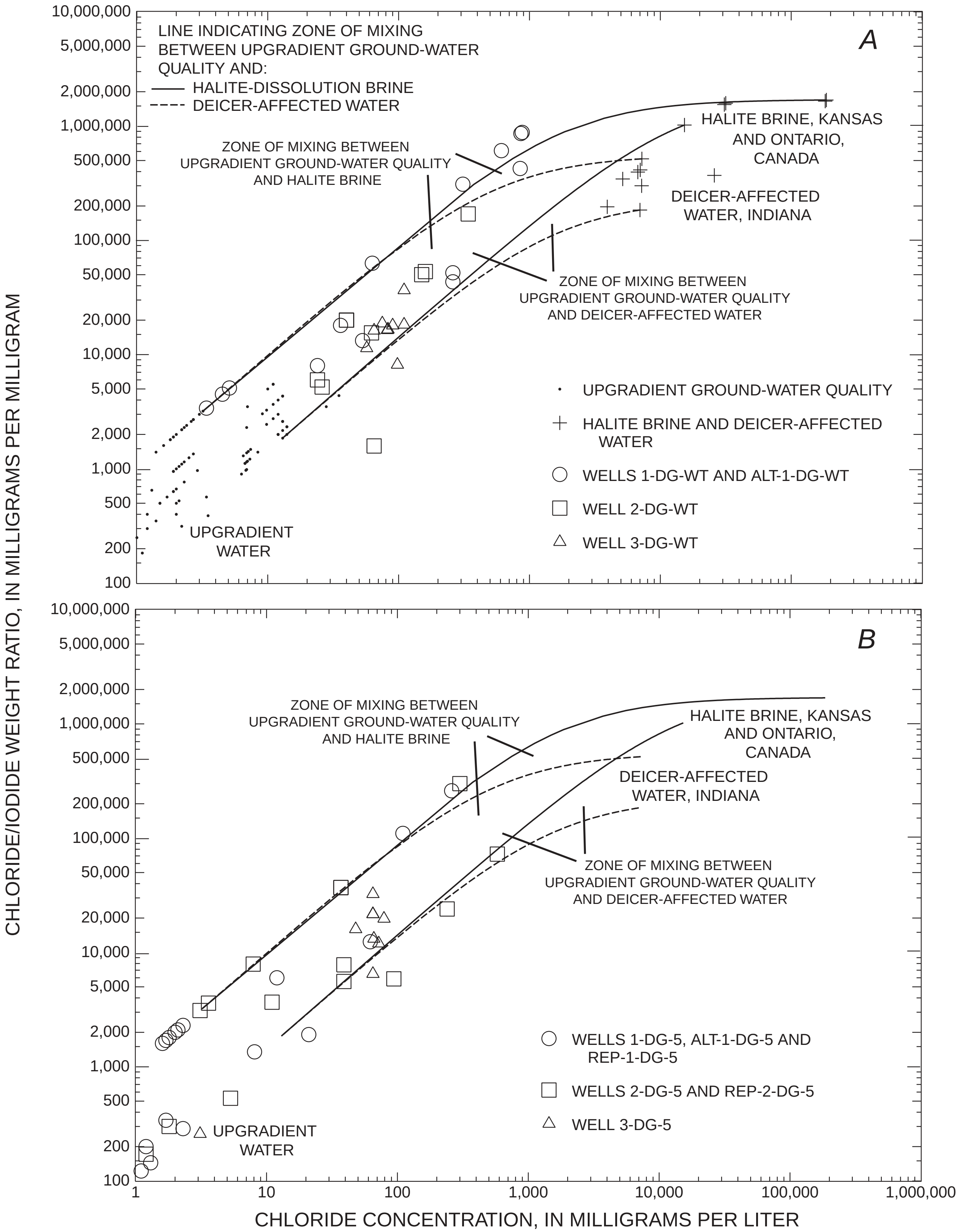


Figure 13. Curves defining zones of mixing between compositions of halite brine, deicer-affected water, and upgradient ground-water quality plotted with 1994–97 chloride/iodide ratios and chloride concentrations for water from downgradient well nests, (*A*) water table and (*B*) level 5 wells, Indiana Dunes National Lakeshore near Beverly Shores, Indiana.

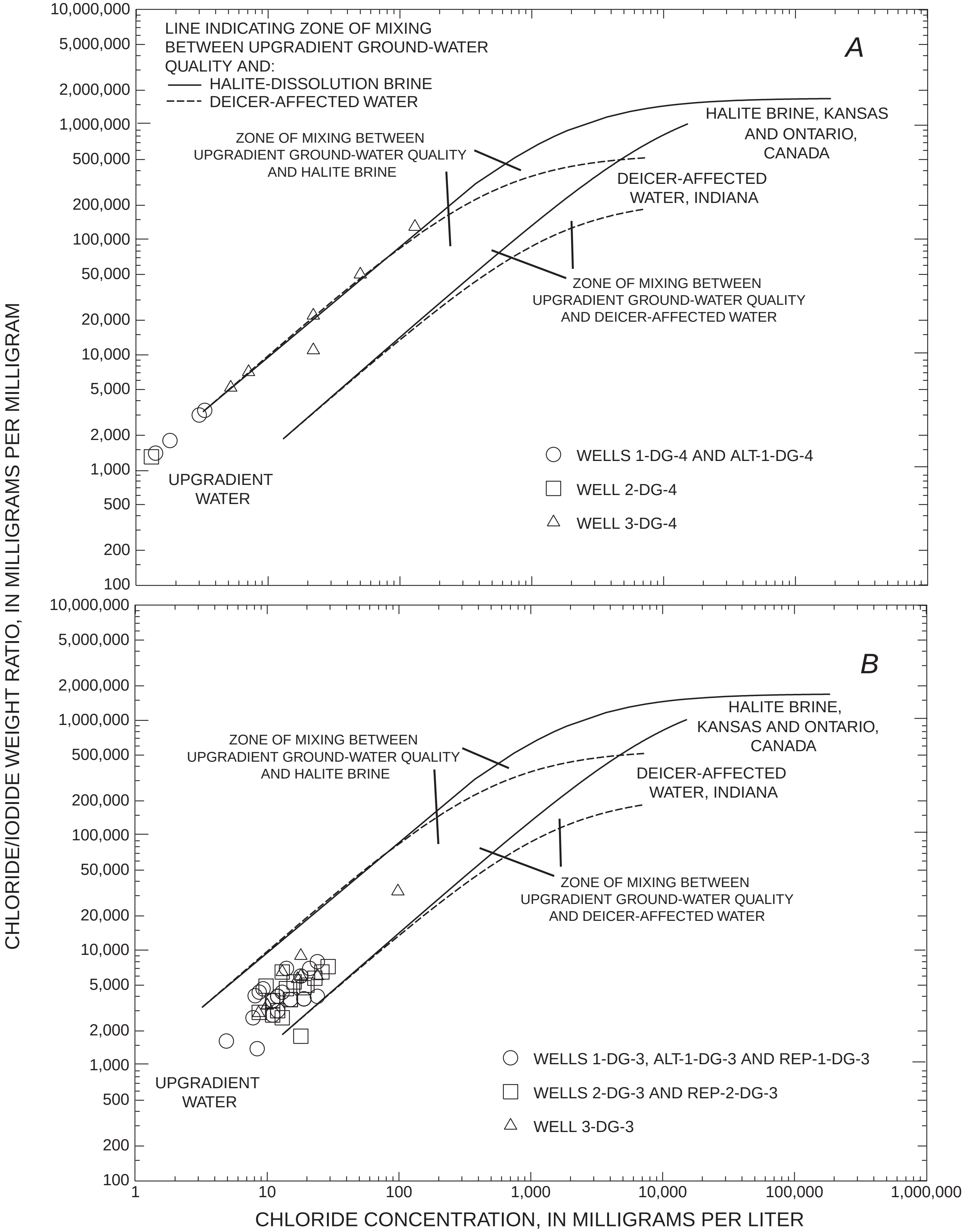


Figure 14. Curves defining zones of mixing between compositions of halite brine, deicer-affected water, and upgradient ground-water quality plotted with 1994–97 chloride/iodide ratios and chloride concentrations for water from downgradient well nests, (*A*) level 4 wells and (*B*) level 3 wells, Indiana Dunes National Lakeshore near Beverly Shores, Indiana.

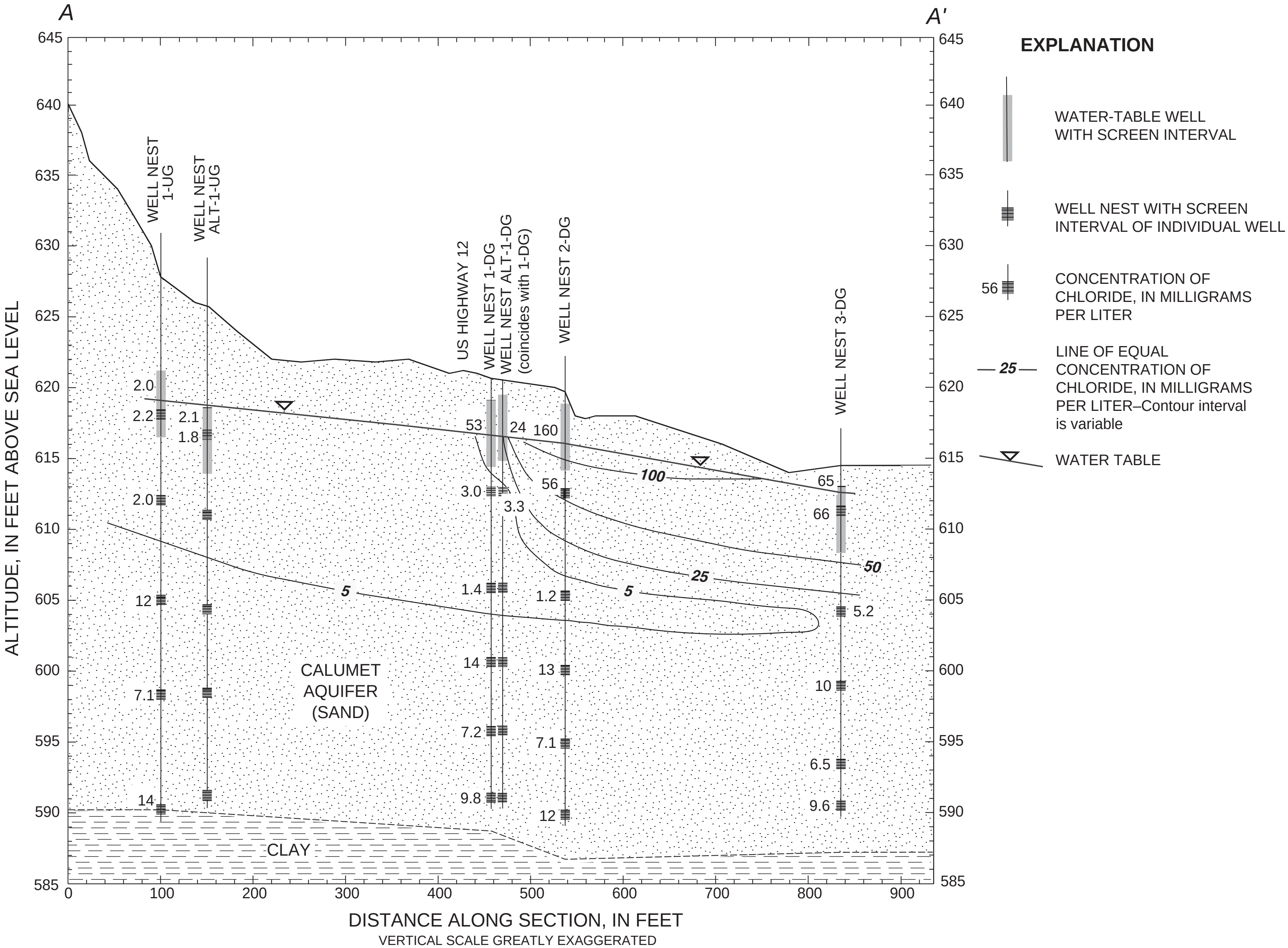


Figure 15. Hydrogeologic section A-A' showing contoured chloride concentrations in ground water, Indiana Dunes National Lakeshore near Beverly Shores, Indiana, November 1996 (trace of section shown in figure 1).

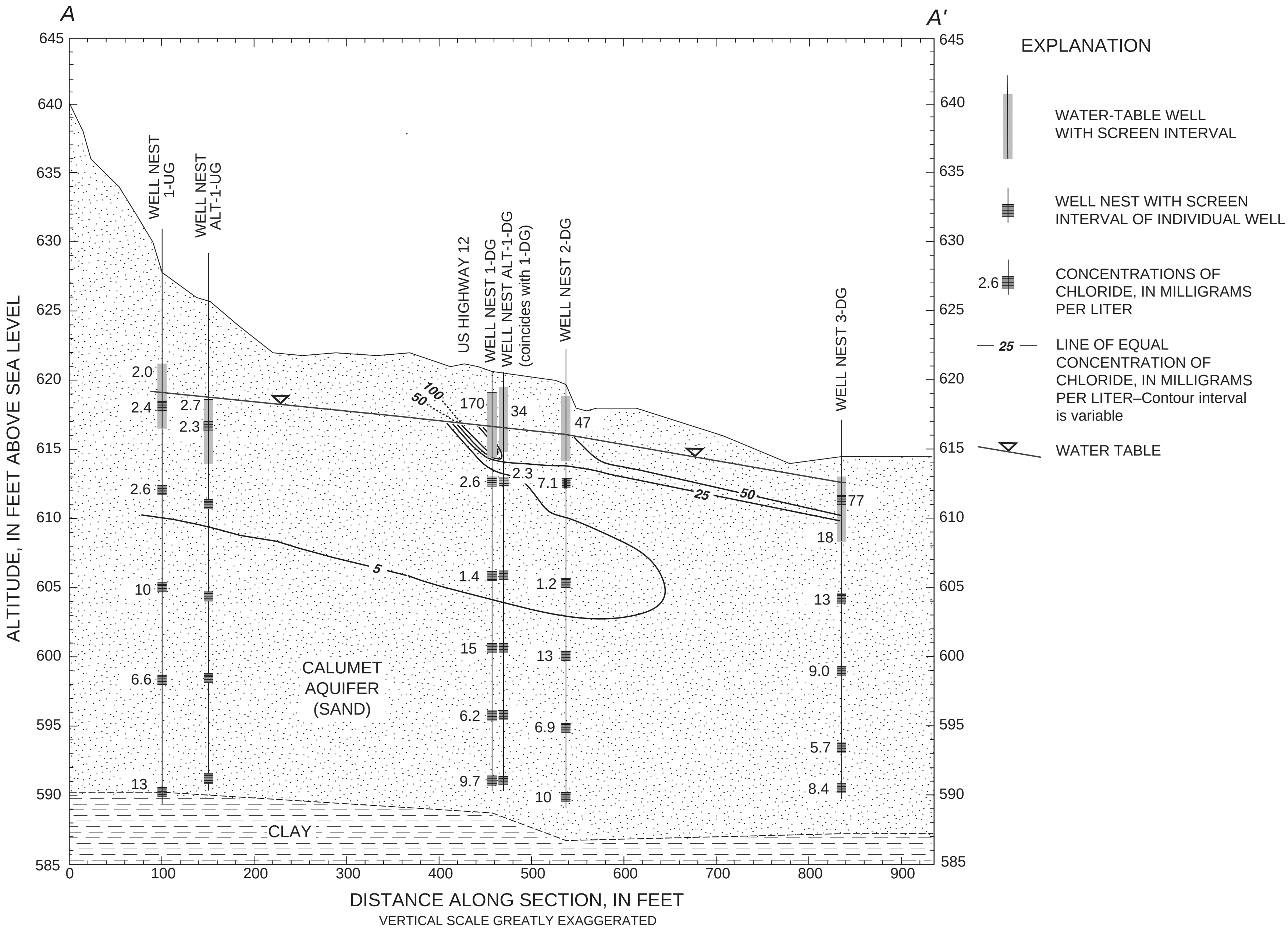


Figure 16. Hydrogeologic section A-A' showing contoured chloride concentrations in ground water, Indiana Dunes National Lakeshore near Beverly Shores, Indiana, January 1997 (trace of section shown in figure 1).

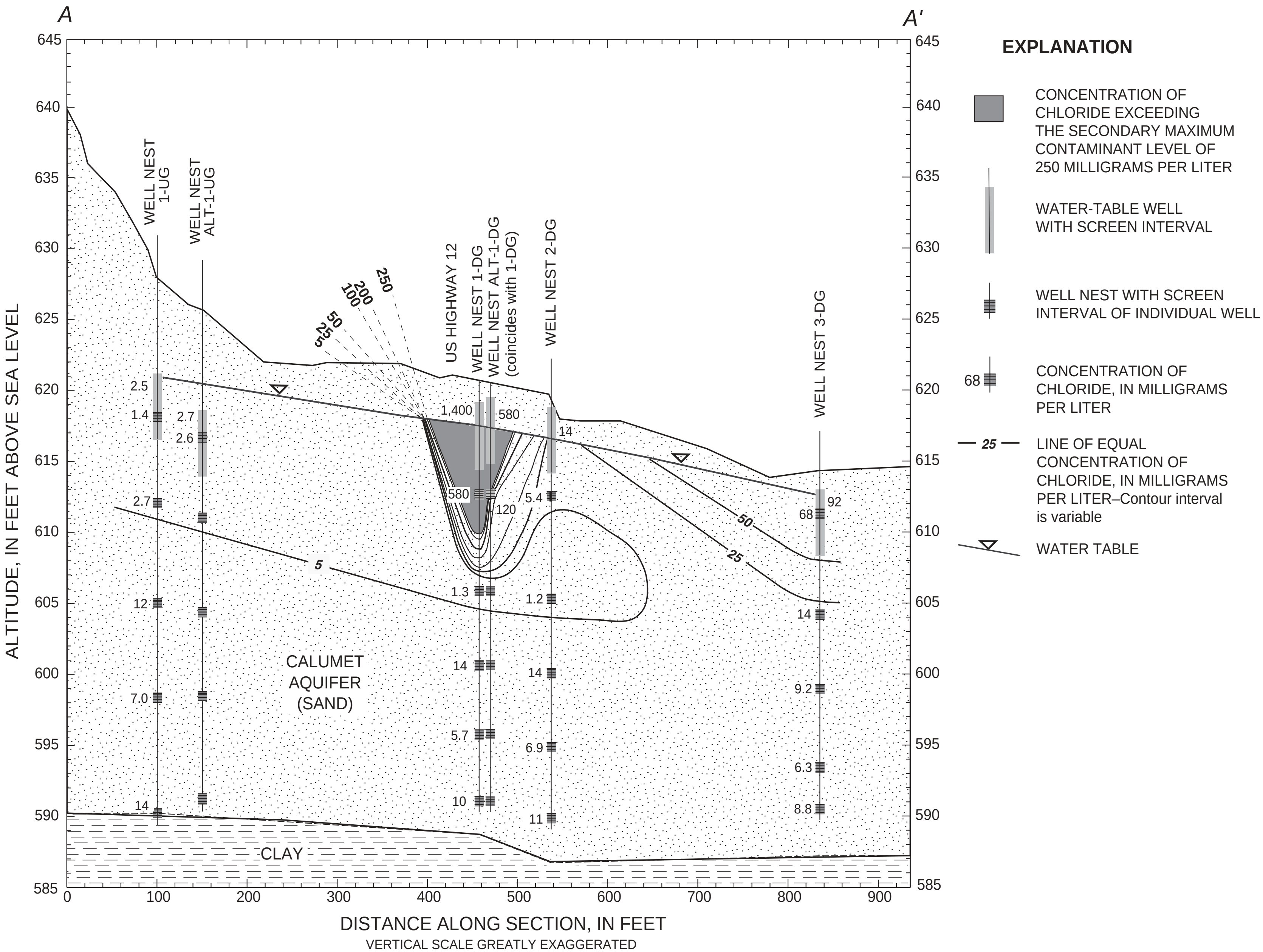


Figure 17. Hydrogeologic section A-A' showing contoured chloride concentrations in ground water, Indiana Dunes National Lakeshore near Beverly Shores, Indiana, March 1997 (trace of section shown in figure 1).

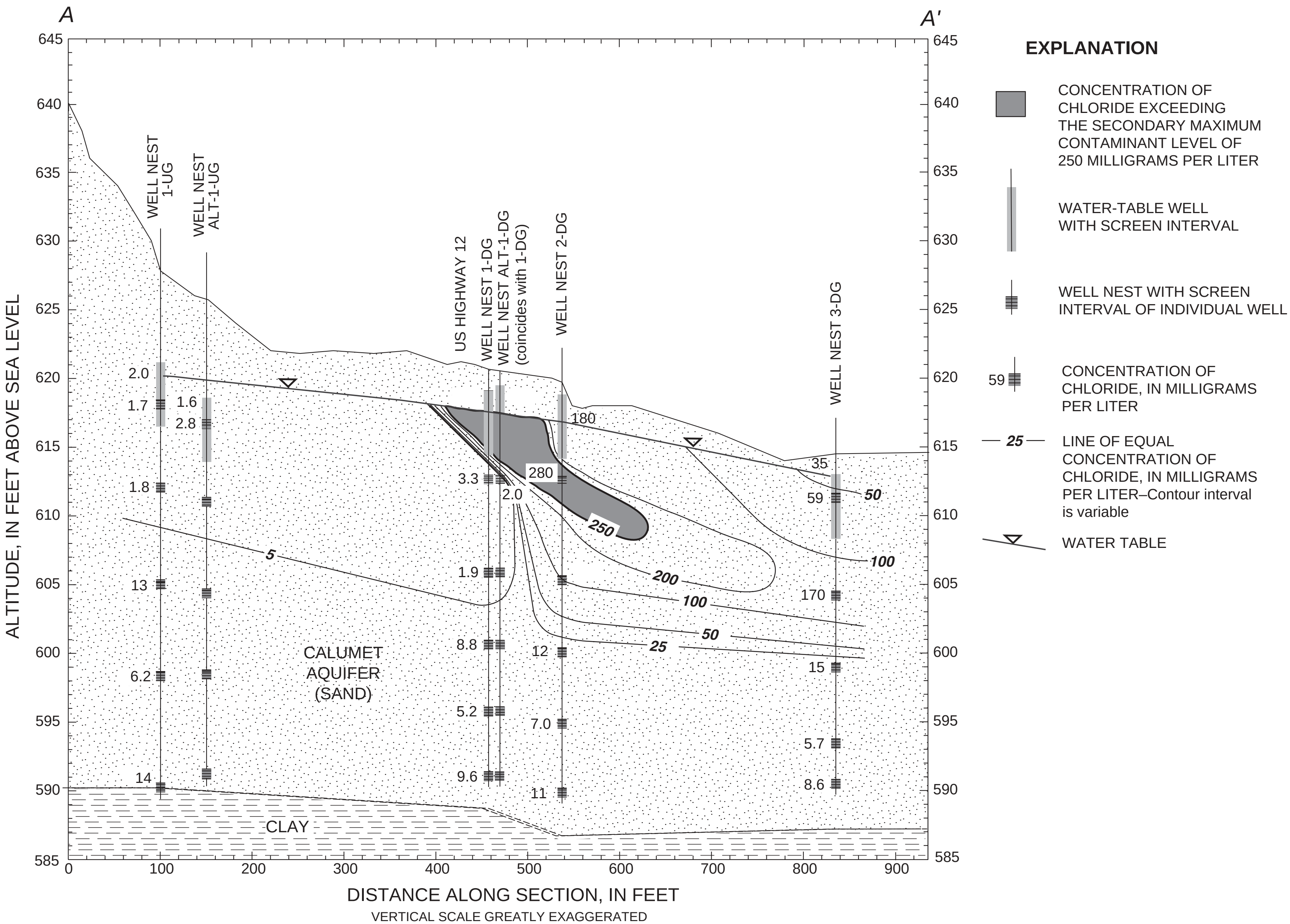


Figure 18. Hydrogeologic section A-A' showing contoured chloride concentrations in ground water, Indiana Dunes National Lakeshore near Beverly Shores, Indiana, June 1997 (trace of section shown in figure 1).

Calumet aquifer in the spring and early summer, followed by a recovery of water quality to smaller concentrations of chloride along the entire section, was observed for each year of data collection.

Recharge by deicer-affected runoff likely occurred to a variable extent throughout the deicer application season. Halite salt works as a chemical deicer at temperatures of about 10°F (about –8°C) and warmer (Gales and VanderMeulen, 1992, p. 136). Air temperatures were warmer than 10°F during most days of the salt-application season but typically were less than 32°F (0°C) during most of December and January of 1995 and 1996 (fig. 19). Dilution of the deicer-affected runoff would be expected to raise its freezing point to a temperature between 10°F and 32°F (about –8°C to 0°C), the latter being the freezing point for water. The potential for recharge of deicer-affected water to reach the water table during freezing conditions at less than 32°F (0°C) was, therefore, considered small because of the potential for runoff to freeze along the roadside or in the unsaturated zone. Most deicer-affected water also would be retained as ice and snow along the roadside after plowing until weather warmed. During the deicer application season, the daily amounts of precipitation, measured as water, were always less than 2 in. (fig. 19).

The vertical distribution of dissolved solids in ground water varied continuously with depth in the Calumet aquifer, as measured by borehole logs of electromagnetic conductivity (fig. 20). The electromagnetic-conductivity values indicated that well screens were appropriately located to sample the parts of the Calumet aquifer with the largest concentrations of deicer-affected water. The changes in electromagnetic-conductivity values were related entirely to changes in water quality; the relative consistency in natural gamma counts from the same wells indicated uniform distributions of gamma-emitting materials that were typical of area dune sand. Electromagnetic-conductivity data verified the presence of water with low dissolved-solids concentrations through the shallow and middle parts of the Calumet aquifer at well sites 1-DG and 2-DG, an area underlain by more conductive water with larger dissolved-solids concentrations at the base of the Calumet aquifer.

The decrease with depth in relative electromagnetic conductivity near the well screen of 1-DG-WT (fig. 20) indicates that the first 2 ft of water below the water table may represent the mixing of deicer-affected water and recharge from precipitation. The changes in electromagnetic conductivity through the longer water-table well screens also indicate that samples collected from the longer well screens represent mixing of water with different chemistries. Longer well screens in the level 1 through 5 wells would, therefore, have been inappropriate for this study.

Concentrations of the major elements in ground water also changed relative to each other during each year, as shown by “Stiff diagrams” of major element composition plotted on hydrogeologic section A–A' for 1 year of quarterly measurements (figs. 21–24). Dissolved solids in water from wells in the zone of deicer-affected water also was composed predominantly of sodium and chloride during much of the year. A comparison of the August and November plots (figs. 21 and 22) illustrates the decrease of sodium and chloride concentrations at all wells in the zone of deicer-affected water except 3-DG-WT and 3-DG-5. The diagrams also illustrate the annual recovery of major element chemistry to nearly background conditions at well 2-DG-5 by the February 1997 sampling (fig. 23).

In the remainder of this section, water-quality variability is described with respect to the following groups of well screen depths: (a) the shallowest part of the Calumet aquifer—WT and level 5 wells; the intermediate part of the Calumet aquifer—(b) level 4 wells and (c) level 3 wells; and (d) the deepest part of the Calumet aquifer—level 2 and 1 wells.

Level WT and 5 Wells

The most variable distribution of major ions was observed in ground water at wells 1-DG-WT, 1-DG-5, 2-DG-WT, and 2-DG-5. During spring and summer, water from these wells had concentrations of dissolved solids that were composed predominantly of sodium and chloride; during fall and early winter, dissolved solids were composed of sodium and bicarbonate; sodium, chloride, and bicarbonate; or calcium and bicarbonate (figs. 21–24). Variable major-ion chemistry also was detected in water from well 3-DG-5, with the same major ions but during different seasons. The seasonal variability in principal cations and anions in dissolved solids indicates a nonconstant source of deicer loading to the ground water, marked by periods of return to conditions similar to natural background.

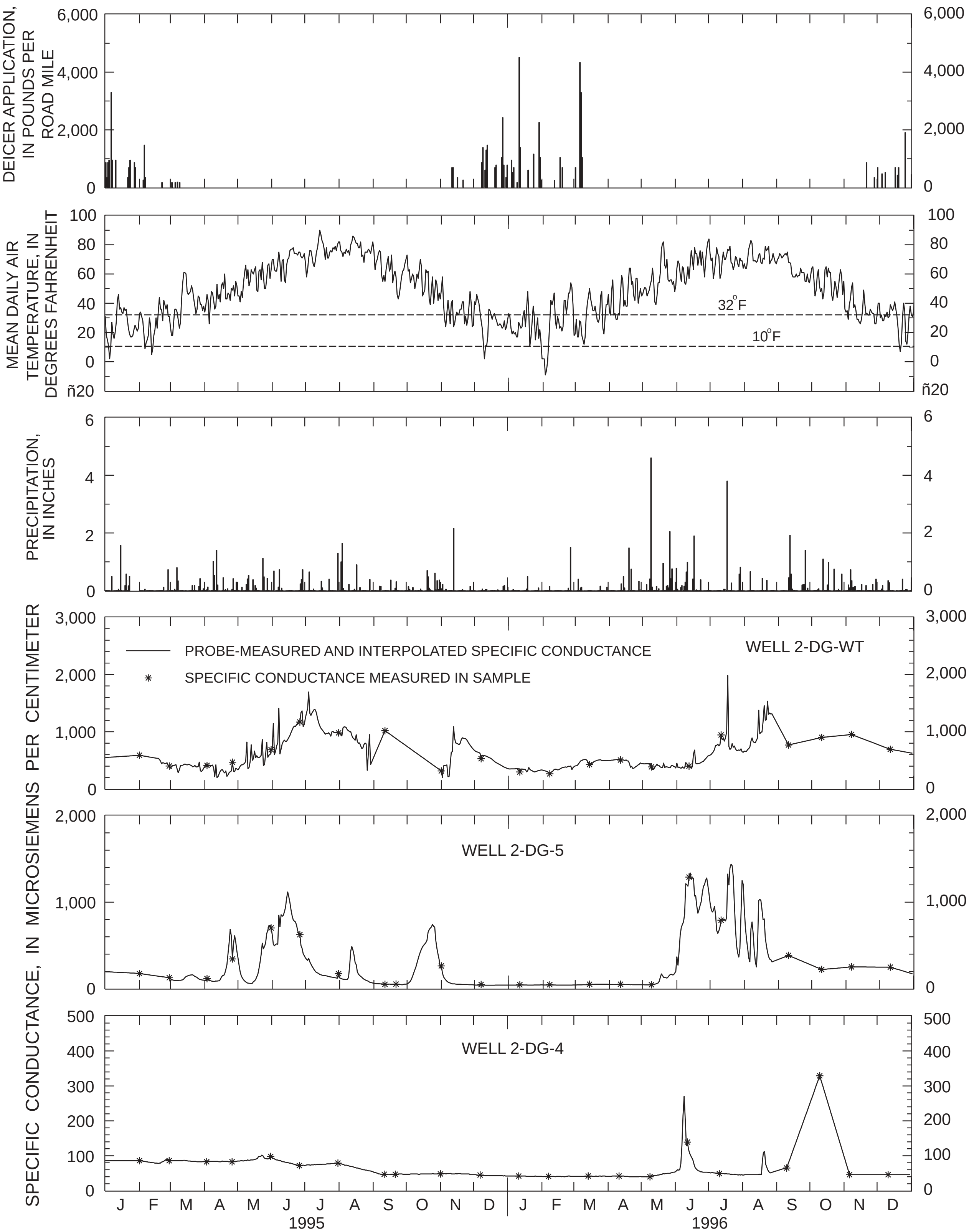


Figure 19. Deicer application, mean daily air temperature, and precipitation at and near the study area, and specific conductance of water from wells 2-DG-WT, 2-DG-5, and 2-DG-4 at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1995–96.

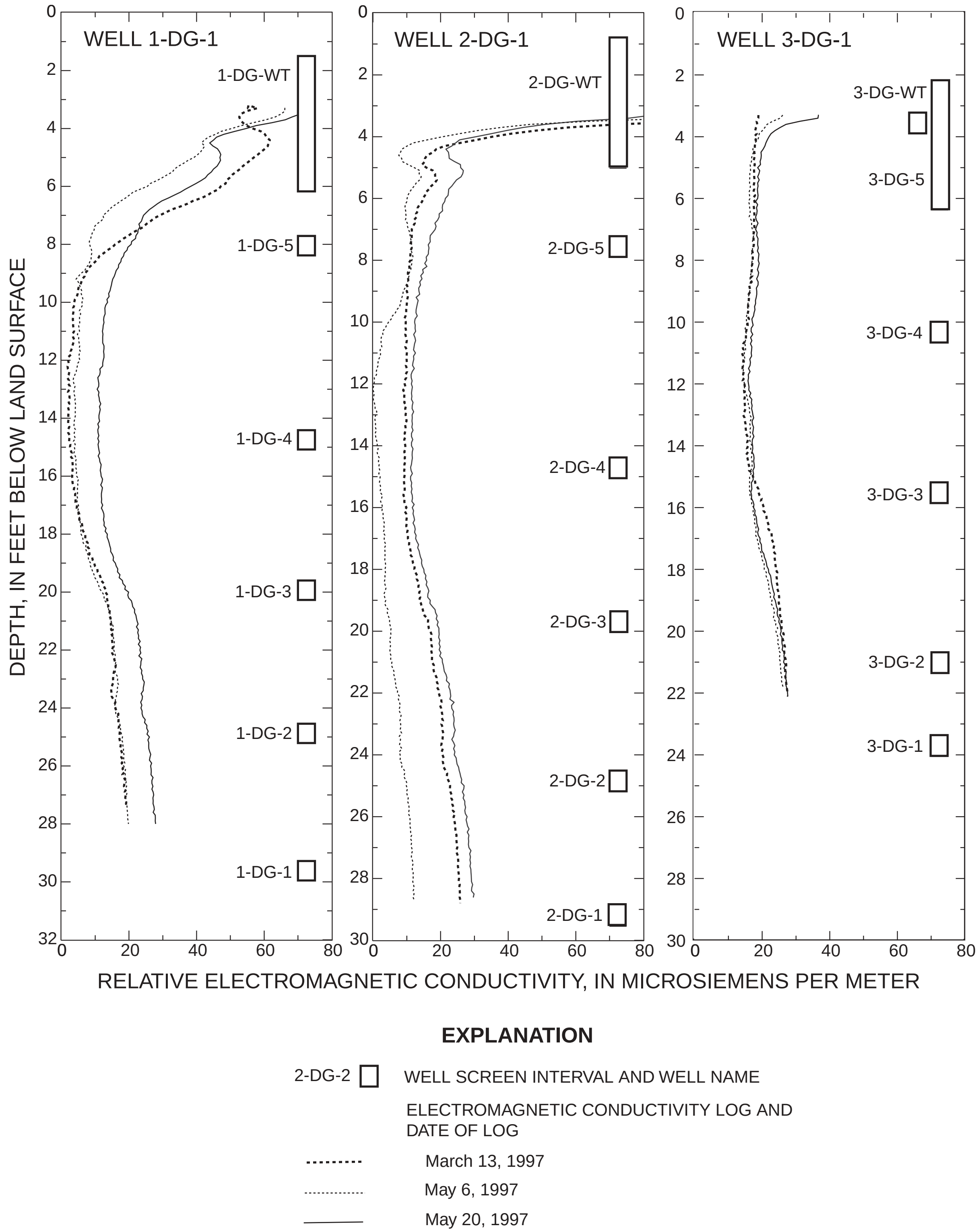


Figure 20. Borehole logs of relative electromagnetic conductivity with depth for three different dates in monitoring wells along hydrogeologic section A-A' at Indiana Dunes National Lakeshore near Beverly Shores, Indiana.

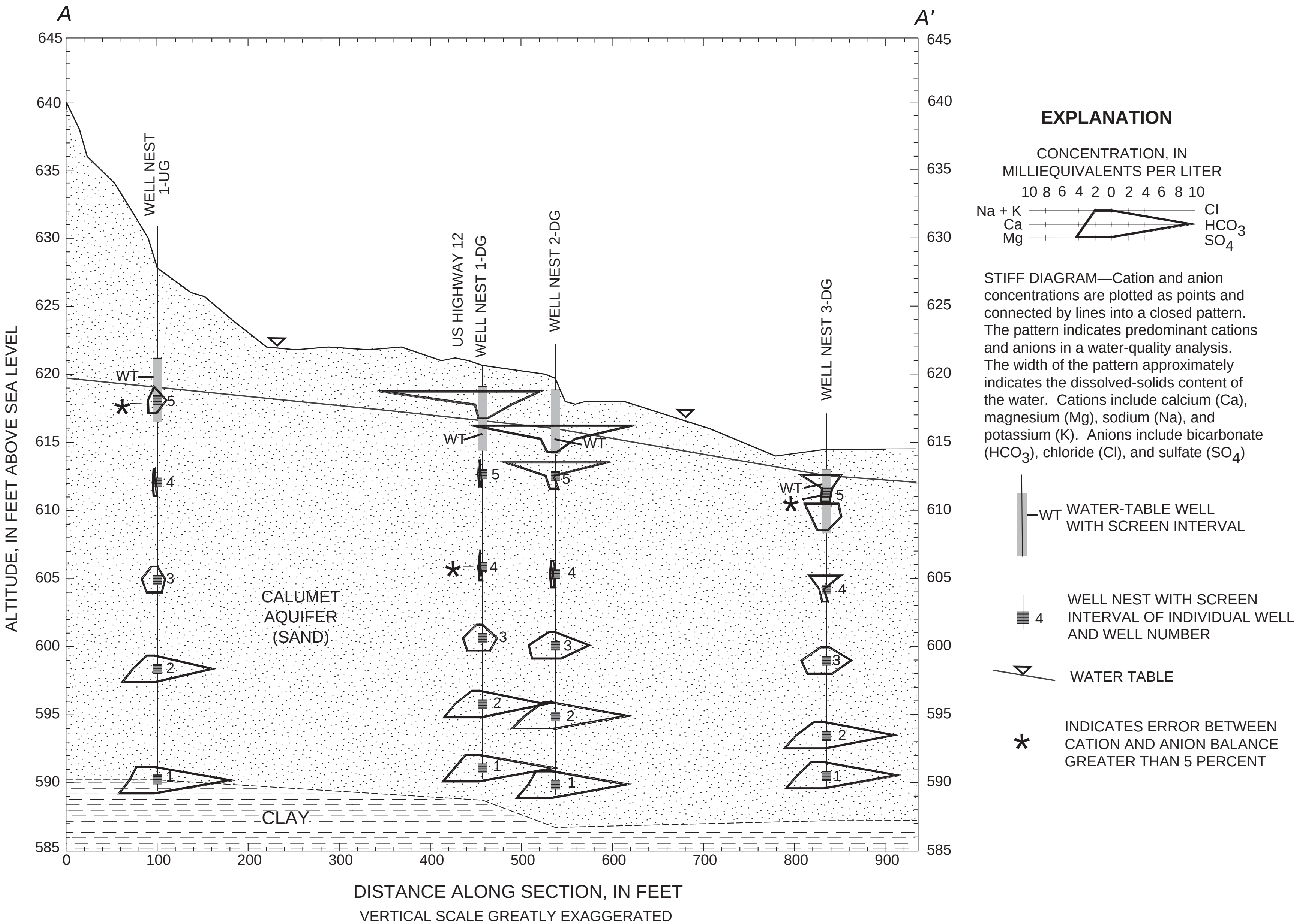


Figure 21. Hydrogeologic section A-A' with Stiff diagrams showing the relation of major ions in ground water at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, August 1996 (trace of section shown in figure 1).

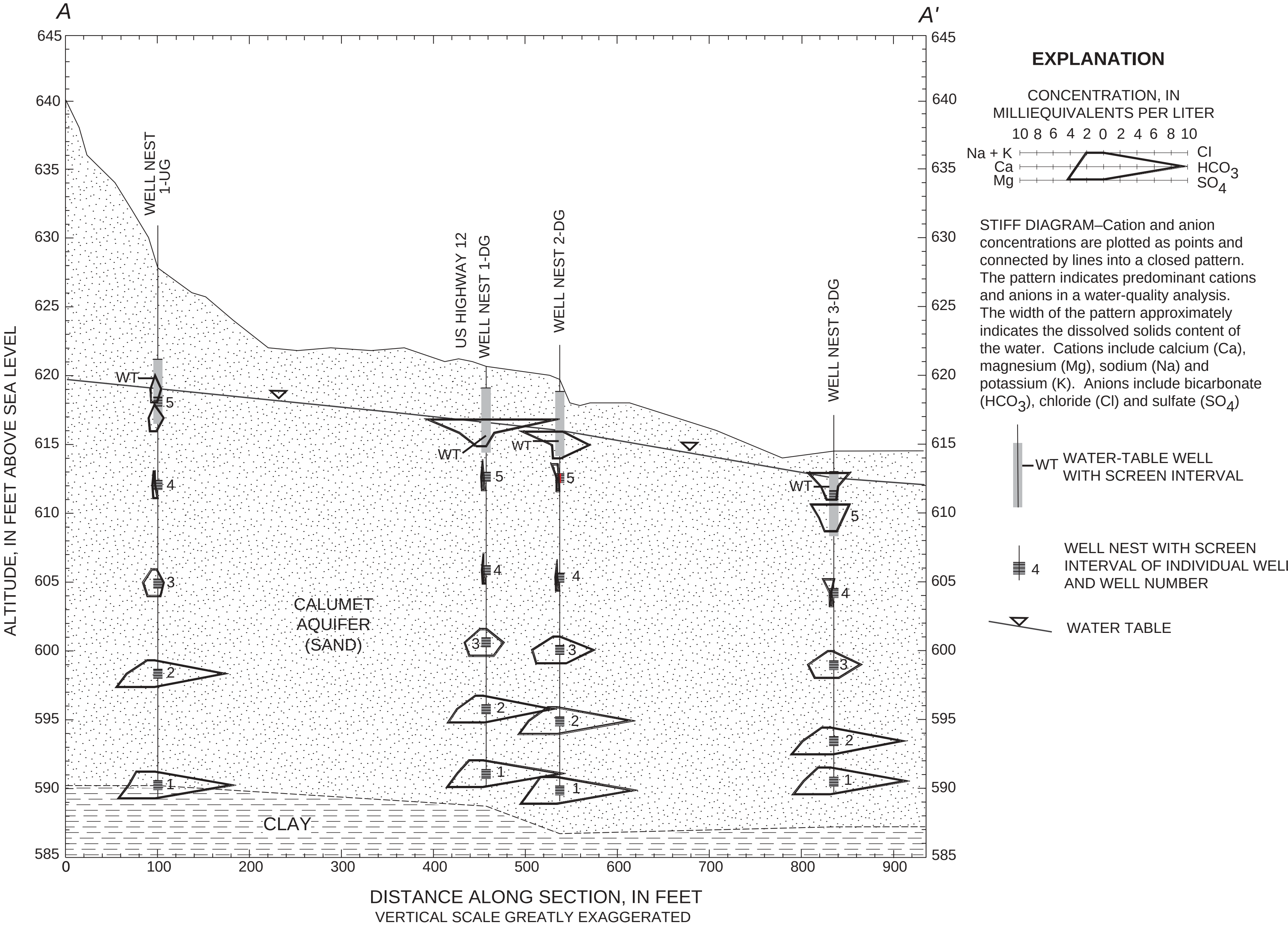


Figure 22. Hydrogeologic section A-A' with Stiff diagrams showing the relation of major ions in ground water at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, November 1996 (trace of section shown in figure 1).

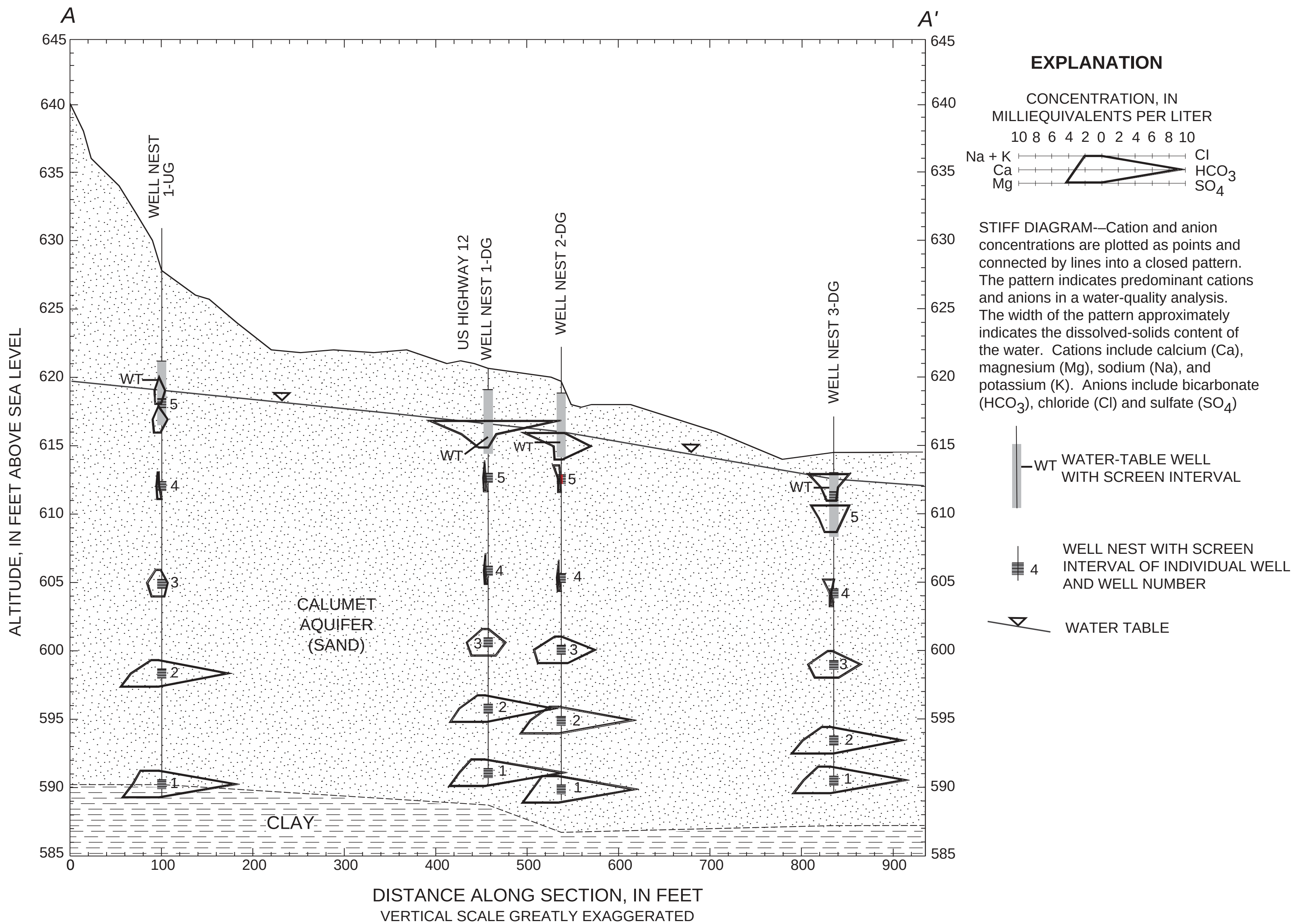


Figure 23. Hydrogeologic section A-A' with Stiff diagrams showing the relation of major ions in ground water at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, February 1997 (trace of section shown in figure 1).

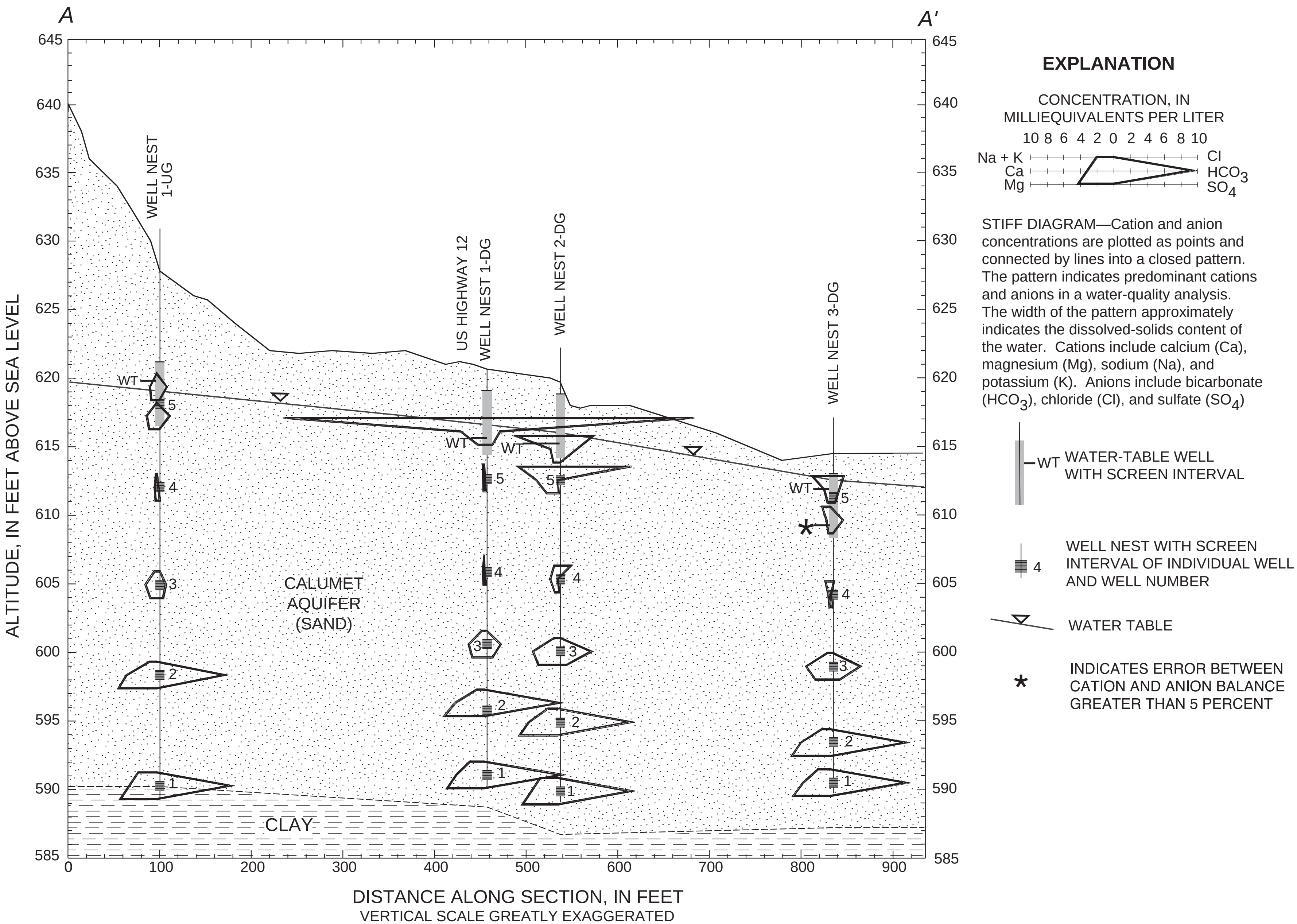


Figure 24. Hydrogeologic section A-A' with Stiff diagrams showing the relation of major ions in ground water at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, May 1997 (trace of section shown in figure 1).

The range in measured chloride concentrations indicated the variable effect of deicer application on ground-water quality at these wells. Chloride concentrations in water ranged from 3.2 to 1,400 in well 1-DG-WT, from 1.3 to 600 in well 1-DG-5, from 14 to 340 in well 2-DG-WT, and from 2.2 to 360 mg/L in well 2-DG-5 (figs. 8–9; table 15). Median chloride concentrations in ground water were 310 in well 1-DG-WT, 2.5 in well 1-DG-5, 65 in well 2-DG-WT, and 33 mg/L in well 2-DG-5. The largest chloride concentrations persisted for longer periods in the WT wells than in the deeper wells and occurred at 2-DG (95 ft downgradient from 1-DG) about 1 month later than at 1-DG. At 1-DG-WT, chloride concentrations were greatest from February through August in 1995, March through September in 1996, and January through June in 1997. At 1-DG-5, chloride concentrations were greatest during March and April in 1995 and 1997, and during May and June in 1996 (table 11). At 2-DG-WT, chloride concentrations were greater than background levels during the entire year, although the largest concentrations were measured in April through July in 1995 and June through September of 1996. At 2-DG-5, chloride concentrations were greatest during April through June in 1995, June through September in 1996, and May through June in 1997.

The distribution of chloride concentrations was similar among the wells along section A–A': 1-UG-WT, 1-UG-5, 1-DG-WT, and 1-DG-5 and the paired "ALT" prefix wells (fig. 8). The chloride concentrations and distribution also were similar among wells on sections A–A' and B–B' (the "REP" prefix wells), as shown by the box-and-whisker plots for wells 1-DG-5 and REP-1-DG-5 (fig. 8).

Automated measurements of specific conductance at wells 2-DG-WT and 2-DG-5 indicated the migration of "pulses" of deicer-affected water past the sensors that were not detected by the monthly sampling (fig. 19). These included various peaks with values of about 400 to 600 µS/cm more than measured in samples collected during monthly sampling. The periodic detection of deicer-affected water by the automated measurements between sampling intervals indicated that sampling or surrogate measurements must be more frequent than monthly if the values are needed to compute masses of deicer that flow past a monitored location. Comparisons of deicer loads in ground water to masses of deicer applied to the road were necessary to evaluate whether deicer chemicals were retained in the Calumet aquifer between yearly applications.

Concentrations of dissolved solids in water from well 3-DG-WT were composed principally of sodium and chloride. By comparison, the principal major-ion compositions in water from well 3-DG-5 changed from sodium and chloride when most affected by deicers to calcium and bicarbonate when least affected. Box-and-whisker plots of chloride concentrations indicated a relatively limited variability in chloride concentration at wells 3-DG-WT and 3-DG-5 (fig. 9). This limited variability in concentrations indicates that the seasonal (pulse) input of deicer-related compounds was being dispersed to nearly stable concentrations as ground water flowed 290 ft downgradient between 2-DG and 3-DG.

Ground water in wells 1-UG-WT and 1-UG-5 had dissolved-solids concentrations that were composed principally of calcium and bicarbonate. Ground water in level WT and 5 wells at 1-UG consistently contained small concentrations of chloride and dissolved solids; there was no evidence of ground water being affected by deicers at 1-UG-5 and 1-UG-WT.

The SMCL for chloride and the drinking-water equivalency level (DWEL) and taste and corrosion standards for sodium (table 1) were most frequently exceeded in the WT wells. The SMCL for chloride (250 mg/L) was exceeded in 30 monthly samples (figs. 8 and 9)—8 samples from 1-DG-WT, 10 samples from ALT-1-DG-WT, 3 samples from 1-DG-5, 2 samples from REP-1-DG-5, 2 samples from 2-DG-WT, 3 samples from 2-DG-5, and 2 samples from REP-2-DG-5. This result indicates that the SMCL was exceeded in approximately 3 percent of the 1,052 chloride samples collected for the study. Sodium concentrations equaled or exceeded the DWEL of 20 mg/L (figs. 10 and 11) in water from wells 1-DG-WT (7 of 9 samples), ALT-1-DG-WT (7 of 7 samples), 1-DG-5, ALT-1-DG-5 and REP-1-DG-5 (1 of 12 samples each), 2-DG-WT (9 of 9 samples), 2-DG-5 (5 of 9 samples), and REP-2-DG-5 (6 of 9 samples). In addition, the sodium standard enforced by the State of Florida (160 mg/L) was exceeded at wells 1-DG-WT (4 of 9 samples), ALT-1-DG-WT (2 of 7 samples), 2-DG-WT (2 of 9 samples), and REP-2-DG-5 (1 of 9 samples).

The Cl/Br and Cl/I ratios in water from the WT and level 5 wells downgradient from US–12 indicated that most samples from these wells were mixtures of background and deicer-affected water (figs. 14 and 15). Cl/Br ratios in water from wells 1-UG-5 and 1-UG-WT ranged from 100 to 200 (figs. 25 and 26). The Cl/Br and Cl/I ratios indicate that water from wells 1-UG-WT and 1-UG-5 were unaffected by deicer contamination. In water from WT wells, the Cl/Br ranged from 1,960 to greater than 8,300. The Cl/Br in water from wells 1-DG-5, 2-DG-5 and 3-DG-5 ranged from greater than 210 to greater than 6,500. The Cl/I ratios in ground water from level WT and 5 wells at downgradient sites also plotted in regions of figure 13 that indicate that the proportion of deicer-affected ground water varies through time.

Tritium concentrations in samples from the level 5 wells indicate that the water recharged the Calumet aquifer at all four sites between about 1987 and 1997. Tritiogenic helium data, collected for wells 1-UG-5 and 3-UG-5, indicate that ground water in those wells recharged the Calumet aquifer in 1997, the year the samples were collected.

Level 4 Wells

The level 4 wells generally contained the lowest concentrations of chemical constituents for all wells along section A–A' (table 15). Ground water from most of the level 4 wells had concentrations of dissolved solids that were composed principally of calcium and bicarbonate water, as was typical for the Calumet aquifer (figs. 21–24; Shedlock and others, 1994). Ground water from well 3-DG-4, however, had dissolved solids that were composed principally of sodium and chloride or sodium, chloride, and sulfate.

Chloride concentrations in ground water ranged from 1.0 to 2.7 for well 1-UG-4, from 1.2 to 11 for well 1-DG-4, from 1.1 to 100 for well 2-DG-4, and from 2.1 to 170 mg/L for well 3-DG-4 (table 15). Median chloride concentrations in ground water were 1.6 for wells 1-UG-4 and 1-DG-4, 1.4 for well 2-DG-4, and 30 mg/L for well 3-DG-4. The summary statistics (table 15) and box-and-whisker plots of chloride concentrations (fig. 8) indicate that ground water from level 4 wells at sites 1-UG and 1-DG was relatively unaffected by deicer application. The wide range of chloride concentrations at wells 2-DG-4 and 3-DG-4 indicates that water quality from wells 2-DG-4 and 3-DG-4 occasionally had characteristics similar to deicer-affected water (fig. 9).

The chloride plume spread deep into the Calumet aquifer to well 3-DG-4, 396 ft from the highway, during June 1997 (fig. 18). Dispersion of the plume to greater depth was affected by the larger hydraulic conductivity of the Calumet aquifer at the depth of the level 3 and 4 wells (fig. 6). The horizontal flow velocity of ground water between 1-DG-4 and 3-DG-4 also was consistently greater than at shallower depths in the Calumet aquifer along section A–A'. Relatively larger quantities of uncontaminated ground water also would flow through those shallower depths, disperse and mix with the contaminated water, and decrease concentrations within the chloride plume. The plume was represented in sectional view in two dimensions only. Flow in the third dimension (in or out of the section) is not discussed because there were not sufficient data points to define it.

Automated measurements of specific conductance at well 2-DG-4 indicated the migration of a “pulse” of deicer-affected water past the sensor in June 1996 that was not detected by the monthly sampling (fig. 19). The pulse had a specific conductance of about 270 μS/cm that was about double the value measured during water sampling at the site later that same month.

Chloride concentrations in water from well 2-DG-4 only exceeded upgrading values of 3 mg/L in 6 of 30 monthly water samples during the sampling period (table 11). Chloride concentrations greater than 3 mg/L were not measured in spring/summer samples collected in 1995 or 1996. By contrast, chloride concentrations in water from well 3-DG-4 exceeded 50 mg/L during June–September 1995, December 1995–March 1996, June–September 1996, and June 1997 (table 11). Chloride concentrations during these periods ranged from 51 to 170 mg/L with a median value of 89 mg/L, indicating when ground water was most strongly affected by deicer.

Sodium concentrations were the smallest among all wells sampled by this project in the level 4 wells at well sites 1-UG, 1-DG, and 2-DG (table 11). By comparison, the concentration of sodium in water from well 3-DG-4 exceeded the DWEL concentration of 20 mg/L in 5 of 9 samples. The sodium concentrations in water from level 4 wells all were less than the State of Florida or taste standard of 160 mg/L.

The analysis of Cl/Br ratios in level 4 wells were limited by concentrations of bromide and iodide that were less than the analytical reporting limit (table 11). The concentration of bromide was less than the analytical method reporting limit (<0.01 mg/L) in 6 of 8 samples.

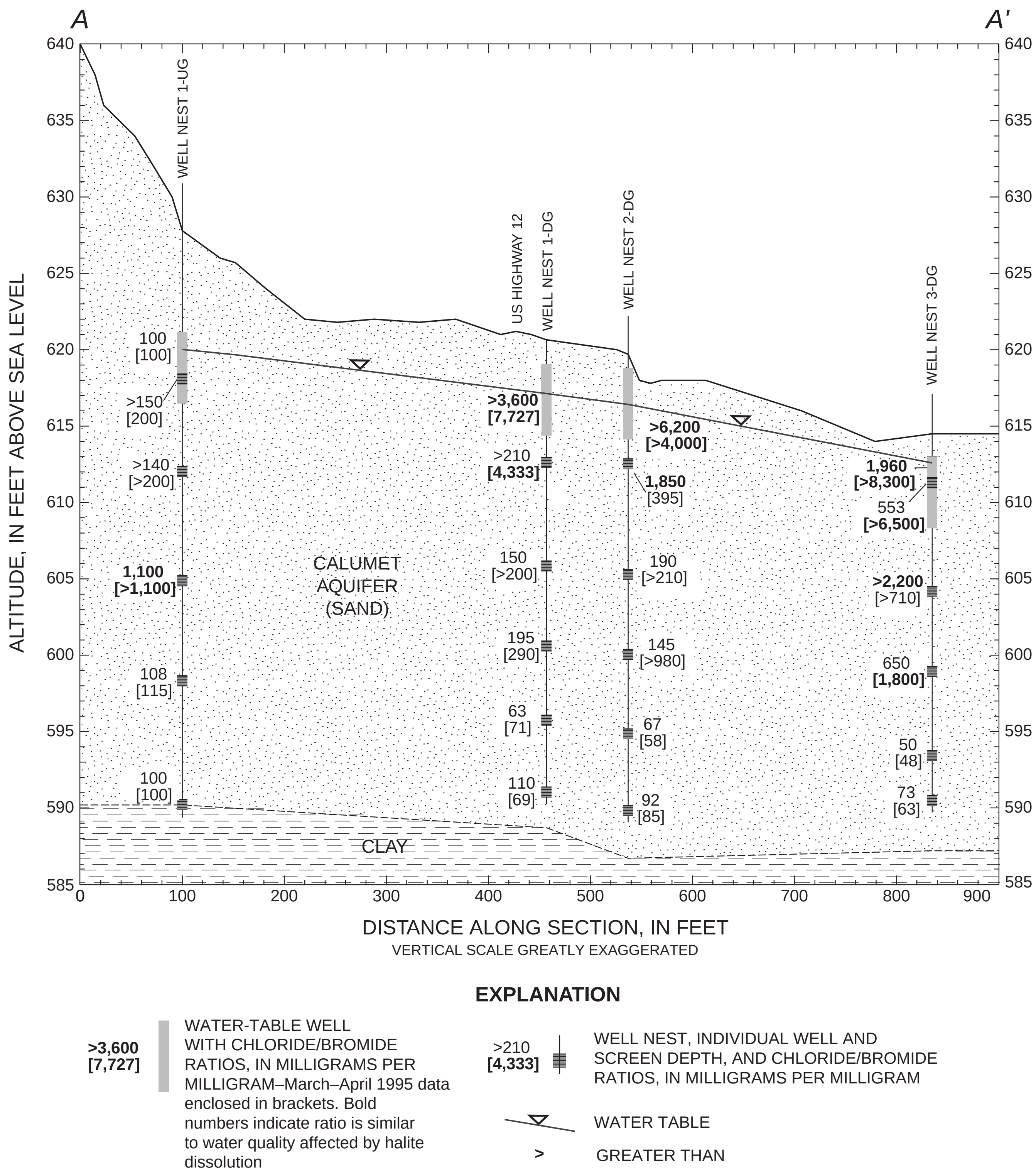


Figure 25. Hydrogeologic section A-A' showing chloride/bromide ratios in ground water at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, December 1994 and March–April 1995 (trace of section shown in figure 1).

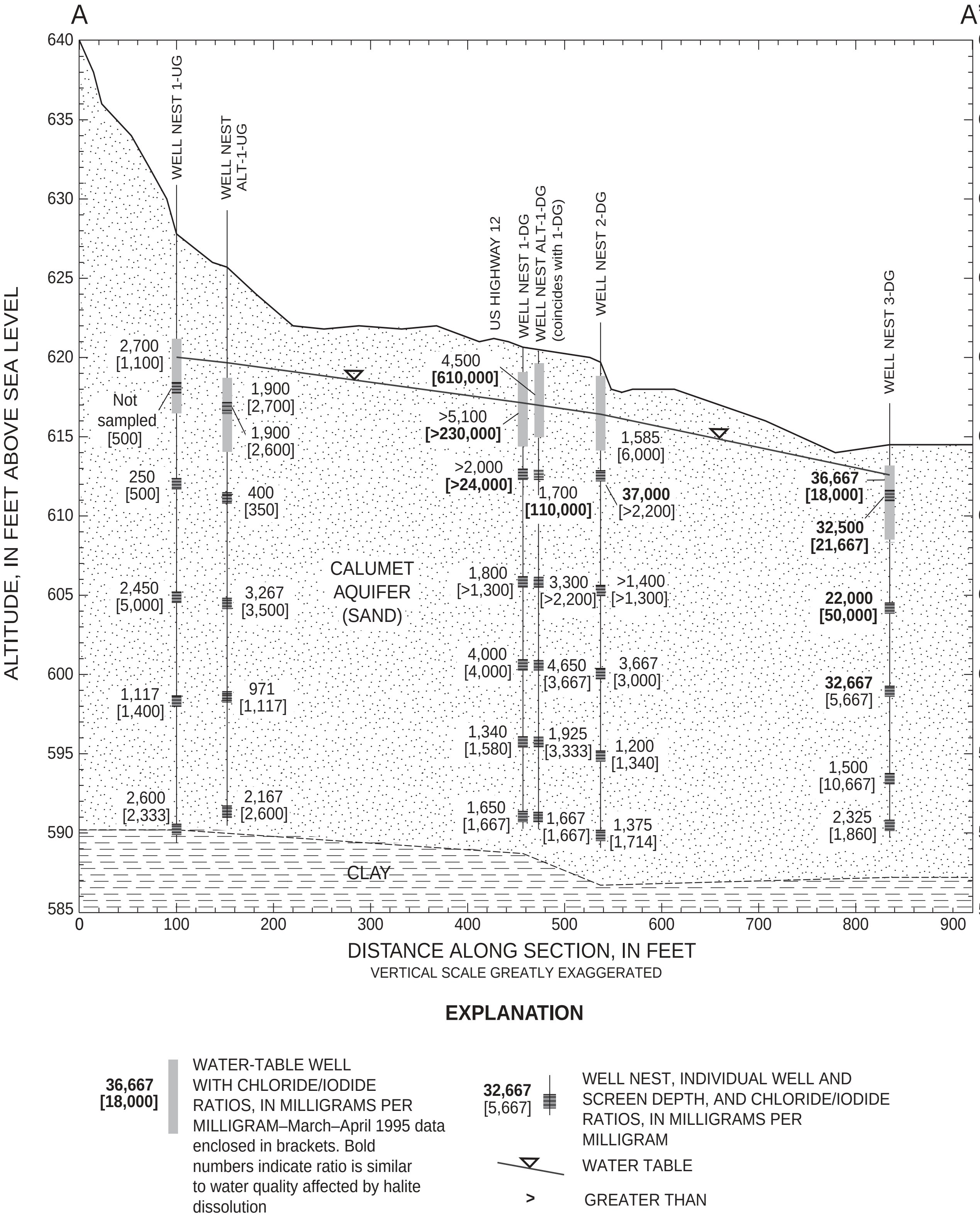


Figure 26. Hydrogeologic section A-A' showing chloride/iodide ratios in ground water at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, October–November 1995 and May 1996 (trace of section shown in figure 1).

The Cl/Br ratio in level 4 wells ranged from greater than 140 to greater than 2,200. The range of Cl/Br values in level 4 wells at sites 1-UG, 1-DG, and 2-DG ranged from greater than 140 to greater than 210, with two computed values of 150 and 190 (fig. 25). The two computed values were approximately within the range cited by Davis and others (1998) for uncontaminated ground water and overlap slightly into the range cited by Vengosh and Pankratov (1998) for ground water affected by domestic sewage (table 5). The Cl/Br values indicate those level 4 wells at sites 1-UG, 1-DG, and 2-DG were not affected during December 1994 and March–April 1995 by prior deicer applications.

The minimum values of Cl/Br ratios were higher in water from well 3-DG-4 than in other level 4 wells. The Cl/Br ratios for well 3-DG-4 were within the range cited by Vengosh and Pankratov (1998) and partially within the range cited by Davis and others (1998) for ground water affected by halite dissolution (table 5). Four samples from well 3-DG-4 had Cl/I ratios and chloride concentrations that plotted in the region indicating the mixing of upgradient ground water with halite brine or deicer-affected water (fig. 14). The remaining samples from that well and other level 4 wells had iodide concentrations less than the reporting limit or were similar to background water quality.

Ground water in the downgradient level 4 wells had tritium values that were typical of water recharged to the Calumet aquifer between 1987 and 1997 (fig. 7; table 4). The dates of ground-water recharge at the downgradient level 4 wells were older than might be expected for a permeable, unconfined, sand aquifer. Mixing of older, deeper, chloride-depleted water with younger, deicer-affected water is indicated by the annual increase in chloride concentrations at well 3-DG-4. The tritium data indicate that ground water from well 1-UG-4 was recharged during 1960–80. The apparently older ground water in the upgradient well indicates either (1) a longer flowpath from land surface to well 1-UG-4 compared to downgradient wells or (2) the mixing of local recharge with tritium-depleted ground water from deep parts of the Calumet aquifer.

The inferred ground-water ages computed for level 4 wells from tritiogenic helium data were within the ranges estimated from tritium concentrations. The date of ground-water recharge of water from well 1-DG-4 was 1990, and the recharge date of water from well 3-DG-4 was 1988 (fig. 7; table 4). These data apparently indicate that deicer compounds measured in ground water from well 3-DG-4 were carried into the Calumet aquifer near the highway no earlier than 1988. Because the level 4 wells were at a depth where downward-migrating recharge was mixing with deep and relatively older ground water, the mixture of older and younger waters provides an apparent ground-water age that was older than the date when deicer compounds actually were introduced. It follows that, as with the tritium dating, the tritiogenic-helium ground-water age should be considered the average recharge date of the flowpaths sampled by the well and not the date of introduction of the deicer into the water sampled from that well.

Level 3 Wells

Concentrations of dissolved solids were principally composed of calcium and sulfate or calcium and bicarbonate in water from upgradient well 1-UG-3 and principally composed of calcium and bicarbonate in water from the downgradient level 3 wells (figs. 21–24). The calcium-sulfate type ground water has not been described previously in this area and was unique to the level 3 wells. The source of sulfate was not known but may be a trace constituent in the aquifer mineralogy.

Chloride concentrations in ground water ranged from 6.6 to 13 for well l-UG-3, from 5.7 to 15 for well 1-DG-3, from 8 to 14 for well 2-DG-3, and from 8.6 to 150 mg/L for well 3-DG-3 (table 15). Median chloride concentrations for water from the same well nests were 11 from 1-UG-3, 12 from wells 1-DG-3 and well 2-DG-3, and 14 mg/L from well 3-DG-3. The small ranges of chloride concentrations in ground water from level 3 wells at well nests 1-UG, 1-DG, and 2-DG indicate that most sites at this depth were unaffected by the application of highway deicers. Chloride concentrations in ground water from well 3-DG-3 (8.6–150 mg/L) were more variable than water from the other level 3 wells (figs. 8 and 9), which indicates that water from this well was affected by mixing of upgradient or deeper ground water with deicer-affected water.

Ground water at 3-DG-3 appeared to be affected infrequently by deicers during the summer. The contoured chloride concentrations for June 1997 portray a plume with chloride concentrations greater than 50 mg/L extending from the highway and past well 3-DG-4 (fig. 18). Well 3-DG-3 was less than 5 ft from 3-DG-4 and may be affected occasionally by the plume. The maximum chloride concentration of 150 mg/L in water from well 3-DG-3 was measured August 3, 1995, but concentrations exceeded 40 mg/L from June to November of 1995 (table 11).

The Cl/Br ratios for level 3 wells ranged from 145 to 1,100 in December 1994 and from 290 to at least 1,800 in March–April 1995 (fig. 25). Although chloride concentrations were relatively small, relatively high Cl/Br values were computed for water chemistry from well 1-UG-3 during December 1994 and March–April, 1995 (fig. 25). The Cl/I ratios for all level 3 wells (except one sample from well 3-DG-3 in November 1995) were similar to background ratios (figs. 14 and 26). The small chloride concentrations and the Cl/I ratio data indicated that the larger Cl/Br ratios in water from well 1-UG-3 were anomalous and appeared to represent some variability in background conditions or laboratory analytical error. The data indicated the potential for some natural variation in Br concentrations and the need to base conclusions of whether water was affected by deicers on more than one indicator.

Level 2 and 1 Wells

The relative concentrations of major ions in water from the level 2 and 1 wells essentially were unchanged during the study, indicating a constant source of chemical constituents and relative isolation from the more variable ground-water quality in shallower parts of the Calumet aquifer. Water from the level 2 and 1 wells had concentrations of dissolved solids that were composed principally of magnesium and bicarbonate or magnesium, calcium, and bicarbonate (figs. 21–24). Shedlock and others (1994) documented similar water quality throughout much of the Calumet aquifer at the IDNL. Hydraulic gradients near the study area indicated that a small amount of ground water discharge may occur from the confining unit into the Calumet aquifer (Shedlock and others, 1994). The potential for upward flow through the confining unit was indicated by a flowing well about 0.5 mi due north of the study area that was completed in the basal sand aquifer immediately below the confining unit.

Water quality in the level 2 and 1 wells upgradient and downgradient from US–12 essentially was similar (figs. 8–11, table 15, figs. 21–24). Chloride concentrations ranged from 4.8 to 14 mg/L in ground water from level 2 and 1 (main transect) wells. The relatively small range of concentrations indicated a constant, low-level source of chloride. Some variability would be expected if deicer application were affecting water from the level 2 and 1 wells. Shedlock and others (1994) measured similar concentrations of chloride in wells screened in other parts of the Calumet aquifer. Most of the sodium concentrations in water from the level 2 and 1 wells exceeded the 20 mg/L DWEL standard (figs. 10–11). The data indicated that the source of sodium and chloride in water from level 2 and 1 wells may relate to upward leakage of water from a deeper aquifer or from bedrock rather than from highway deicers.

The Cl/Br ratio in level 2 and 1 wells ranged from 48 to 115 (fig. 25). The Cl/Br ratios were within the ranges cited by Davis and others (1998) for atmospheric deposition and uncontaminated ground water. The Cl/I ratios in water from the level 2 and 1 wells downgradient from US–12 were similar to ratios from upgradient ground water (fig. 26). The Cl/I ratios indicated no effect on water quality from deicer application in the deepest ground water at the study area.

Isotopic data indicated that the water from level 2 and 1 wells was relatively isolated from surface recharge. Ground water from the level 2 and 1 wells contained concentrations of tritium indicative of prebomb (1952) recharge (fig. 7; table 4). Tritiogenic helium ages indicated that ground water from level 2 and 1 wells apparently recharged the Calumet aquifer between 1887 and 1930. These dates could be explained by recharge and flow along very long flowpaths or by upward leakage of older ground water from deeper units below the confining unit into the base of the Calumet aquifer.

PROCESSES AFFECTING THE DISTRIBUTION OF DEICER-AFFECTED WATER QUALITY IN A PART OF THE CALUMET AQUIFER

Understanding the processes that affect concentrations of deicer-related chemicals in the Calumet aquifer may help highway managers improve the deicer application process and minimize the effects on ground-water quality. Concentrations of deicer-related chemicals may be affected by exchange with cations sorbed onto aquifer sediments, dispersion and retardation related to the tortuosity of flow through the aquifer, mixing with unaffected ground water, and advective transport by ground water.

Cation Exchange

The cation exchange capacity (CEC) values for samples of aquifer sands collected at the study site ranged from 0.20 to 0.49 milliequivalent per 100 grams (meq/100 g) of aquifer sediment (table 8). A milliequivalent (meq) is defined as a weight of a chemical substance, divided by the formula weight of its composition elements and the assumed charge of the species. For example, calcium and magnesium have assumed charges of 2, and sodium and potassium have assumed charges of 1. These CEC values agree with values cited for analysis of calcareous and noncalcareous sand from other sites (0.33 to 0.7 meq/100 g of solid from Reardon and others, 1983, p. 426; 0.265 meq/100 g of solid from Cherry and others, 1981). CEC values for pure clay minerals by comparison range from about 1 to 200 meq/100 g (Drever, 1982). At the study area, the Calumet aquifer contains a relatively small fraction of clay minerals and organic material.

Minor amounts of cation exchange occurred within the Calumet aquifer but did not retard transport of most of the deicer-related sodium. Seasonal increases of calcium, magnesium, and potassium in ground water at wells 1-DG-WT and 2-DG-WT accompanied periods of larger sodium and chloride concentrations. The relatively small CEC of the aquifer sand indicated, however, that the exchange of sediment-sorbed cations for deicer-related sodium in ground water does not appreciably retard sodium transport rates in ground water. This conclusion was indicated by the water-quality data where sodium concentrations greater than upgradient values were determined in ground water from well 3-DG-4 despite a relatively long flowpath and residence time in the Calumet aquifer.

Some deicer-related sodium has sorbed onto mineral exchange sites in relatively shallow aquifer sediment. Exchangeable sodium concentrations were determined to be slightly larger in the shallow sediment samples relative to the deeper sediment samples (table 8). Exchangeable cations were analyzed to indicate the abundance of cations sorbed onto the aquifer sediment that were available for reversible sorption. Exchangeable calcium concentrations were noticeably larger in the deeper sediment samples relative to the shallower sediment samples at sites 1-DG and 3-DG (table 8). Exchangeable magnesium concentrations were largest in samples from the deeper parts of the Calumet aquifer at site 3-DG. The similarity of the larger concentrations of calcium and magnesium in the aqueous and solid phases indicated that the two phases were approaching equilibrium. Relatively long ground-water residence times, as indicated by ground-water recharge dates, also indicated the potential of equilibrium between water and sediment chemistry in the deeper parts of the Calumet aquifer.

Saturation paste extracts were measured in the six samples to determine the amounts of the water-soluble anions chloride, bromide, and iodide present in the Calumet aquifer. Soluble chloride concentrations were largest in the samples from site 3-DG (table 8). The largest concentration of chloride (89 mg/L) was measured at site 3-DG at the 7-ft depth. Large concentrations of chloride at site 3-DG may be a result of the time of sample collection; water-quality data from this study (table 11) indicated that by late summer most deicer-related chloride had been transported from 1-DG to sites farther downgradient. Solid-phase samples were collected during August and September of 1994.

The soluble chloride concentration in sediments from shallow parts of the Calumet aquifer at site 1-DG was 15 mg/L, about three times higher than the mid-aquifer concentration (4.7 mg/L) but similar to the concentration deeper in the aquifer (12 mg/L; table 8). The concentration of soluble chloride in deep parts of the Calumet aquifer, where ground-water recharge dates were the oldest measured during the study, indicated that the bedrock probably was a source of some chloride. The relatively low concentrations of soluble chloride in the sample from 15 ft at site 1-DG agreed with water-quality data from well 1-DG-4, which was not affected greatly by deicers (table 8). Soluble chloride concentrations in the sample collected from a 3-ft depth at site 1-DG (table 8) indicated the persistence of deicer residues throughout the year at sites near the highway.

The concentration of extractable iodide was about 30 times larger in the 13-ft depth sample from site 3-DG, positioned near well screen 3-DG-4, than in any other sample (table 8). The concentration of extractable iodide was about 1,000 or more times larger in sample 3-DG-13 than in water from adjacent

Table 8. Cation exchange capacity, chemical characteristics of aquifer-sediment samples, and ratios of sodium to calcium plus magnesium in 1994–97 water samples from Indiana Dunes National Lakeshore near Beverly Shores, Indiana

[meq, milliequivalents; g, grams; Na, sodium; Ca, calcium; Mg, magnesium; mg/L, milligrams per liter; dup, duplicate sample; --, not measured]

Well site where solid phase was sampled (depth sampled, in feet[a])	Cation exchange capacity (meq/ 100 g)	Exchange-able sodium, corrected (meq/ 100 g)	Exchange-able calcium, corrected (meq/ 100 g)	Exchange-able magnesium, corrected (meq/ 100 g)	Ratio calculated from solid-phase sample $\frac{Na}{(Ca+Mg)}$	Chloride in solution saturation extract (mg/L)	Iodide in solution saturation extract (mg/L)	Well closest to solid-phase sample depth	Minimum ratio calculated from water sample $\frac{Na}{(Ca+Mg)}$	Median ratio calculated from water sample $\frac{Na}{(Ca+Mg)}$	Maximum ratio calculated from water sample $\frac{Na}{(Ca+Mg)}$
1-DG (3)	0.49	0.11	0.64	0.11	0.15	15	0.2	1-DG-5	0.23	0.31	2.1
1-DG (3, dup)	.48	.1	.63	.12	.13	--	--	--	--	--	--
1-DG (15)	.2	.01	.04	.005	.22	4.7	.1	1-DG-4	.19	.24	.36
1-DG (15, dup)	.2	.02	.04	.005	.44	3.7	.1	--	--	--	--
1-DG (29)	.28	.03	14.	.28	.0021	12.	.1	1-DG-1	.20	.21	.21
1-DG (29, dup)	.27	.02	14.	.30	.0014	11.	.1	--	--	--	--
3-DG (7)	.26	.09	.26	.04	.3	89.	.1	3-DG-5	.56	.86	1.4
3-DG (7, dup)	.25	.09	.26	.04	.3	--	--	--	--	--	--
3-DG (13)	.36	.03	.18	.08	.12	10.	3	3-DG-4	2.3	5.2	19.
3-DG (13, dup)	.36	.01	.17	.04	.048	9.9	2.8	--	--	--	--
3-DG (15)	.29	.02	4.7	2.2	.0029	24	.1	3-DG-3	.064	.11	.63
3-DG (15, dup)	.29	.02	4.2	1.9	.0033	--	--	--	--	--	--

[a]Solid-phase samples at the 1-DG site were collected September 14, 1994. Solid-phase samples at the 3-DG site were collected August 31, 1994.

well 3-DG-4. Other extractable iodide concentrations in aquifer sediment were greater than iodide concentrations in water by about 200 times or less. The data indicate either a potential error in the extractable iodide determinations or that extractable iodide was kinetically limited from equilibrating with ground water. Concentrations of soluble bromide in these samples all were less than the method reporting limit (0.2 mg/L).

Dispersion and Retardation of Deicer-Related Constituents

Hydrologic and isotopic data can be used to calculate ground-water-flow rates through the Calumet aquifer. In the absence of hydrodynamic dispersion, a nonreactive, conservative ion like chloride would move through the Calumet aquifer at the same rate as the ground water. If dispersion or retardation were active processes, then chloride concentrations would decrease along directions of ground-water flow but would affect an increasingly larger volume of the aquifer with increasing distance from the deicer source. Hydrodynamic dispersion includes two processes—mechanical mixing and chemical diffusion.

The decrease in chloride concentrations with increasing distance along the ground-water flowpath supports the conclusion that mechanical dispersion (mixing) substantially affects the distribution of deicer-related compounds in the Calumet aquifer. The chloride concentration contours indicated that the deicer-related compounds affected a larger volume of aquifer material with increasing time and distance from the application site, and the maximum measured concentrations decreased in the downgradient direction.

Tritium and tritiogenic helium dating indicated that the average age of water sampled from well 3-DG-4 was about 9 years. If the water quality and ground-water velocities accurately portray transport rates in the Calumet aquifer, isotopic ground-water age dates indicate that (1) recently recharged ground water at 3-DG-4 has mixed with older, deeper water to produce an apparently older than expected age, or (2) the concentration gradient has caused deicers to chemically diffuse into deeper, older water despite the primarily horizontal flowpath. Chemical diffusion generally is less significant than dispersion in actively flowing ground-water systems (Freeze and Cherry, 1979). The diffusion explanation was, therefore, unlikely, and ground-water mixing of very recent and older water at the intermediate depth wells was likely.

Chemical retardation can result from interactions between ions in solution and the aquifer sediment. Reversible cation exchange of aqueous sodium for mineralogic calcium is an example. The result of retardation is an apparent transport rate of an ion in solution that is slower than the linear velocity of ground water. Solid-phase analyses, discussed previously, indicated that the capacity of the aquifer to retard sodium was small, and noticeable quantities of sodium already had been sorbed to clay minerals. As a result, retardation of sodium by this process was unlikely.

The rate of deicer-plume migration was about 1.6 or more times faster than the average linear velocity computed with data from slug-test results and water-level measurements. The rate of deicer-plume migration was about 3.1 ft/d between the weeks of March 11 and June 16, 1997 (about 96 days), as estimated by the rate of advance of the 200-mg/L chloride contour (about 300 ft). The rate of plume migration indicated either that the assumed porosity value was too large or that the results from the slug-test analyses underestimated the actual hydraulic conductivities. Because the deicer-plume migration integrates hydraulic conductivity across a larger part of the aquifer than was measured by slug testing, the larger plume velocity agrees with the commonly observed scalar increase in hydraulic conductivity values with increased scale of measurement (Schulze-Makuch and others, 1999).

Retention of Deicer-Related Constituents

The concentrations of highway-deicer chemicals passing site 2-DG during the period January 1, 1995, to December 31, 1996, were estimated to evaluate the extent to which deicer-related compounds were retained in the aquifer from one application season to the next. The computations were based on the hourly specific-conductance measurements made in wells 2-DG-4, 2-DG-5, and 2-DG-WT and monthly measurements of specific-conductance values and chloride concentrations in water samples.

Specific-conductance values and chloride concentrations were measured in water samples on the same dates on 28 occasions in well 2-DG-WT, on 29 occasions in well 2-DG-5, and on 29 occasions in well 2-DG-4. Equations relating chloride to specific conductance were calculated for each well by using linear regression (fig. 27). The relations were used to estimate a continuous record of chloride concentrations for each of the three wells (fig. 28).

The estimated records indicated that chloride concentrations in wells 2-DG-4 and 2-DG-5 were relatively larger from January to August/September in 1995 and from May through December in 1996 but returned to background levels from October 1995 to April 1996. This result indicated that chloride was not being retained in the Calumet aquifer near wells 2-DG-4 or 2-DG-5.

At well 2-DG-WT, chloride concentrations only briefly approached background concentrations during April 1995 and January 1996 but did not sustain low concentrations for a prolonged period. This information indicated that chloride, in solid or aqueous forms, may be retained in the unsaturated zone and in the Calumet aquifer near the highway. Retention of deicer in the unsaturated zone between deicer-application seasons depends on the unsaturated-zone permeability, adsorption properties, depth to the water table, precipitation patterns, and other factors.

The annual mass of deicer passing through the Calumet aquifer along section A–A' was estimated by summing the estimated mass of chloride in ground water flowing past the automated sensors at well nest 2-DG in wells 2-DG-WT, 2-DG-5, and 2-DG-4. No road-deicer effects were documented in samples from well 2-DG-3. Each daily estimate of chloride concentration was assumed to represent an aquifer thickness halfway to the next well screen above and below the sensor. The daily estimate of chloride concentrations from each sensor (in milligrams per liter) was multiplied by the volume of aquifer represented by one day of ground-water flow past each well (the representative thickness of the aquifer, multiplied by an assumed width of 1 ft, the average linear ground-water velocity at that well screen, and one day—the duration of flow). Velocity values were linearly interpolated between the computed values in table 14 to form a daily record of computed velocities. The resulting masses of chloride then were summed for the period of deicer application to compute an annual mass of chloride flowing in ground water past the wells at 2-DG (table 9).

The data indicated that some deicer may be retained in the Calumet aquifer and unsaturated zone between annual salt-application periods. The estimated masses of chloride transported in ground water past 2-DG in 1995 and 1996 were either about the same as (1995) or less than (1996) the masses of chloride applied to US–12 during those years of the study (table 9). The approximately 1.9-pound-per-foot excess of deicer applied in the same year to the roadway in 1995–96 as compared with the amount transported in ground water indicated the potential for some retention of deicer-related chloride in the ground-water flow system under study. The most likely source of retained deicer would be the incomplete flushing of deicer from the unsaturated zone. Another possibility is that transport of chloride in the third spatial dimension, which cannot be shown along section A–A', could account for the excess of applied deicer over deicer transported in ground water. The comparison also may incorporate some unknown imprecision in the reported values of deicer applied to the roadway or of the hydraulic parameters of the aquifer.

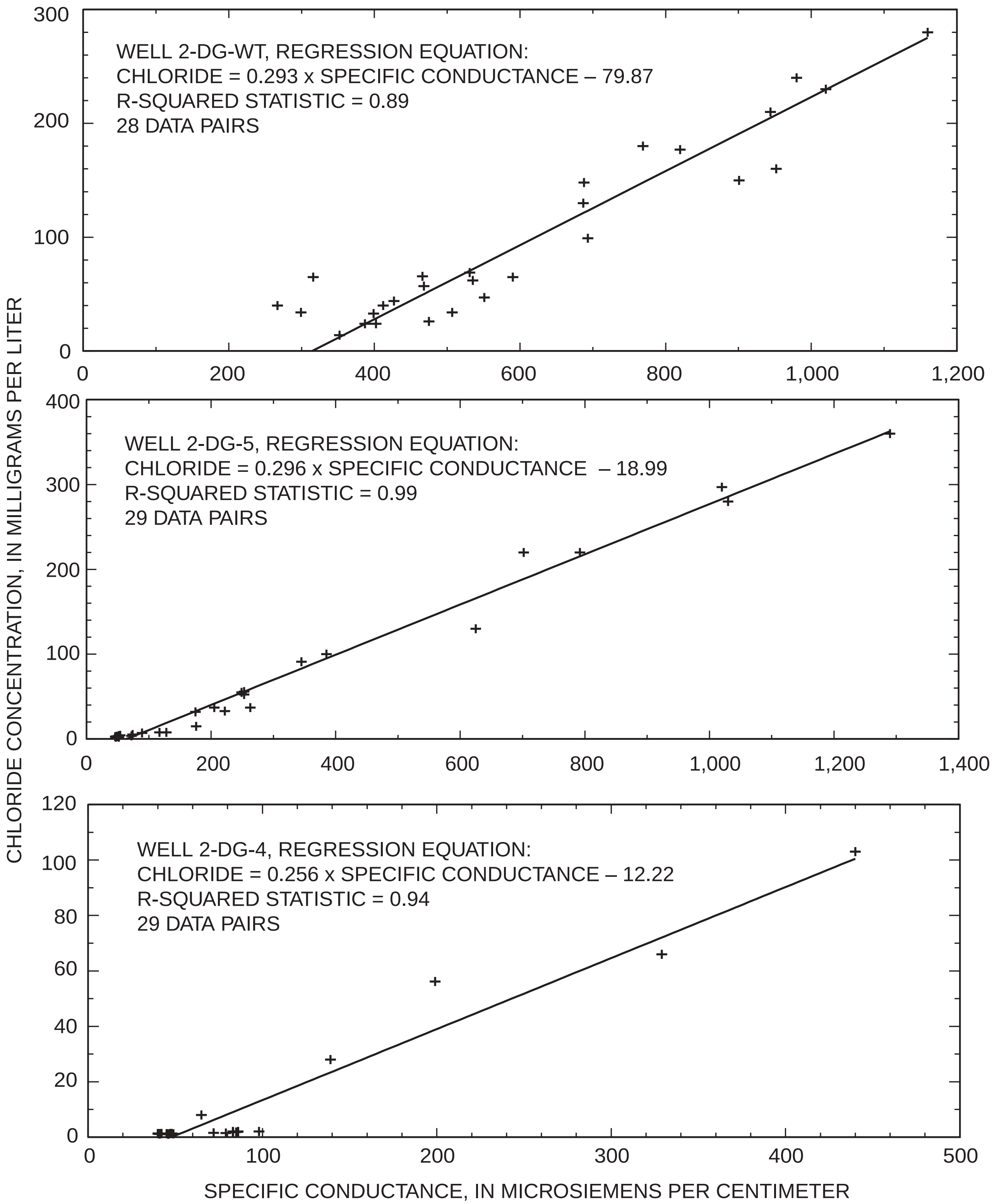


Figure 27. Chloride concentration with specific-conductance values and calculated linear regression relations for wells 2-DG-WT, 2-DG-5, and 2-DG-4 at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97.

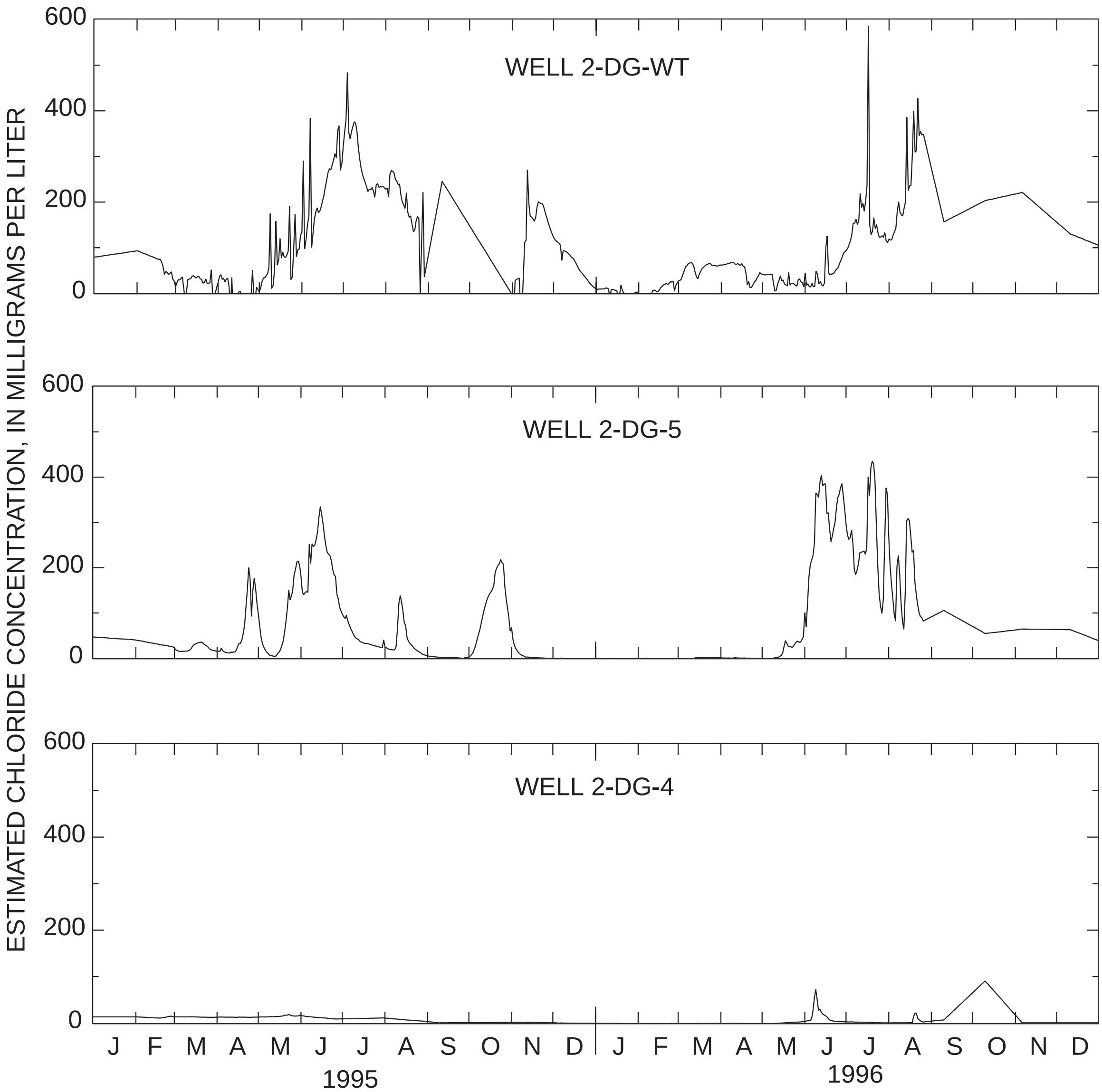


Figure 28. Continuous chloride concentrations estimated from specific-conductance data in wells at site 2-DG, Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1995–96.

Table 9. Comparison of mass of deicer applied to U.S. Highway 12, measured as chloride, 1993–97, with estimated mass of chloride in ground water that flowed past well site 2-DG at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–96

Deicer application year (December–November)	Mass of salt applied, in pounds of chloride per feet of highway per deicer application year	Estimated mass of chloride flowing past wells at 2-DG, in pounds of chloride per feet of aquifer width per deicer application year
1993–94	4.96	Not monitored
1884–95	1.82	1.83
1995–96	4.52	2.59
1996–97	4.36	Not monitored
Annual average	3.92	2.21

SUMMARY AND CONCLUSIONS

Ground-water quality in the Calumet aquifer was affected by deicer applications to US–12. The most pronounced effects were restricted to the upper 5 ft of the saturated zone near US–12 and in the upper one-third to one-half of the Calumet aquifer along the direction of ground-water flow northward from US–12. Data collected for this study indicated that the aquifer thickness affected by deicer application increased with distance from US–12. The effects of deicer application were identified in ground water from the water table to a depth of 15 ft below the water table at a distance of 400 ft from US–12. The downgradient distance at which the effects of deicers could no longer be detected was not determined.

Chloride and sodium concentrations increased in ground water because of deicer applications. Peak concentrations in water-table wells downgradient from US–12 were as much as 1,000 times greater than concentrations in ground water from upgradient water-table wells. Peak concentrations decreased with increased distance from US–12. Approximately 3 percent of the chloride analyses done for the study exceeded the SMCL for drinking water. At site 1-DG-WT, slightly more than 50 percent of the samples exceeded the SMCL. Sodium concentrations frequently equaled or exceeded the DWEL of 20 mg/L in water from wells 1-DG-WT (7 of 9 samples), ALT-1-DG-WT (7 of 7 samples), 2-DG-5 (5 of 9 samples), REP-2-DG-5 (6 of 9 samples), and 2-DG-WT (9 of 9 samples). In addition, the sodium standard enforced by the State of Florida (160 mg/L) was exceeded at wells 1-DG-WT (4 of 9 samples), ALT-1-DG-WT (2 of 7 samples), REP-2-DG-5 (1 of 9 samples), and 2-DG-WT (2 of 9 samples).

A seasonal chloride input to the ground-water system was evident in the shallowest wells near US–12 but was less evident at downgradient well sites. Ground water at shallow downgradient wells maintained less variable, but still deicer-affected, chloride and sodium concentrations.

Concentrations of chloride and sodium decreased in the Calumet aquifer mainly because of dispersion. The cation exchange capacity of the aquifer sediment was limited, and substantial quantities of deicer-related sodium were transported more than 400 ft from US–12. Dispersion resulted in decreased chloride concentrations with increased distance from US–12, but the thickness of the affected aquifer correspondingly increased.

Continuous specific-conductance data indicated that some deicer may be retained throughout the year in shallower parts of the Calumet aquifer near US–12. The data established the presence of a varied but continuous input of chloride to the water table near US–12. Peak concentrations of deicer-affected constituents occasionally were detected by the automated daily measurements of specific conductance that were made between the monthly samplings of ground water. The data indicated that more frequent sampling than monthly intervals would be necessary if maximum chloride concentrations were to be measured.

Results of borehole electromagnetic induction logging indicated that well screens were appropriately located in the Calumet aquifer to sample deicer-affected ground water and to delineate the chloride-concentration profile at each well site. Estimated rates of chloride transport by ground water indicated that the deicer-affected water was transported more than 400 ft from the highway before the next application season began. Water-quality data indicated that chloride concentrations at the water table at all downgradient well sites did not return to background conditions before the next application season began.

Chloride was the simplest tracer of deicer effects where halite was the only highway deicer used. Chloride was relatively conservative in the ground-water system, did not commonly occur in high concentrations, and was easy to sample and inexpensive to analyze. Sodium was less conservative in the ground-water system than chloride because the concentration can be modified by cation exchange. The Cl/Br and Cl/I ratios, in combination with chloride and nitrate concentrations, proved useful in this study to distinguish deicer-related chloride from other potential sources such as deeper formation brine and sewage-affected water, particularly where concentrations were not exceedingly high or when a nonsteady input was not evident. Interpretation of Cl/Br and Cl/I ratios was inconclusive when bromide and iodide concentrations were less than their method reporting limits of 0.01 mg/L (Br) and 0.001 mg/L (I). Iodide concentrations were less frequently determined to be below the method reporting limit (0.001 mg/L) and were most useful in evaluating the source of chloride to ground water.

Ground-water dating by tritium and tritiogenic helium, in combination with hydrogeologic information about lithologies and direction of flow, was useful in evaluating which parts of the Calumet aquifer were sensitive to ground-water contamination. Water with the youngest ages was sampled from wells screened in the upper 10–15 ft of the aquifer.

Some deicer may be retained in the Calumet aquifer and unsaturated zone between annual salt-application periods. Chloride concentrations at wells 1-DG-WT and 2-DG-WT remained greater than background (5 mg/L or less) through much or all of the year. The estimated masses of chloride transported in ground water past 2-DG in 1995 and 1996 either were slightly greater than (1995) or less than (1996) the masses of chloride applied to US–12 during the study.

The results of this study should be considered site and year specific. The relative effects of processes affecting the distribution of deicers in the subsurface will vary from site to site depending on differences in hydrogeology, deicer application methods, and climatic history. Cation exchange and hydrodynamic dispersion, for example, may affect concentrations of deicers more strongly at a site where the percentage of clay minerals in an aquifer are higher. Results at the study site also may differ for periods with varied climatic histories.

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SUPPLEMENTAL DATA

Table 10. Comparison of chloride, sodium, iodide, and bromide for environmental and sequential duplicate samples of water from wells at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1995–97

[mm/dd/yy, month/day/year; hhmm, hours and minutes; mg/L, milligram per liter; LPD, log percent difference (calculated as (ln(S/D) × 100, where S = concentration of constituent in regular sample and D = concentration of constituent in sequential duplicate sample); <, less than; NC, log percent difference not computed because one value was less than reporting limit]

Well name	Date sampled (mm/dd/yy)	Time of environmental sample collection (hhmm)	Chloride, environmental sample (mg/L)	Time of sequential duplicate sample collection (hhmm)	Chloride, sequential duplicate sample (mg/L)	LPD (absolute value)
1-UG-1	02/27/95	1345	12	1346	13	8.
1-UG-1	04/09/96	1615	13	1621	13	0.
1-UG-1	07/17/96	1145	13	1146	13	0.
1-UG-2	08/02/95	1335	6.6	1336	6.6	0.
1-UG-2	05/08/96	1600	8.4	1606	8.3	1.2
1-UG-2	06/10/96	1705	6.4	1706	6.5	1.6
1-UG-2	09/11/96	1355	7.1	1356	7	1.4
1-UG-3	11/02/95	1130	9.8	1131	9.8	0.
1-UG-3	01/12/96	940	7.7	941	7.8	1.3
1-UG-4	03/30/95	1045	2	1046	2	0.
1-UG-4	04/26/95	945	1.9	946	1.5	23.6
1-UG-4	09/06/95	920	1.1	921	1.2	8.7
1-UG-4	11/13/96	1500	2	1501	2.1	4.9
1-UG-5	02/13/97	1400	2.1	1401	2	4.9
1-UG-5	04/23/97	1025	1.2	1026	1.1	8.7
1-UG-WT	12/05/95	1040	3.1	1041	2.9	6.7
1-UG-WT	10/09/96	750	1.3	751	1.2	8.
1-UG-WT	05/14/97	1020	1.9	1021	2	5.1
ALT-1-UG-1	09/06/95	1530	13	1531	13	0.
ALT-1-UG-1	09/25/95	1510	12	1511	13	8.
ALT-1-UG-1	03/11/96	1530	12	1531	12	0.
ALT-1-UG-3	08/03/95	1045	9.1	1046	8.9	2.2
ALT-1-UG-5	06/16/97	1510	2.8	1511	2.7	3.6
ALT-1-UG-WT	02/08/96	1105	1.8	1106	1.8	0.
ALT-1-UG-WT	08/20/96	1050	1.8	1051	1.8	0.
ALT-1-UG-WT	09/11/96	850	2	851	1.9	5.1
ALT-1-UG-WT	12/12/96	1010	2.4	1011	2.4	0.
ALT-1-UG-WT	03/12/97	1200	2.7	1206	2.7	0.
1-DG-1	03/01/95	1115	9.9	1116	9.9	0.
1-DG-1	03/27/95	1550	9.6	1551	9.5	1.
1-DG-1	09/11/95	1130	9.8	1131	9.7	1.
1-DG-1	11/01/95	1225	9.9	1226	9.9	0.
1-DG-1	03/12/96	1810	9.9	1811	8.9	10.6
1-DG-1	05/07/96	1905	10	1906	10	0.
1-DG-3	04/25/95	1115	7.4	1116	7.2	2.7
1-DG-3	01/22/97	1005	15	1006	15	0.
1-DG-3	02/11/97	835	15	836	15	0.
1-DG-4	07/10/96	1130	1.4	1131	1.4	0.
1-DG-4	09/09/96	1625	1.2	1626	1.3	8.
1-DG-4	05/20/97	1605	1.3	1606	1.3	0.
1-DG-5	12/07/95	845	2.6	846	2.6	0.

Table 10. Comparison of chloride, sodium, iodide, and bromide for environmental and sequential duplicate samples of water from wells at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1995–97—Continued

Well name	Date sampled (mm/dd/yy)	Time of environmental sample collection (hhmm)	Chloride, environmental sample (mg/L)	Time of sequential duplicate sample collection (hhmm)	Chloride, sequential duplicate sample (mg/L)	LPD (absolute value)
1-DG-5	02/06/96	1320	1.8	1321	1.7	5.7
1-DG-5	04/24/97	1035	597	1036	592	0.8
1-DG-WT	05/30/95	1645	430	1646	430	0.
1-DG-WT	11/07/96	1220	53	1221	56	5.5
ALT-1-DG-1	09/21/95	940	9.3	941	9.3	0.
ALT-1-DG-2	04/10/96	1355	9.7	1401	9.5	2.1
ALT-1-DG-3	08/01/95	1515	5.7	1516	5.6	1.8
ALT-1-DG-3	03/12/96	1400	11	1401	11	0.
ALT-1-DG-4	01/10/96	1555	1.9	1556	1.9	0.
ALT-1-DG-4	06/13/96	1505	1.3	1506	1.4	7.4
ALT-1-DG-4	08/14/96	1445	1.2	1446	1.2	0.
2-DG-1	06/26/95	1645	11	1646	11	0.
2-DG-1	07/31/95	1700	11	1701	11	0.
2-DG-1	12/07/95	1435	9.2	1436	11	17.9
2-DG-1	05/09/96	1300	12	1301	11	8.7
2-DG-2	09/11/95	1545	6.5	1546	6.4	1.6
2-DG-2	09/21/95	1500	6.3	1501	6.7	6.2
2-DG-2	02/07/96	940	6.2	941	6.4	3.2
2-DG-2	03/14/96	1115	6.4	1116	6.4	0.
2-DG-2	04/11/96	1025	6.7	1031	6.4	4.6
2-DG-2	12/11/96	1445	7.1	1446	7.1	0.
2-DG-2	02/19/97	945	6.8	946	7.1	4.3
2-DG-3	06/18/97	925	12.3	926	12.4	0.8
2-DG-4	09/10/96	1015	8	1016	8.1	1.2
2-DG-4	10/10/96	1305	66	1306	63	4.7
2-DG-4	11/06/96	1610	1.2	1611	1.2	0.
2-DG-5	07/11/96	1625	220	1626	230	4.4
2-DG-5	01/22/97	1245	7.1	1246	6.6	7.3
2-DG-5	03/12/97	1830	5.4	1836	5.4	0.
3-DG-1	04/05/95	1000	8.8	1001	8.8	0.
3-DG-1	06/28/95	1530	9.1	1531	8.8	3.4
3-DG-1	11/06/95	1750	9.3	1751	9	3.3
3-DG-1	01/11/96	1330	9.4	1331	9.6	2.1
3-DG-2	09/07/95	1415	6.3	1416	6.4	1.6
3-DG-2	04/11/96	1800	39	1801	37	5.3
3-DG-2	08/13/96	1325	6.6	1326	6.7	1.5
3-DG-2	03/11/97	1510	6.3	1516	6.4	1.6
3-DG-3	01/31/95	1305	11	1306	11	0.
3-DG-3	04/27/95	1020	30	1021	30	0.
3-DG-3	06/12/96	1820	8.7	1826	8.7	0.
3-DG-3	10/10/96	755	12	756	12	0.
3-DG-3	11/12/96	1620	10	1621	10	0.
3-DG-3	05/16/97	810	10.4	811	10.5	1.
3-DG-4	02/28/95	930	3.8	931	3.8	0.
3-DG-4	06/01/95	1200	60	1201	60	0.
3-DG-4	04/23/97	1450	21.2	1451	21	.9

Table 10. Comparison of chloride, sodium, iodide, and bromide for environmental and sequential duplicate samples of water from wells at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1995–97—Continued

Well name	Date sampled (mm/dd/yy)	Time of environmental sample collection (hhmm)	Chloride, environmental sample (mg/L)	Time of sequential duplicate sample collection (hhmm)	Chloride, sequential duplicate sample (mg/L)	LPD (absolute value)
3-DG-5	02/07/96	1445	48	1446	48	0.
3-DG-WT	07/11/96	1050	71	1051	70	1.4
3-DG-WT	06/17/97	955	35.1	956	34.5	1.7
REP-1-UG-WT	08/16/96	910	2.3	911	2.4	4.3
REP-1-UG-5	05/07/96	1020	2.2	1021	2.2	0.
REP-1-DG-3	12/06/95	900	23	901	22	4.4
REP-1-DG-3	04/08/96	1720	6.5	1726	6.7	3.
REP-1-DG-5	05/31/95	1345	1.3	1346	1.4	7.4
REP-1-DG-5	02/14/97	1145	1.3	1146	1.5	14.3
REP-2-DG-3	06/27/95	1515	22	1516	21	4.7
REP-2-DG-3	01/11/96	1605	27	1606	28	3.6
REP-2-DG-3	01/22/97	1515	19	1516	20	5.1
REP-2-DG-5	05/31/95	1710	150	1711	140	6.9
REP-2-DG-5	09/26/95	1030	2	1031	2	0.
REP-2-DG-5	06/12/96	1140	200	1146	200	0.
REP-2-DG-5	12/10/96	1445	7.6	1446	7.2	5.4
Maximum			**597**		**592**	**23.6**
75th percentile			**12**		**12**	**4.8**
Median			**8.4**		**8.3**	**1.4**
25th percentile			**2.7**		**2.7**	**0.**
Minimum			**1.1**		**1.1**	**0.**
Number of samples or comparisons			**103**		**103**	**103**

Well name	Date sampled (mm/dd/yy)	Time of environmental sample collection (hhmm)	Sodium, environmental sample (mg/L)	Time of sequential duplicate sample collection (hhmm)	Sodium, sequential duplicate sample (mg/L)	LPD (absolute value)
1-UG-2	05/08/96	1600	21	1606	21	0.
1-UG-3	11/02/95	1130	4.4	1131	4.7	6.6
1-UG-4	03/30/95	1045	1.4	1046	1.4	0.
1-UG-4	11/13/96	1500	1.2	1501	1.1	8.7
1-UG-5	02/13/97	1400	1.2	1401	1.1	8.7
1-UG-WT	05/14/97	1020	1.2	1021	1.2	0.
ALT-1-UG-WT	02/08/96	1105	1.1	1106	1.1	0.
ALT-1-UG-WT	08/20/96	1050	1.4	1051	1.4	0.
1-DG-1	03/27/95	1550	36	1551	37	2.7
1-DG-1	11/01/95	1225	38	1226	38	0.
1-DG-1	05/07/96	1905	37	1906	37	0.
1-DG-3	02/11/97	835	7	836	7.2	2.8
1-DG-4	05/20/97	1605	1.4	1606	1.4	0.
1-DG-5	02/06/96	1320	1.4	1321	1.4	0.
1-DG-WT	11/07/96	1220	100	1221	120	18.2

Table 10. Comparison of chloride, sodium, iodide, and bromide for environmental and sequential duplicate samples of water from wells at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1995–97—Continued

Well name	Date sampled (mm/dd/yy)	Time of environmental sample collection (hhmm)	Sodium, environmental sample (mg/L)	Time of sequential duplicate sample collection (hhmm)	Sodium, sequential duplicate sample (mg/L)	LPD (absolute value)
ALT-1-DG-4	08/14/96	1445	1.6	1446	1.6	0.
2-DG-1	05/09/96	1300	43	1301	45	4.5
2-DG-2	02/07/96	940	25	941	25	0.
2-DG-2	02/19/97	945	23	946	23	0.
2-DG-4	11/06/96	1610	1.9	1611	1.7	11.1
3-DG-1	04/05/95	1000	30	1001	30	0.
3-DG-1	11/06/95	1750	34	1751	35	2.9
3-DG-2	08/13/96	1325	24	1326	24	0.
3-DG-3	11/12/96	1620	9.9	1621	9.9	0.
3-DG-3	05/16/97	810	6.9	811	6.8	1.5
3-DG-5	02/07/96	1445	34	1446	35	2.9
REP-1-UG-WT	08/16/96	910	2	911	1.8	10.5
REP-1-UG-5	05/07/96	1020	1.3	1021	1.3	0.
REP-1-DG-5	02/14/97	1145	1.4	1146	1.3	7.4
Maximum			**100**		**120**	**18.2**
75th percentile			**30**		**30**	**4.5**
Median			**6.9**		**6.8**	**0.**
25th percentile			**1.4**		**1.4**	**0.**
Minimum			**1.1**		**1.1**	**0.**
Number of samples or comparisons			**29**		**29**	**29**

Well name	Date sampled (mm/dd/yy)	Time of environmental sample collection (hhmm)	Iodide, environmental sample (mg/L)	Time of sequential duplicate sample collection (hhmm)	Iodide, sequential duplicate sample (mg/L)	LPD (absolute value)
1-UG-2	05/08/96	1600	0.006	1606	0.006	0.
1-UG-3	11/02/95	1130	.004	1131	.003	28.8
1-UG-4	03/30/95	1045	.001	1046	.001	0.
1-UG-4	11/13/96	1500	.005	1501	.003	51.1
1-UG-5	02/13/97	1400	.004	1401	.004	0.
1-UG-WT	05/14/97	1020	.003	1021	.003	0.
ALT-1-UG-WT	02/08/96	1105	.001	1106	.001	0.
ALT-1-UG-WT	08/20/96	1050	<.001	1051	.002	NC
1-DG-1	03/27/95	1550	.006	1551	.007	15.4
1-DG-1	11/01/95	1225	.006	1226	.006	0.
1-DG-1	05/07/96	1905	.006	1906	.007	15.4
1-DG-3	02/11/97	835	.004	836	.003	28.8
1-DG-4	05/20/97	1605	<.001	1606	<.001	NC
1-DG-5	02/06/96	1320	0.001	1321	<0.001	NC
1-DG-WT	11/07/96	1220	.004	1221	.004	0.
ALT-1-DG-4	08/14/96	1445	<.001	1446	<0.001	NC
2-DG-1	05/09/96	1300	.007	1301	.007	0.
2-DG-2	02/07/96	940	.005	941	.005	0.

Table 10. Comparison of chloride, sodium, iodide, and bromide for environmental and sequential duplicate samples of water from wells at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1995–97—Continued

Well name	Date sampled (mm/dd/yy)	Time of environmental sample collection (hhmm)	Iodide, environmental sample (mg/L)	Time of sequential duplicate sample collection (hhmm)	Iodide, sequential duplicate sample (mg/L)	LPD (absolute value)
2-DG-2	02/19/97	945	0.006	946	0.005	18.2
2-DG-4	11/06/96	1610	<.001	1611	<.001	NC
3-DG-1	04/05/95	1000	.004	1001	.004	0.
3-DG-1	11/06/95	1750	.004	1751	.005	22.3
3-DG-2	08/13/96	1325	.004	1326	.004	0.
3-DG-3	11/12/96	1620	.003	1621	.003	0.
3-DG-3	05/16/97	810	.003	811	.003	0.
3-DG-5	02/07/96	1445	.003	1446	.003	0.
REP-1-UG-WT	08/16/96	910	<.001	911	<.001	NC
REP-1-UG-5	05/07/96	1020	<.001	1021	.001	NC
REP-1-DG-5	02/14/97	1145	.009	1146	.009	0.
Maximum			**.009**		**.009**	**51.1[a]**
75th percentile			**.005**		**.005**	**15.4[a]**
Median			**.004**		**.003**	**0.[a]**
25th percentile			**.001**		**.001**	**0.[a]**
Minimum			**<.001**		**<.001**	**0.[a]**
Number of samples or comparisons			**29**		**29**	**22[a]**

Well name	Date sampled (mm/dd/yy)	Time of environmental sample collection (hhmm)	Bromide, environmental sample (mg/L)	Time of sequential duplicate sample collection (hhmm)	Bromide, sequential duplicate sample (mg/L)	LPD (absolute value)
1-UG-4	03/30/95	1045	<0.01	1046	<0.01	NC
1-DG-1	03/27/95	1550	.14	1551	0.14	0.
3-DG-1	04/05/95	1000	.14	1001	.17	19.4
Maximum			**.14**		**.17**	**19.4[a]**
Minimum			**<.01**		**<.01**	**0.[a]**
Number of samples or comparisons			**3**		**3**	**2[a]**

[a]Statistics for log percent differences include only comparisons where iodide or bromide concentrations were either both greater than or both less than the same reporting limit for both environmental and sequential duplicate analyses.

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97

[USGS, U.S. Geological Survey; mm/dd/yy, month/day/year; hhmm, hours and minutes; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter; ^{o}C, degrees Celsius; ft BLS, feet below land surface; --, not measured or determined; <, less than; ANC, acid-neutralizing capacity; FET, field-equivalent titration, $CaCO_3$, calcium carbonate; IT, incremental titration; CO_3, carbonate ion; HCO_3, bicarbonate ion; N, nitrogen; all concentrations reported are as dissolved constituents]

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conduct-ance (µS/cm)	Temper-ature (^{o}C)	Chloride (mg/L)	Water level (ft BLS)
413946087002601	1-UG-1	12/19/94	1615	0.2	7.5	836	10.5	12	9.11
413946087002601	1-UG-1	01/30/95	1545	.3	7.5	817	10.2	13	8.57
413946087002601	1-UG-1	02/27/95	1345	.2	7.5	793	10.1	12	8.88
413946087002601	1-UG-1	03/30/95	0920	.2	7.3	804	10.6	12	8.37
413946087002601	1-UG-1	04/26/95	0915	.2	7.5	801	11.3	12	7.94
413946087002601	1-UG-1	06/01/95	0840	.3	7.4	789	11.8	12	7.7
413946087002601	1-UG-1	06/27/95	1115	.2	7.4	820	12.5	13	9.02
413946087002601	1-UG-1	08/02/95	1535	.2	7.3	820	12.7	13	9.97
413946087002601	1-UG-1	09/06/95	1610	.1	7.8	830	11.8	13	10.7
413946087002601	1-UG-1	09/25/95	1430	.1	7.3	823	11.6	12	11.1
413946087002601	1-UG-1	11/03/95	1135	.1	7.4	825	10.5	13	11.43
413946087002601	1-UG-1	12/05/95	1030	.1	7.7	818	11	13	10.39
413946087002601	1-UG-1	01/12/96	1115	.1	7.9	817	10.9	14	10.59
413946087002601	1-UG-1	02/08/96	1525	.1	7.3	796	11.1	12	10.33
413946087002601	1-UG-1	03/11/96	1615	.1	7.4	813	11.2	13	9.87
413946087002601	1-UG-1	040/9/96	1615	.1	7.4	816	11	13	9.8
413946087002601	1-UG-1	05/08/96	1830	.1	7.8	819	11.6	14	9.05
413946087002601	1-UG-1	06/10/96	1910	.2	7.6	834	11.3	12	6.28
413946087002601	1-UG-1	07/17/96	1145	.1	8.3	828	11.8	13	8.79
413946087002601	1-UG-1	08/21/96	0800	.1	7.5	834	11.6	13	9.27
413946087002601	1-UG-1	09/11/96	1330	.1	7.7	818	11.5	13	10.11
413946087002601	1-UG-1	10/09/96	0935	.1	7.4	830	11.1	14	10.2
413946087002601	1-UG-1	11/13/96	0910	.1	7.5	807	10.6	14	9.49
413946087002601	1-UG-1	12/12/96	0855	.1	7.5	823	10.8	13	9.19
413946087002601	1-UG-1	01/24/97	0950	.1	7.5	808	10.8	13	9.01
413946087002601	1-UG-1	02/13/97	0940	.1	7.4	810	10.7	14	8.61
413946087002601	1-UG-1	03/12/97	1100	.1	7.7	811	11.1	14	7.48

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conduct-ance (µS/cm)	Temper-ature (°C)	Chloride (mg/L)	Water level (ft BLS)
413946087002601	1-UG-1	04/23/97	0835	0.1	7.3	807	10.9	13.6	8.17
413946087002601	1-UG-1	05/14/97	0835	.1	7.4	783	11.2	13.6	8.36
413946087002601	1-UG-1	06/16/97	1700	.1	7.5	894	11.2	13.9	8.02
413946087002602	1-UG-2	12/19/94	1800	.2	7	702	10.5	6.5	--
413946087002602	1-UG-2	01/30/95	1620	.3	7.6	723	10.3	6.6	8.33
413946087002602	1-UG-2	02/27/95	1420	.2	7.7	688	10.2	6.8	8.64
413946087002602	1-UG-2	03/30/95	1245	.2	7.3	684	10.8	6.9	8.15
413946087002602	1-UG-2	04/25/95	1630	.3	7.4	679	11.2	7.3	7.4
413946087002602	1-UG-2	06/01/95	1000	.2	7.4	669	11.4	6.5	7.46
413946087002602	1-UG-2	06/27/95	0900	.2	7.6	699	11.5	7	8.49
413946087002602	1-UG-2	08/02/95	1335	.2	7.4	698	12.2	6.6	9.73
413946087002602	1-UG-2	09/06/95	1215	.2	7.5	719	12.3	6.4	10.47
413946087002602	1-UG-2	09/22/95	1120	.1	7.3	726	10.9	6.4	10.87
413946087002602	1-UG-2	11/02/95	1325	.1	7.7	746	11	6.7	11.2
413946087002602	1-UG-2	12/05/95	1420	.1	7.5	733	10.9	6.8	10.16
413946087002602	1-UG-2	01/12/96	1235	.1	7.9	735	10.9	7.6	10.35
413946087002602	1-UG-2	02/08/96	1325	.1	7.4	730	11	7	10.09
413946087002602	1-UG-2	03/11/96	1430	.1	7.4	722	11	7.9	9.63
413946087002602	1-UG-2	04/09/96	1405	.1	7.4	721	10.9	7.8	9.56
413946087002602	1-UG-2	05/08/96	1600	.1	7.6	708	11.5	8.4	8.81
413946087002602	1-UG-2	06/10/96	1705	.1	7.5	795	11.1	6.4	5.93
413946087002602	1-UG-2	07/17/96	0935	.1	7.6	666	11.4	8	8.56
413946087002602	1-UG-2	08/21/96	1035	.1	7.7	661	11.7	7.4	9.04
413946087002602	1-UG-2	09/11/96	1355	.1	7.8	660	11.4	7.1	9.87
413946087002602	1-UG-2	10/08/96	1550	.1	7.5	672	10.8	7	9.97
413946087002602	1-UG-2	11/13/96	1200	.1	7.5	679	10.6	7.1	9.25
413946087002602	1-UG-2	12/12/96	0925	.1	7.5	711	10.9	6.8	8.74
413946087002602	1-UG-2	01/24/97	1115	.1	7.5	723	11	6.6	8.78
413946087002602	1-UG-2	02/13/97	1150	.1	7.4	726	11	7.3	8.37
413946087002602	1-UG-2	03/12/97	1320	.1	7.7	742	10.7	7	7.25
413946087002602	1-UG-2	04/23/97	0905	.1	7.4	728	10.8	6.7	7.94
413946087002602	1-UG-2	05/14/97	0935	.1	7.4	728	10.8	6.9	8.13
413946087002602	1-UG-2	06/16/97	1420	.1	7.7	762	10.8	6.2	7.79

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conduct-ance (μS/cm)	Temper-ature (^{o}C)	Chloride (mg/L)	Water level (ft BLS)
413946087002603	1-UG-3	12/21/94	1000	0.2	6	256	10.8	11	8.8
413946087002603	1-UG-3	01/30/95	1645	.4	6.2	254	10.2	11	8.27
413946087002603	1-UG-3	02/27/95	1445	.2	6.4	245	9.8	10	8.61
413946087002603	1-UG-3	03/29/95	1355	.2	5.9	242	10.2	11	8.07
413946087002603	1-UG-3	04/25/95	1710	.3	6.2	246	10.7	12	7.33
413946087002603	1-UG-3	06/01/95	1030	.3	6.1	250	11.1	12	7.39
413946087002603	1-UG-3	06/27/95	1000	.2	6.2	234	11.1	11	8.42
413946087002603	1-UG-3	08/03/95	1110	.3	6.1	229	11.7	11	9.67
413946087002603	1-UG-3	09/06/95	1420	.2	6.4	206	12.2	12	10.41
413946087002603	1-UG-3	09/25/95	1600	.1	5.9	207	11.3	11	10.79
413946087002603	1-UG-3	11/02/95	1130	.1	6.1	207	11.3	9.8	10.03
413946087002603	1-UG-3	12/05/95	0815	.2	6.2	197	11.2	9.4	10.09
413946087002603	1-UG-3	01/12/96	0940	.1	6.3	170	11	7.7	10.28
413946087002603	1-UG-3	02/08/96	0830	.2	6.3	161	10.9	6.9	1.02
413946087002603	1-UG-3	03/11/96	1400	.1	6.1	169	10.7	7.8	9.56
413946087002603	1-UG-3	04/08/96	1800	.2	6.1	189	10.1	9	9.49
413946087002603	1-UG-3	05/09/96	0920	.1	6.2	213	10.8	10	8.75
413946087002603	1-UG-3	06/10/96	1630	.2	6	153	10.5	6.6	5.91
413946087002603	1-UG-3	07/17/96	1110	.1	7	261	11.5	13	8.49
413946087002603	1-UG-3	08/20/96	1545	.1	6.3	270	11.3	13	8.97
413946087002603	1-UG-3	09/11/96	0940	.1	6.3	261	11.4	13	9.8
413946087002603	1-UG-3	10/08/96	1415	.2	6.1	257	11	12	9.9
413946087002603	1-UG-3	11/13/96	1415	.1	7.7	251	10.8	12	9.17
413946087002603	1-UG-3	12/12/96	0820	.2	6.4	247	11	11	9.09
413946087002603	1-UG-3	01/24/97	1135	.1	6.3	230	10.9	10	8.71
413946087002603	1-UG-3	02/13/97	1255	.2	6.3	231	10.9	11	8.3
413946087002603	1-UG-3	03/12/97	1230	.2	6.4	238	10.4	12	7.18
413946087002603	1-UG-3	04/23/97	0740	.2	6	242	10	13.2	7.86
413946087002603	1-UG-3	05/13/97	1435	.2	6.1	240	10.1	13.1	8.05
413946087002603	1-UG-3	06/16/97	1445	.1	6.4	263	10.4	13.3	7.71
413946087002604	1-UG-4	12/21/94	1135	2.6	5	76	11.6	1.4	8.78
413946087002604	1-UG-4	01/31/95	0900	2.1	5.3	92	9.2	1.4	8.23
413946087002604	1-UG-4	02/27/95	1510	1.5	5.3	99	8.9	1.7	8.56

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994-97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conduct-ance (μS/cm)	Temper-ature (°C)	Chloride (mg/L)	Water level (ft BLS)
413946087002604	1-UG-4	03/30/95	1045	0.9	5.2	103	9.2	2	8.03
413946087002604	1-UG-4	04/26/95	0945	.5	5.3	108	9.7	1.9	7.31
413946087002604	1-UG-4	06/01/95	0925	.4	5.2	121	10.5	1.6	7.36
413946087002604	1-UG-4	06/27/95	0815	.4	5.4	101	10.9	1.6	8.39
413946087002604	1-UG-4	08/02/95	1455	.6	5.1	109	12.4	1.4	9.63
413946087002604	1-UG-4	09/06/95	0920	.8	4.8	70	13.2	1.1	10.38
413946087002604	1-UG-4	09/22/95	1235	.8	4.8	63	11.8	1.2	10.77
413946087002604	1-UG-4	11/02/95	1605	.1	4.9	56	11.8	1	11.11
413946087002604	1-UG-4	12/05/95	1215	.2	5	57	11.6	1.1	10.06
413946087002604	1-UG-4	01/12/96	0920	.2	5.3	62	10.5	1.2	10.25
413946087002604	1-UG-4	02/08/96	1000	.3	5.1	62	10.1	1.2	9.99
413946087002604	1-UG-4	03/12/96	0900	.4	5.2	62	9.4	1.3	9.53
413946087002604	1-UG-4	04/09/96	1140	.3	4.9	58	8.8	1.4	9.46
413946087002604	1-UG-4	05/08/96	1525	.2	5.2	58	9.9	1.5	8.71
413946087002604	1-UG-4	06/11/96	1500	.4	5.2	57	10.2	1.4	5.39
413946087002604	1-UG-4	07/17/96	1300	.2	5.2	56	11.4	1.6	8.47
413946087002604	1-UG-4	08/20/96	1310	1.2	5.2	50	12.7	1.7	8.94
413946087002604	1-UG-4	09/11/96	1155	2	5.1	47	12.2	1.7	9.77
413946087002604	1-UG-4	10/09/96	1040	1.1	5.1	52	11.9	1.7	9.88
413946087002604	1-UG-4	11/13/96	1500	.3	5.4	58	11.4	2	9.15
413946087002604	1-UG-4	12/12/96	1045	.2	5.1	59	11.1	2.2	8.85
413946087002604	1-UG-4	01/24/97	1150	.2	5.1	57	10.2	2.6	8.68
413946087002604	1-UG-4	02/13/97	1030	.3	5.2	56	9.9	2.5	8.27
413946087002604	1-UG-4	03/12/97	1250	.2	5.2	55	9.2	2.7	7.15
413946087002604	1-UG-4	04/23/97	0800	.3	5	54	8.9	2.3	7.84
413946087002604	1-UG-4	05/13/97	1555	.4	4.8	58	9.3	2.2	8.02
413946087002604	1-UG-4	06/16/97	1720	.3	5.4	64	9.9	1.8	7.69
413946087002605	1-UG-5	12/21/94	1325	2.6	6.5	129	10.9	1.5	9
413946087002605	1-UG-5	01/31/95	0930	3.3	6.7	161	8	2.6	8.46
413946087002605	1-UG-5	02/27/95	1530	3.4	6.7	191	7.5	2.3	8.89
413946087002605	1-UG-5	03/29/95	1630	3.1	6.5	208	7.5	2	8.2
413946087002605	1-UG-5	04/26/95	0830	2.5	6.8	205	9	2.9	7.64
413946087002605	1-UG-5	06/01/95	0900	1.5	6.7	228	10.9	2.6	7.59

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conduct-ance (µS/cm)	Temper-ature (°C)	Chloride (mg/L)	Water level (ft BLS)
413946087002605	1-UG-5	06/27/95	0930	1	6.8	198	11.9	2.6	8.73
413946087002605	1-UG-5	12/05/95	1300	--	--	--	--	1.9	--
413946087002605	1-UG-5	02/08/96	1245	10.5	6.6	98	8.2	2.3	10.23
413946087002605	1-UG-5	03/12/96	1030	8.1	6.3	118	9.2	2	9.77
413946087002605	1-UG-5	04/09/96	1640	11.8	7.1	110	7.8	1.2	9.7
413946087002605	1-UG-5	05/08/96	1745	1	6.3	136	10.2	2	8.94
413946087002605	1-UG-5	06/10/96	1450	3.1	5.8	107	11.5	2.6	5.76
413946087002605	1-UG-5	07/17/96	0950	.1	7.8	163	13.3	4.6	8.7
413946087002605	1-UG-5	08/20/96	0900	--	6.6	--	--	3.5	9.17
413946087002605	1-UG-5	09/11/96	1100	8.6	6.3	124	14.8	3.2	10.01
413946087002605	1-UG-5	10/09/96	0900	9	6.4	134	12.2	2.2	10.1
413946087002605	1-UG-5	11/13/96	1330	.6	7.1	182	10.8	2.2	9.39
413946087002605	1-UG-5	12/12/96	0840	.9	6.7	156	10	1.8	9.09
413946087002605	1-UG-5	01/24/97	1030	2.8	7.2	106	8.6	2.4	9.21
413946087002605	1-UG-5	02/13/97	1400	3.5	6.5	116	8.3	2.1	8.5
413946087002605	1-UG-5	03/12/97	1000	2	6.9	158	8.1	1.4	7.37
413946087002605	1-UG-5	04/23/97	1025	2.1	6.5	174	9.1	1.2	8.06
413946087002605	1-UG-5	05/14/97	1415	2.2	6.6	189	9	3.4	8.25
413946087002605	1-UG-5	06/16/97	1600	1.5	6.7	171	10.9	1.7	7.93
413946087002606	1-UG-WT	12/21/94	1525	3.8	6.1	102	10.9	1.3	9.12
413946087002606	1-UG-WT	01/31/95	1010	4.2	6.4	125	8.5	1.9	8.61
413946087002606	1-UG-WT	02/27/95	1555	4.4	6.5	121	7.7	1.9	8.9
413946087002606	1-UG-WT	03/29/95	1520	5.6	6.3	138	7.9	2.7	8.39
413946087002606	1-UG-WT	04/25/95	1745	6.1	6.4	143	8.9	4.8	7.65
413946087002606	1-UG-WT	06/01/95	0800	5.8	6.7	158	10.5	2.6	7.71
413946087002606	1-UG-WT	06/27/95	1030	5.5	6.5	143	12	1.5	8.74
413946087002606	1-UG-WT	08/03/95	0915	5.6	6.1	91	12.7	1.5	9.22
413946087002606	1-UG-WT	09/06/95	1350	6.8	5.3	50	14.6	2	10.72
413946087002606	1-UG-WT	09/25/95	1725	6.8	5.3	49	13.2	1.9	11.11
413946087002606	1-UG-WT	11/07/95	0900	6.4	5.4	55	11.2	2.7	11.44
413946087002606	1-UG-WT	12/05/95	1040	<9.9	5.7	59	11	3.1	10.4
413946087002606	1-UG-WT	01/12/96	1245	9.5	6.4	54	9.2	2.9	10.6
413946087002606	1-UG-WT	02/08/96	1030	7.9	5.6	55	9.1	3	10.33

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conduct-ance (µS/cm)	Temper-ature (°C)	Chloride (mg/L)	Water level (ft BLS)
413946087002606	1-UG-WT	03/12/96	1045	3.8	6	70	8.8	2.5	9.87
413946087002606	1-UG-WT	04/09/96	1305	4.5	5.7	62	8.3	1.8	9.81
413946087002606	1-UG-WT	05/09/96	1020	3.3	6.1	89	10.6	2.2	9.05
413946087002606	1-UG-WT	06/10/96	1930	4.4	6	118	11.1	3.1	5.35
413946087002606	1-UG-WT	07/17/96	1315	1.2	6.2	114	12.3	3	8.81
413946087002606	1-UG-WT	08/20/96	1210	.8	6	96	13.6	1.9	9.28
413946087002606	1-UG-WT	09/11/96	0915	1.3	5.5	67	13.4	1.3	10.12
413946087002606	1-UG-WT	10/09/96	0750	2	5.7	61	12.2	1.3	10.21
413946087002606	1-UG-WT	11/13/96	1100	2.9	6.2	74	11.3	2	9.49
413946087002606	1-UG-WT	12/12/96	1030	4.2	6.1	68	10.5	2.3	9.19
413946087002606	1-UG-WT	01/24/97	1045	4.2	6.6	83	8.9	2	9.02
413946087002606	1-UG-WT	02/13/97	1500	4.8	6.5	98	8.6	1.9	8.61
413946087002606	1-UG-WT	03/12/97	1135	5	6.9	110	7.9	2.5	7.49
413946087002606	1-UG-WT	04/23/97	0925	3.5	6.6	126	8.4	1.8	8.18
413946087002606	1-UG-WT	05/14/97	1020	3.5	6.7	134	9.1	1.9	8.37
413946087002606	1-UG-WT	06/16/97	1620	2.2	6.5	164	11.5	2	8.04
413947087002601	ALT-1-UG-1	08/02/95	1615	.2	7.3	835	12	13	7.98
413947087002601	ALT-1-UG-1	09/06/95	1530	.1	8	847	12.2	13	8.7
413947087002601	ALT-1-UG-1	09/25/95	1510	.1	7.3	835	11.4	12	9.08
413947087002601	ALT-1-UG-1	11/03/95	0935	.1	7.4	829	10.3	13	9.34
413947087002601	ALT-1-UG-1	12/05/95	0945	.1	7.8	835	10.9	13	8.34
413947087002601	ALT-1-UG-1	01/12/96	1040	.1	7.7	826	10.7	13	8.54
413947087002601	ALT-1-UG-1	02/08/96	1445	.1	7.3	824	11	12	8.29
413947087002601	ALT-1-UG-1	03/11/96	1530	.1	7.3	829	11.1	12	7.8
413947087002601	ALT-1-UG-1	04/09/96	1525	.1	7.4	833	10.9	12	7.77
413947087002601	ALT-1-UG-1	05/08/96	1915	.1	7.7	834	11.2	13	7.03
413947087002601	ALT-1-UG-1	06/10/96	1830	.1	7.6	818	11.6	13	6.65
413947087002601	ALT-1-UG-1	07/17/96	1225	.1	8	845	11.6	12	6.87
413947087002601	ALT-1-UG-1	08/21/96	0900	.1	7.6	846	11.5	13	7.3
413947087002601	ALT-1-UG-1	09/11/96	1250	.1	7.6	849	11.7	12	8.12
413947087002601	ALT-1-UG-1	08/21/97	1550	.1	7.3	814	11.5	--	7.31
413947087002602	ALT-1-UG-2	08/02/95	1415	.2	7.4	779	11.9	6.5	6.82
413947087002602	ALT-1-UG-2	09/06/95	1245	.1	7.5	790	11.8	6.9	7.54

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conduct-ance (μS/cm)	Temper-ature (°C)	Chloride (mg/L)	Water level (ft BLS)
413947087002602	ALT-1-UG-2	09/22/95	1155	0.1	7.4	789	10.9	6.9	7.93
413947087002602	ALT-1-UG-2	11/02/95	1450	.1	7.5	797	11	6.8	9.2
413947087002602	ALT-1-UG-2	12/05/95	1350	.1	7.3	778	11.1	6.8	8.18
413947087002602	ALT-1-UG-2	01/12/96	1205	.1	7.8	774	10.9	7.1	8.38
413947087002602	ALT-1-UG-2	02/08/96	1405	.1	7.3	776	10.9	6.3	8.13
413947087002602	ALT-1-UG-2	03/11/96	1500	.1	7.3	779	11	6.6	7.65
413947087002602	ALT-1-UG-2	04/09/96	1445	.1	7.3	786	10.6	6.9	7.62
413947087002602	ALT-1-UG-2	05/08/96	1650	.1	7.6	793	10.9	6.7	6.87
413947087002602	ALT-1-UG-2	06/10/96	1750	.1	7.6	689	11.3	8	6.59
413947087002602	ALT-1-UG-2	07/17/96	0900	.1	7.6	804	11	7.1	6.67
413947087002602	ALT-1-UG-2	08/21/96	0945	.1	7.6	806	11.2	6.9	7.13
413947087002602	ALT-1-UG-2	09/11/96	1430	.1	7.6	802	11.2	7.4	7.96
413947087002603	ALT-1-UG-3	08/03/95	1045	.3	6	199	12	9.1	--
413947087002603	ALT-1-UG-3	09/06/95	1450	.1	6.6	191	12.4	10	--
413947087002603	ALT-1-UG-3	09/25/95	1530	.1	5.9	193	11.6	10	--
413947087002603	ALT-1-UG-3	11/02/95	1000	.2	5.9	194	11.7	9.8	9.24
413947087002603	ALT-1-UG-3	12/05/95	0850	.2	5.9	195	11.5	10	8.23
413947087002603	ALT-1-UG-3	01/12/96	1005	.2	6.3	187	10.9	10	8.41
413947087002603	ALT-1-UG-3	02/08/96	0900	.2	6	184	10.6	9.1	8.16
413947087002603	ALT-1-UG-3	03/11/96	1335	.2	6	178	10.4	8.4	7.68
413947087002603	ALT-1-UG-3	04/09/96	1730	.2	6	167	9.7	7.8	7.65
413947087002603	ALT-1-UG-3	05/09/96	0830	.4	6.1	158	10.4	7	6.9
413947087002603	ALT-1-UG-3	06/10/96	1550	.1	6.2	240	11.2	12	6.58
413947087002603	ALT-1-UG-3	07/17/96	1040	.1	6.9	170	11.1	9.3	6.74
413947087002603	ALT-1-UG-3	08/20/96	1455	.1	6	194	11.4	11	7.16
413947087002603	ALT-1-UG-3	09/11/96	1005	.1	6.1	202	12	13	7.99
413947087002604	ALT-1-UG-4	08/02/95	1435	.3	5.4	104	12.5	1.7	7.8
413947087002604	ALT-1-UG-4	09/06/95	0950	.2	5	82	13.1	1.6	8.51
413947087002604	ALT-1-UG-4	09/22/95	1210	.4	5.1	83	12.3	1.4	8.9
413947087002604	ALT-1-UG-4	11/02/95	1525	.9	5	73	12.2	1.2	9.17
413947087002604	ALT-1-UG-4	12/05/95	1130	.4	5	64	11.7	1	8.16
413947087002604	ALT-1-UG-4	01/12/96	0900	.2	5.5	59	10.3	1	8.35
413947087002604	ALT-1-UG-4	02/08/96	0930	.2	5.1	61	9.7	1.1	8.1

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conduct-ance (μS/cm)	Temper-ature (^oC)	Chloride (mg/L)	Water level (ft BLS)
413947087002604	ALT-1-UG-4	03/12/96	0920	0.2	5	68	8.9	1.3	7.62
413947087002604	ALT-1-UG-4	04/09/96	1220	.4	5.1	66	8.7	1.3	7.59
413947087002604	ALT-1-UG-4	05/08/96	1500	.5	5	63	9.9	1.4	6.84
413947087002604	ALT-1-UG-4	06/11/96	1400	.3	5.2	60	10.2	1.6	7
413947087002604	ALT-1-UG-4	07/17/96	1240	.1	5.3	54	11.4	1.5	6.68
413947087002604	ALT-1-UG-4	08/20/96	1400	.2	5.2	54	12.4	1.7	7.11
413947087002604	ALT-1-UG-4	09/11/96	1215	.1	4.9	53	12.6	1.7	7.94
413947087002604	ALT-1-UG-4	08/21/97	1630	.6	4.9	54	11.8	--	7.13
413947087002605	ALT-1-UG-5	08/03/95	1030	4.9	6.4	147	14.1	1.8	7.78
413947087002605	ALT-1-UG-5	09/06/95	1110	9.1	5.9	81	17.6	1.6	8.49
413947087002605	ALT-1-UG-5	09/25/95	1620	8	6.2	76	14.5	1.7	8.88
413947087002605	ALT-1-UG-5	11/07/95	1040	6	5.8	64	12	1.9	9.16
413947087002605	ALT-1-UG-5	12/05/95	1320	10	5.7	63	10.8	2.1	8.14
413947087002605	ALT-1-UG-5	01/12/96	1140	9.6	7.3	55	8	2.6	8.33
413947087002605	ALT-1-UG-5	02/08/96	1200	8.1	5.8	55	8.5	2.6	8.09
413947087002605	ALT-1-UG-5	03/12/96	0935	3.9	5.6	59	7.4	2.8	7.6
413947087002605	ALT-1-UG-5	04/09/96	1705	4.5	5.9	58	7.3	2.5	7.57
413947087002605	ALT-1-UG-5	05/08/96	1725	4.2	6.3	57	10	2.6	6.83
413947087002605	ALT-1-UG-5	06/10/96	1520	.5	6.5	141	11	3.8	6.85
413947087002605	ALT-1-UG-5	07/17/96	1015	1.2	6.7	158	13.4	2.9	6.67
413947087002605	ALT-1-UG-5	08/20/96	0945	--	5.8	--	--	2.1	7.09
413947087002605	ALT-1-UG-5	09/11/96	1020	.7	5.3	62	15.2	1.9	7.92
413947087002605	ALT-1-UG-5	10/09/96	0825	1.4	5.3	68	13.1	1.7	7.97
413947087002605	ALT-1-UG-5	11/13/96	1245	3	5.6	69	11.5	1.8	7.22
413947087002605	ALT-1-UG-5	12/12/96	0955	5.2	6.2	62	9.9	1.7	6.93
413947087002605	ALT-1-UG-5	01/24/97	1200	5.5	5.6	61	8.3	2.3	7.81
413947087002605	ALT-1-UG-5	02/13/97	1620	6.8	5.6	61	8	2.4	6.39
413947087002605	ALT-1-UG-5	03/12/97	1015	6.1	6.2	75	7.4	2.6	5.33
413947087002605	ALT-1-UG-5	04/23/97	1000	6	5.9	85	8.1	2.8	5.98
413947087002605	ALT-1-UG-5	05/14/97	1255	5.8	5.9	91	8.9	2.9	6.16
413947087002605	ALT-1-UG-5	06/16/97	1510	3.3	6.2	81	11.5	2.8	5.79
413947087002605	ALT-1-UG-5	08/21/97	1610	3.2	5.7	62	13.5	--	7.11
413947087002606	ALT-1-UG-WT	08/03/95	0830	4.2	6.1	108	13.6	1.7	7.87

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conduct-ance (μS/cm)	Temper-ature (°C)	Chloride (mg/L)	Water level (ft BLS)
413947087002606	ALT-1-UG-WT	09/06/95	1320	3.6	5.8	61	14.7	1.7	8.59
413947087002606	ALT-1-UG-WT	09/25/95	1650	3.5	5.6	62	13.9	1.8	8.98
413947087002606	ALT-1-UG-WT	11/07/95	0930	4.4	5.6	59	12.5	1.9	9.25
413947087002606	ALT-1-UG-WT	12/05/95	1115	4.9	5.6	57	11.1	2.2	8.24
413947087002606	ALT-1-UG-WT	01/12/96	1305	5.3	5.7	54	9.4	2.2	8.44
413947087002606	ALT-1-UG-WT	02/08/96	1105	5.4	5.7	52	8.8	1.8	8.18
413947087002606	ALT-1-UG-WT	03/12/96	1110	5.9	5.8	59	8	1.8	7.69
413947087002606	ALT-1-UG-WT	04/09/96	1235	5.8	5.6	61	7.5	2	7.67
413947087002606	ALT-1-UG-WT	05/09/96	1000	5.4	6	90	9.8	2.7	6.91
413947087002606	ALT-1-UG-WT	06/10/96	1950	2.9	6.5	100	10.9	3.8	7.47
413947087002606	ALT-1-UG-WT	07/17/96	1340	3.1	6	111	13.1	2.5	6.76
413947087002606	ALT-1-UG-WT	08/20/96	1050	3.2	6.1	95	13.8	1.8	7.18
413947087002606	ALT-1-UG-WT	09/11/96	0850	3.8	6	71	14.2	2	8.01
413947087002606	ALT-1-UG-WT	10/09/96	0815	4.2	5.6	60	13	1.8	8.06
413947087002606	ALT-1-UG-WT	11/13/96	1010	--	6.1	77	11.7	2.1	7.32
413947087002606	ALT-1-UG-WT	12/12/96	1010	4.6	5.8	79	10.4	2.4	7.03
413947087002606	ALT-1-UG-WT	01/24/97	1220	5	6.1	94	8.5	2.7	6.9
413947087002606	ALT-1-UG-WT	02/13/97	1720	6.4	6.2	107	8	2.3	6.48
413947087002606	ALT-1-UG-WT	03/12/97	1200	5.8	6.5	131	7.6	2.7	5.42
413947087002606	ALT-1-UG-WT	04/23/97	0945	5.6	6.2	137	8.2	2.5	6.06
413947087002606	ALT-1-UG-WT	05/14/97	1200	5.5	6.2	125	8.8	1.9	6.25
413947087002606	ALT-1-UG-WT	06/16/97	1535	4.9	6.4	120	11.4	1.6	5.88
413950087002601	1-DG-1	12/13/94	1050	.2	7.7	820	11.2	9.9	3.93
413950087002601	1-DG-1	02/01/95	1225	.2	7.4	798	11.5	10	3.76
413950087002601	1-DG-1	03/01/95	1115	.2	7.7	793	9.7	9.9	3.52
413950087002601	1-DG-1	03/27/95	1550	.2	7.6	786	10.5	9.6	3.59
413950087002601	1-DG-1	04/25/95	1245	.2	7.5	788	11.5	9.4	3.15
413950087002601	1-DG-1	06/28/95	1045	.1	7.5	806	12	9.5	4.03
413950087002601	1-DG-1	05/30/95	1630	.2	7.3	770	11.9	9.8	3.12
413950087002601	1-DG-1	08/01/95	1335	.2	7.3	785	14	9.4	4.93
413950087002601	1-DG-1	09/11/95	1130	.1	7.8	814	12.5	9.8	5.66
413950087002601	1-DG-1	09/21/95	0910	.1	7.5	807	11.6	9.5	5.99
413950087002601	1-DG-1	11/01/95	1225	<.1	7.5	827	12.3	9.9	5.79

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conduct-ance (μS/cm)	Temper-ature (°C)	Chloride (mg/L)	Water level (ft BLS)
413950087002601	1-DG-1	12/07/95	0925	0.1	7.6	809	11.4	9.6	5.06
413950087002601	1-DG-1	01/10/96	1215	.1	7.3	809	11.6	9.5	5.19
413950087002601	1-DG-1	02/06/96	1145	.1	7.4	793	11.9	9.6	5.08
413950087002601	1-DG-1	03/12/96	1810	.1	7.4	804	11.6	9.9	4.38
413950087002601	1-DG-1	04/10/96	1215	.1	7.3	808	11.6	9.5	4.64
413950087002601	1-DG-1	05/07/96	1905	.1	7.6	815	10.9	10	3.48
413950087002601	1-DG-1	06/13/96	1740	.1	7.8	835	11.8	9.6	2.91
413950087002601	1-DG-1	07/10/96	1505	--	7.9	809	12	9.5	3.9
413950087002601	1-DG-1	08/15/96	1140	.1	7.6	821	12.5	9.4	4.23
413950087002601	1-DG-1	09/09/96	1515	.1	7.4	818	12.2	9.3	5.14
413950087002601	1-DG-1	10/09/96	1340	.1	7.6	809	11.9	9.7	4.75
413950087002601	1-DG-1	11/07/96	1435	.1	7.4	814	11.4	9.8	4.38
413950087002601	1-DG-1	12/11/96	1115	.1	7.5	807	11.6	9.9	4.06
413950087002601	1-DG-1	01/22/97	0910	.1	7.6	814	11.5	9.7	4.1
413950087002601	1-DG-1	02/11/97	1615	.1	7.3	804	11.4	9.6	3.71
413950087002601	1-DG-1	03/11/97	1025	.1	7.5	800	11.2	10	3.11
413950087002601	1-DG-1	04/24/97	0845	.1	7.4	799	10.7	9.8	3.5
413950087002601	1-DG-1	05/20/97	1400	.1	7.5	811	11.3	9.6	3.55
413950087002601	1-DG-1	06/17/97	1610	.1	7.6	797	11.2	9.6	2.95
413950087002601	1-DG-1	08/22/97	0935	.1	7.6	809	12.2	--	4.21
413950087002602	1-DG-2	12/13/94	1235	.2	7.7	808	11.7	5	3.95
413950087002602	1-DG-2	02/01/95	1300	.2	7.4	788	11.7	4.8	3.73
413950087002602	1-DG-2	030/1/95	1145	.2	7.6	784	9.6	5.1	3.49
413950087002602	1-DG-2	03/28/95	0925	.2	7.5	771	10.6	5	3.36
413950087002602	1-DG-2	04/25/95	1200	.2	7.4	771	10.9	5.2	3.11
413950087002602	1-DG-2	05/30/95	1750	.2	7.3	740	11	5.7	3.09
413950087002602	1-DG-2	06/28/95	1000	.2	7.4	785	12.1	5.8	4
413950087002602	1-DG-2	08/01/95	1625	.2	7.2	761	13.7	6.2	4.9
413950087002602	1-DG-2	09/08/95	1200	.1	7.5	783	12.2	6.4	5.62
413950087002602	1-DG-2	09/21/95	1040	.1	7.5	762	12	6.4	5.96
413950087002602	1-DG-2	10/31/95	1535	<.1	7.4	774	12.4	6.7	5.75
413950087002602	1-DG-2	12/07/95	1130	.1	7.4	758	12.1	6.9	5.05
413950087002602	1-DG-2	01/10/96	1700	.1	7.4	746	12.1	6.7	5.11

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conduct-ance (μS/cm)	Temper-ature (°C)	Chloride (mg/L)	Water level (ft BLS)
413950087002602	1-DG-2	02/06/96	1455	0.1	7.4	729	11.8	6.8	5.06
413950087002602	1-DG-2	03/12/96	1635	.1	7.2	760	11.5	7.4	4.34
413950087002602	1-DG-2	04/10/96	1430	.1	7.5	734	11.3	7.4	4.61
413950087002602	1-DG-2	05/07/96	1630	.1	7.5	736	10.6	7.9	4.03
413950087002602	1-DG-2	06/13/96	1415	.1	7.5	749	11.8	7.9	2.88
413950087002602	1-DG-2	07/10/96	1650	.1	7.6	728	11.3	7.7	3.88
413950087002602	1-DG-2	08/15/96	1040	.1	7.5	746	12.5	7.5	4.21
413950087002602	1-DG-2	09/09/96	1345	.1	7.4	738	12.7	7.5	5.1
413950087002602	1-DG-2	10/09/96	1510	.1	7.4	720	12.2	7.4	4.71
413950087002602	1-DG-2	11/07/96	1135	.1	7.3	731	12	7.2	4.35
413950087002602	1-DG-2	12/11/96	1015	.2	7.4	724	11.9	6.9	4.02
413950087002602	1-DG-2	01/22/97	0835	.2	7.6	736	11.6	6.2	4.08
413950087002602	1-DG-2	02/11/97	1710	.1	7.4	729	11.2	6.1	3.68
413950087002602	1-DG-2	03/11/97	1245	.1	7.4	741	10.7	5.7	3.08
413950087002602	1-DG-2	04/24/97	1015	.1	7.4	772	10.1	5.4	3.48
413950087002602	1-DG-2	05/20/97	1705	.1	7.4	794	10.5	5.6	3.52
413950087002602	1-DG-2	06/17/97	1430	.1	7.5	807	10.8	5.2	2.92
413950087002603	1-DG-3	12/12/94	1455	.2	6.8	300	12.1	7.8	3.85
413950087002603	1-DG-3	02/01/95	1335	.3	6.8	322	11.6	8.5	3.66
413950087002603	1-DG-3	03/01/95	1210	.1	7.1	342	9.4	9.1	3.41
413950087002603	1-DG-3	03/27/95	1410	.3	7	321	9.4	8.7	3.54
413950087002603	1-DG-3	04/25/95	1115	.3	6.6	274	9.9	7.4	3.04
413950087002603	1-DG-3	05/30/95	1720	.3	6.7	246	10.7	5.7	3.02
413950087002603	1-DG-3	06/28/95	1105	.2	6.9	236	11.5	5.7	3.92
413950087002603	1-DG-3	08/01/95	1445	.2	6.6	237	13.7	6.6	4.83
413950087002603	1-DG-3	09/08/95	1220	.1	6.9	255	13.1	8.1	5.55
413950087002603	1-DG-3	09/21/95	1205	.1	6.7	267	13.1	8.7	5.89
413950087002603	1-DG-3	10/30/95	1630	<.1	6.8	353	13.3	12	5.68
413950087002603	1-DG-3	12/06/95	1335	.2	6.9	378	12.8	12	4.95
413950087002603	1-DG-3	01/10/96	1340	.1	6.7	418	12	13	5.08
413950087002603	1-DG-3	02/06/96	1735	.2	6.8	436	11.1	12	4.98
413950087002603	1-DG-3	03/12/96	1340	.1	6.6	462	10.8	12	4.3
413950087002603	1-DG-3	04/10/96	1650	.1	6.5	433	10.1	12	4.53

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994-97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conduct-ance (µS/cm)	Temper-ature (°C)	Chloride (mg/L)	Water level (ft BLS)
413950087002603	1-DG-3	05/08/96	0840	0.1	6.6	428	9.7	12	3.96
413950087002603	1-DG-3	06/13/96	1600	.1	6.5	423	11.8	12	2.82
413950087002603	1-DG-3	07/10/96	1010	.1	6.7	412	11.2	12	3.9
413950087002603	1-DG-3	08/15/96	1515	.1	6.8	378	12.7	13	4.14
413950087002603	1-DG-3	09/09/96	1650	.1	6.6	389	12.9	13	5.04
413950087002603	1-DG-3	10/09/96	1530	.1	6.7	396	13.2	14	4.64
413950087002603	1-DG-3	11/07/96	1705	.2	6.7	402	12.8	14	4.27
413950087002603	1-DG-3	12/11/96	1045	.2	6.8	396	12.4	15	3.96
413950087002603	1-DG-3	01/22/97	1005	.2	6.7	404	11.4	15	3.71
413950087002603	1-DG-3	02/11/97	0835	.2	6.4	399	10.5	15	3.62
413950087002603	1-DG-3	03/11/97	1310	.1	6.6	391	10	14	3.02
413950087002603	1-DG-3	04/24/97	0910	.1	6.6	356	9.3	11.9	3.41
413950087002603	1-DG-3	05/20/97	1455	.1	6.6	343	10.3	11	3.45
413950087002603	1-DG-3	06/17/97	1635	.1	6.8	282	10.4	8.8	2.85
413950087002604	1-DG-4	12/12/94	1615	.2	4.9	87	11.9	3	3.89
413950087002604	1-DG-4	02/01/95	1400	.3	4.8	81	10.2	2.3	3.73
413950087002604	1-DG-4	03/01/95	1230	.2	5.4	83	7.9	2	3.46
413950087002604	1-DG-4	03/28/95	1410	.3	5.1	79	8.4	2	3.33
413950087002604	1-DG-4	04/25/95	1030	.4	5	83	9	1.9	3.1
413950087002604	1-DG-4	05/30/95	1530	.4	5.1	99	11.4	1.6	3.07
413950087002604	1-DG-4	06/28/95	1130	.2	5	76	12.3	1.8	3.98
413950087002604	1-DG-4	08/01/95	1355	.2	5	77	15.4	2	4.91
413950087002604	1-DG-4	09/11/95	1245	.2	4.8	48	15.9	1.9	5.61
413950087002604	1-DG-4	09/21/95	1100	.1	4.6	48	15.1	1.9	5.94
413950087002604	1-DG-4	10/31/95	1315	.1	5.2	55	14.7	1.8	5.75
413950087002604	1-DG-4	12/06/95	1510	.2	4.8	40	12.9	1.6	5.01
413950087002604	1-DG-4	01/10/96	1535	.2	4.7	41	11	1.9	5.15
413950087002604	1-DG-4	02/06/96	1705	.2	4.9	38	10	1.6	5.05
413950087002604	1-DG-4	03/12/96	1440	.2	4.7	39	9.2	1.7	4.32
413950087002604	1-DG-4	04/10/96	1620	.2	4.8	62	9.6	11	4.6
413950087002604	1-DG-4	05/07/96	1820	.1	5	38	8.9	1.3	4.01
413950087002604	1-DG-4	06/13/96	1530	.1	4.8	41	12.2	1.2	2.87
413950087002604	1-DG-4	07/10/96	1130	.1	4.8	41	12	1.4	3.86

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994-97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conduct-ance (μS/cm)	Temper-ature (°C)	Chloride (mg/L)	Water level (ft BLS)
413950087002604	1-DG-4	08/14/96	1540	0.1	4.9	42	14.3	1.3	4.19
413950087002604	1-DG-4	09/09/96	1625	.1	4.8	42	14.8	1.2	5.09
413950087002604	1-DG-4	10/09/96	1210	.1	4.7	42	14.9	1.3	4.7
413950087002604	1-DG-4	11/07/96	1745	.1	4.7	41	14	1.4	4.33
413950087002604	1-DG-4	12/11/96	1320	.2	4.7	39	12.4	1.4	4.02
413950087002604	1-DG-4	01/22/97	0945	.2	4.9	38	10.4	1.4	3.35
413950087002604	1-DG-4	02/11/97	1505	.2	4.8	38	9.5	1.4	3.68
413950087002604	1-DG-4	03/11/97	1330	.2	4.7	38	8.7	1.3	3.08
413950087002604	1-DG-4	04/24/97	0945	.1	4.8	38	8.5	1.2	3.47
413950087002604	1-DG-4	05/20/97	1605	.1	4.9	40	9.7	1.3	3.51
413950087002604	1-DG-4	06/17/97	1535	.1	5.2	44	10.7	1.9	2.91
413950087002604	1-DG-4	08/22/97	1025	.1	4.6	39	14.4	--	4.23
413950087002605	1-DG-5	12/13/94	0920	4.1	5.2	76	10.7	2.1	4.01
413950087002605	1-DG-5	02/01/95	1430	3.9	5.2	66	7.6	1.3	3.81
413950087002605	1-DG-5	03/01/95	1245	4.5	5.5	70	5.3	1.6	3.55
413950087002605	1-DG-5	03/28/95	1100	4.6	5.2	865	6.9	260	3.43
413950087002605	1-DG-5	04/25/95	1315	4.4	5.3	302	9.1	75	3.17
413950087002605	1-DG-5	05/30/95	1600	3.7	5.2	92	12.5	2.4	3.16
413950087002605	1-DG-5	06/28/95	0830	3.8	5	66	15	1.6	4.06
413950087002605	1-DG-5	08/01/95	1530	3.9	5	72	19.9	2.4	5
413950087002605	1-DG-5	09/11/95	1145	3.7	4.8	41	19.9	2.1	5.7
413950087002605	1-DG-5	09/21/95	1220	4	4.7	40	18.5	2.1	6.03
413950087002605	1-DG-5	11/01/95	1505	4.1	5.8	55	16.4	2	5.83
413950087002605	1-DG-5	12/07/95	0845	6	4.9	42	10.7	2.6	5.1
413950087002605	1-DG-5	01/10/96	1355	3.7	5.3	37	8.5	1.6	5.23
413950087002605	1-DG-5	02/06/96	1320	4.6	5.4	36	7.3	1.8	5.13
413950087002605	1-DG-5	03/12/96	1650	5.1	5.2	36	6.9	1.8	4.42
413950087002605	1-DG-5	04/10/96	1455	4.7	5.5	37	8.1	2	4.68
413950087002605	1-DG-5	05/07/96	1655	6.3	5.1	103	9	24	4.1
413950087002605	1-DG-5	06/13/96	1315	6.2	5.2	295	14.8	84	2.96
413950087002605	1-DG-5	07/10/96	1215	6.6	4.9	34	15.9	2	3.94
413950087002605	1-DG-5	08/15/96	1615	6.3	4.3	37	18.5	2.8	4.29
413950087002605	1-DG-5	09/09/96	1440	7	4.8	35	18.9	2.7	5.18

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conduct-ance (μS/cm)	Temper-ature (°C)	Chloride (mg/L)	Water level (ft BLS)
413950087002605	1-DG-5	10/09/96	1355	8	4.7	40	17.4	3.1	4.8
413950087002605	1-DG-5	11/07/96	1535	6.7	4.9	41	14.3	3	4.43
413950087002605	1-DG-5	12/11/96	1220	6.2	4.9	39	10.4	2.6	4.11
413950087002605	1-DG-5	01/22/97	0925	6.6	5.4	38	7.8	2.6	4.17
413950087002605	1-DG-5	02/11/97	0950	6.3	5.2	37	6.5	2.3	3.78
413950087002605	1-DG-5	03/11/97	1210	6.9	4.9	1,800	6.6	580	3.18
413950087002605	1-DG-5	04/24/97	1035	7	5	1,920	7.7	597	3.57
413950087002605	1-DG-5	05/21/97	0905	7.3	5.3	38	10.4	2.7	3.62
413950087002605	1-DG-5	06/17/97	1340	6.8	5.7	48	13.1	3.3	3.01
413950087002605	1-DG-5	08/22/97	1000	6.2	4.8	44	18.5	--	4.3
413950087002606	1-DG-WT	12/12/94	1340	8.2	7	333	9.7	36	3.9
413950087002606	1-DG-WT	02/01/95	1455	7	6.5	1,370	6.1	380	3.71
413950087002606	1-DG-WT	03/01/95	1315	7.5	6.8	1,570	4.1	430	3.46
413950087002606	1-DG-WT	03/28/95	1235	8.2	6.8	2,740	6.7	850	3.33
413950087002606	1-DG-WT	04/25/95	0945	8.4	7.1	2,870	11.6	810	3.08
413950087002606	1-DG-WT	05/30/95	1645	6.8	7	1,730	13.8	430	3.07
413950087002606	1-DG-WT	06/28/95	0915	5.9	6.7	2,900	17.3	730	3.97
413950087002606	1-DG-WT	08/01/95	1140	5.2	6.7	850	21.2	160	4.87
413950087002606	1-DG-WT	09/08/95	1045	9.5	6.2	95	19.5	5.8	5.64
413950087002606	1-DG-WT	10/31/95	0900	8.4	5.9	92	10	4.5	5.74
413950087002606	1-DG-WT	12/06/95	1355	<10.4	6	215	9.6	9.2	5
413950087002606	1-DG-WT	01/10/96	1510	10.6	6.5	72	6.9	3.2	4.85
413950087002606	1-DG-WT	02/06/96	1520	12.3	7.2	83	5.7	5.1	5.03
413950087002606	1-DG-WT	03/12/96	1455	7.8	6.1	581	5.9	160	4.31
413950087002606	1-DG-WT	04/10/96	1120	7.2	6.2	1,110	7.3	340	4.58
413950087002606	1-DG-WT	05/07/96	1350	9.2	6.3	2,210	9.6	610	4
413950087002606	1-DG-WT	06/13/96	1700	7.4	6.8	3,380	15.6	920	2.86
413950087002606	1-DG-WT	07/10/96	1530	6.9	6.9	2,630	18.8	680	3.84
413950087002606	1-DG-WT	08/14/96	1630	6.2	6.8	1,320	20.8	260	4.18
413950087002606	1-DG-WT	09/09/96	1740	8.6	6.9	1,170	20	200	5.08
413950087002606	1-DG-WT	10/09/96	1150	6	7.1	581	17.2	44	4.68
413950087002606	1-DG-WT	11/07/96	1220	5.6	7.4	537	13.3	53	4.32
413950087002606	1-DG-WT	12/11/96	1235	5.9	7.3	352	8.7	35	3.99

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conduct-ance (µS/cm)	Temper-ature (°C)	Chloride (mg/L)	Water level (ft BLS)
413950087002606	1-DG-WT	01/22/97	1020	8.1	7.4	798	6	170	4.05
413950087002606	1-DG-WT	02/11/97	1345	7.4	6.8	1,170	5.3	310	3.66
413950087002606	1-DG-WT	03/11/97	1110	8.5	6.7	4,530	5.4	1,400	3.06
413950087002606	1-DG-WT	04/24/97	0745	7.6	7	2,810	8	841	3.45
413950087002606	1-DG-WT	05/20/97	1210	7	7.1	3,090	11.6	880	3.49
413950087002606	1-DG-WT	06/17/97	1445	3.8	7	3,020	15.2	805	2.89
413950087002501	ALT-1-DG-1	08/01/95	1300	.2	7.2	781	13.1	9.2	4.84
413950087002501	ALT-1-DG-1	09/11/95	1100	.1	7.6	811	12.3	10	5.57
413950087002501	ALT-1-DG-1	09/21/95	0940	.1	7.7	798	11.6	9.3	5.9
413950087002501	ALT-1-DG-1	11/01/95	0845	<.1	7.4	827	12	10	5.69
413950087002501	ALT-1-DG-1	12/07/95	1000	.1	7.6	797	11.1	9.2	4.97
413950087002501	ALT-1-DG-1	01/10/96	1250	.1	7.3	794	11.6	9.7	5.09
413950087002501	ALT-1-DG-1	02/06/96	1055	.1	7.4	798	11.8	9.2	4.98
413950087002501	ALT-1-DG-1	03/12/96	1735	<1.1	7.4	816	11.1	9.7	4.27
413950087002501	ALT-1-DG-1	04/10/96	1300	.1	7.7	804	11.5	9	4.54
413950087002501	ALT-1-DG-1	05/07/96	1945	.1	7.8	809	10.9	10	3.95
413950087002501	ALT-1-DG-1	06/13/96	1830	.1	7.9	833	11.7	9.3	2.82
413950087002501	ALT-1-DG-1	07/10/96	1340	<1.1	7.4	722	14.2	9.3	3.81
413950087002501	ALT-1-DG-1	08/15/96	1330	.1	7.9	765	13.4	9.4	4.14
413950087002501	ALT-1-DG-1	090/9/96	1545	.1	7.5	809	11.9	9.1	5.04
413950087002502	ALT-1-DG-2	08/01/95	1650	.2	7.2	597	12.8	8.3	4.93
413950087002502	ALT-1-DG-2	09/08/95	1130	.1	7.5	635	12.1	8	5.67
413950087002502	ALT-1-DG-2	09/21/95	1010	.1	7.5	632	11.9	7.9	6
413950087002502	ALT-1-DG-2	10/31/95	1605	<.1	7.4	679	12.2	7.7	5.79
413950087002502	ALT-1-DG-2	12/07/95	1100	.1	7.3	668	11.9	7.9	5.08
413950087002502	ALT-1-DG-2	01/10/96	1630	.2	7.4	648	12	7.8	5.19
413950087002502	ALT-1-DG-2	02/06/96	1420	.2	7.3	627	11.6	8.4	5.09
413950087002502	ALT-1-DG-2	03/12/96	1605	.1	7.2	628	11.4	9	4.37
413950087002502	ALT-1-DG-2	04/10/96	1355	.1	7.6	564	11.1	9.7	4.63
413950087002502	ALT-1-DG-2	05/07/96	1540	.1	7.3	580	10.5	10	4.13
413950087002502	ALT-1-DG-2	06/13/96	1455	.1	7.6	605	11.9	9.3	2.92
413950087002502	ALT-1-DG-2	07/10/96	1620	.1	7.4	603	11.4	8.7	3.89
413950087002502	ALT-1-DG-2	08/15/96	0945	.1	7.4	610	11.7	8.5	4.24

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conduct-ance (µS/cm)	Temper-ature (°C)	Chloride (mg/L)	Water level (ft BLS)
413950087002502	ALT-1-DG-2	09/09/96	1410	0.1	7.3	617	12.1	8.7	5.14
413950087002503	ALT-1-DG-3	08/01/95	1515	.2	6.2	149	13.5	5.7	5.03
413950087002503	ALT-1-DG-3	09/08/95	1245	.1	6.1	143	13.1	6.8	5.74
413950087002503	ALT-1-DG-3	09/21/95	1145	.1	6	152	13.1	7.4	6.08
413950087002503	ALT-1-DG-3	10/30/95	1550	--	6.2	202	13.4	9.3	5.87
413950087002503	ALT-1-DG-3	12/06/95	1310	.2	6.2	230	12.6	10	5.14
413950087002503	ALT-1-DG-3	01/10/96	1315	.2	6.2	285	11.7	11	5.27
413950087002503	ALT-1-DG-3	02/06/96	1805	.1	6.3	293	11	11	5.16
413950087002503	ALT-1-DG-3	03/12/96	1400	.1	6.1	304	10.5	11	4.44
413950087002503	ALT-1-DG-3	04/10/96	1725	.1	6	329	9.9	31	4.71
413950087002503	ALT-1-DG-3	05/08/96	0810	.1	6.2	272	9.6	11	4.13
413950087002503	ALT-1-DG-3	06/13/96	1630	.1	6.2	264	11.4	11	3.01
413950087002503	ALT-1-DG-3	07/10/96	1045	.1	6.3	226	11.4	9.2	3.97
413950087002503	ALT-1-DG-3	08/15/96	1425	.1	6.5	183	13.7	8.1	4.32
413950087002503	ALT-1-DG-3	09/09/96	1710	.1	6.2	202	12.9	8.7	5.22
413950087002504	ALT-1-DG-4	08/01/95	1415	3.3	4.7	91	15.4	1.6	--
413950087002504	ALT-1-DG-4	09/11/95	1225	2.3	4.5	62	16.5	1.6	--
413950087002504	ALT-1-DG-4	09/21/95	1120	2.7	4.3	62	15.1	1.6	--
413950087002504	ALT-1-DG-4	10/31/95	1140	2.4	4.9	75	14.6	3.3	5.74
413950087002504	ALT-1-DG-4	12/06/95	1445	2.8	4.3	61	12.8	1.9	5.02
413950087002504	ALT-1-DG-4	01/10/96	1555	2.7	4.5	59	10.9	1.9	5.14
413950087002504	ALT-1-DG-4	02/06/96	1640	2.2	4.6	60	9.8	1.8	5.05
413950087002504	ALT-1-DG-4	03/12/96	1420	2.1	4.4	56	9.2	1.6	4.31
413950087002504	ALT-1-DG-4	04/10/96	1530	2	4.4	229	9.1	49	4.58
413950087002504	ALT-1-DG-4	05/07/96	1755	1.9	4.7	60	8.9	2.2	4
413950087002504	ALT-1-DG-4	06/13/96	1505	2.1	4.6	58	12.2	1.3	2.87
413950087002504	ALT-1-DG-4	07/10/96	1105	1.7	4.6	59	12	1.3	3.85
413950087002504	ALT-1-DG-4	08/14/96	1445	1.5	4.6	57	14.5	1.2	4.18
413950087002504	ALT-1-DG-4	09/09/96	1605	1.7	4.5	53	14.9	1.3	5.08
413950087002505	ALT-1-DG-5	08/01/95	1600	3.7	5.2	73	18	1.3	--
413950087002505	ALT-1-DG-5	09/11/95	1205	2.6	5.1	45	19	1.7	--
413950087002505	ALT-1-DG-5	09/21/95	1245	2.7	4.9	44	17.7	1.7	--
413950087002505	ALT-1-DG-5	11/01/95	1640	3.2	5.6	58	16.2	1.7	5.69

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conduct-ance (μS/cm)	Temper-ature (°C)	Chloride (mg/L)	Water level (ft BLS)
413950087002505	ALT-1-DG-5	12/07/95	0825	3.2	5.2	43	11.1	2	4.95
413950087002505	ALT-1-DG-5	01/10/96	1415	4.6	5.2	41	9	1.8	5.09
413950087002505	ALT-1-DG-5	02/06/96	1345	3.8	5.3	37	7.8	1.6	4.98
413950087002505	ALT-1-DG-5	03/12/96	1705	4.5	5.2	39	6.9	1.8	4.25
413950087002505	ALT-1-DG-5	04/10/96	1520	4.8	4.9	132	8.3	27	4.53
413950087002505	ALT-1-DG-5	05/07/96	1720	4.9	5.2	396	8.7	110	3.95
413950087002505	ALT-1-DG-5	06/13/96	1300	5.4	5.4	51	13.4	4.4	2.81
413950087002505	ALT-1-DG-5	07/10/96	1245	6	5.2	42	14.8	2.3	3.79
413950087002505	ALT-1-DG-5	08/15/96	1730	5.7	4.8	31	17.5	2.5	4.13
413950087002505	ALT-1-DG-5	09/09/96	1430	5.2	5.3	35	18.1	3	5.03
413950087002505	ALT-1-DG-5	10/09/96	1410	5.9	4.7	38	16.7	3.2	4.64
413950087002505	ALT-1-DG-5	11/07/96	1620	5.1	5	40	14.2	3.3	4.26
413950087002505	ALT-1-DG-5	12/11/96	1155	5.4	5.1	39	10.8	2.8	3.94
413950087002505	ALT-1-DG-5	01/22/97	1125	5.7	5.1	39	8.3	2.3	3.99
413950087002505	ALT-1-DG-5	02/11/97	1110	4.8	5.2	38	7.1	2	3.61
413950087002505	ALT-1-DG-5	03/11/97	1145	6.1	5.4	293	6.9	120	3
413950087002505	ALT-1-DG-5	04/24/97	1110	7.6	5.3	679	7.8	202	3.39
413950087002505	ALT-1-DG-5	05/21/97	0950	8.1	5.3	41	10.1	2.2	3.43
413950087002505	ALT-1-DG-5	06/17/97	1400	7.7	5.9	36	12.3	2	2.83
413950087002506	ALT-1-DG-WT	08/01/95	1210	3.4	6.5	557	21.5	74	--
413950087002506	ALT-1-DG-WT	11/07/95	1325	6.8	6.1	150	13.9	5.1	5.51
413950087002506	ALT-1-DG-WT	12/06/95	1415	<11.6	6.5	442	8.8	13	5.13
413950087002506	ALT-1-DG-WT	01/10/96	1430	12.3	6.6	120	6	2.8	5.26
413950087002506	ALT-1-DG-WT	02/06/96	1610	12.5	6.7	288	5.3	3.4	5.16
413950087002506	ALT-1-DG-WT	03/12/96	1525	11.9	6.6	199	6.2	25	4.43
413950087002506	ALT-1-DG-WT	04/10/96	1040	8.9	6.2	1,720	7.3	520	4.7
413950087002506	ALT-1-DG-WT	05/07/96	1435	8.6	6.4	897	9.4	230	4.12
413950087002506	ALT-1-DG-WT	06/13/96	1640	4.3	6.8	2,320	15.8	580	2.98
413950087002506	ALT-1-DG-WT	07/10/96	1550	.7	6.7	2,040	18.5	570	3.96
413950087002506	ALT-1-DG-WT	08/14/96	1750	.4	6.8	1,410	20.3	260	4.3
413950087002506	ALT-1-DG-WT	09/09/96	1725	7.4	6.4	940	20.3	140	5.21
413950087002506	ALT-1-DG-WT	10/09/96	1130	7.6	6.6	424	17.3	15	4.81
413950087002506	ALT-1-DG-WT	11/07/96	1330	2.6	6.9	393	13.3	24	4.43

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conduct-ance (µS/cm)	Temper-ature (°C)	Chloride (mg/L)	Water level (ft BLS)
413950087002506	ALT-1-DG-WT	12/11/96	1250	5.1	6.8	271	8.8	7.2	4.11
413950087002506	ALT-1-DG-WT	01/22/97	1140	5	6.8	357	6.4	34	4.16
413950087002506	ALT-1-DG-WT	02/11/97	1225	6.3	6.6	349	5.3	63	3.78
413950087002506	ALT-1-DG-WT	03/11/97	1055	6.3	7	1,900	5.8	580	3.17
413950087002506	ALT-1-DG-WT	04/24/97	0805	7.1	6.6	2,360	7.9	726	3.57
413950087002506	ALT-1-DG-WT	05/20/97	1115	4	6.7	3,240	14	859	3.6
413950087002506	ALT-1-DG-WT	06/17/97	1500	1.5	7.1	2,990	15.9	737	3.03
413951087002601	2-DG-1	12/20/94	0835	.2	7.6	795	11.3	11	3.7
413951087002601	2-DG-1	02/01/95	0845	.2	7.5	804	11.4	11	3.45
413951087002601	2-DG-1	02/28/95	1325	.2	7.6	791	11	11	3.17
413951087002601	2-DG-1	04/04/95	1100	.1	7.5	791	10.5	11	3.38
413951087002601	2-DG-1	04/26/95	1545	.2	7.5	787	11.7	11	3.02
413951087002601	2-DG-1	05/31/95	1020	.2	7.4	770	12.8	11	3.01
413951087002601	2-DG-1	06/26/95	1645	.2	7.4	799	12.3	11	3.8
413951087002601	2-DG-1	07/31/95	1700	.2	7.5	788	13.6	11	4.55
413951087002601	2-DG-1	09/11/95	1415	.1	7.7	812	12.8	11	5.39
413951087002601	2-DG-1	09/21/95	1600	.1	7.5	810	11.6	12	5.59
413951087002601	2-DG-1	11/01/95	1735	.1	7.7	807	12.4	11	5.13
413951087002601	2-DG-1	12/07/95	1435	.1	7.5	800	11.6	9.2	4.62
413951087002601	2-DG-1	01/11/96	0950	.1	7.4	796	11.4	11	4.71
413951087002601	2-DG-1	02/07/96	0910	.1	7.5	775	11.8	11	4.67
413951087002601	2-DG-1	03/14/96	1030	.1	7.3	787	12.4	11	3.88
413951087002601	2-DG-1	04/11/96	1145	.1	7.5	812	13.2	11	4.24
413951087002601	2-DG-1	05/09/96	1300	.1	8	803	12.6	12	3.63
413951087002601	2-DG-1	06/12/96	1400	.1	7.7	840	12.6	11	4.61
413951087002601	2-DG-1	07/11/96	1530	.1	7.6	807	12.3	12	4.05
413951087002601	2-DG-1	08/19/96	1840	--	--	--	--	11	4.03
413951087002601	2-DG-1	09/10/96	0900	.1	7.5	815	11.9	11	4.8
413951087002601	2-DG-1	10/10/96	1415	.1	7.7	817	11.6	12	4.24
413951087002601	2-DG-1	11/06/96	1905	.1	7.5	809	12.1	12	4.08
413951087002601	2-DG-1	12/11/96	1515	.1	7.5	804	11.7	11	3.69
413951087002601	2-DG-1	01/22/97	1230	.1	7.4	809	11.9	10	3.75
413951087002601	2-DG-1	02/19/97	1220	.1	7.4	788	11.9	11	3.43

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conduct-ance (μS/cm)	Temper-ature (°C)	Chloride (mg/L)	Water level (ft BLS)
413951087002601	2-DG-1	03/12/97	1930	0.1	7.7	804	11.4	11	3
413951087002601	2-DG-1	04/23/97	1215	.1	7.4	796	11.7	11	3.28
413951087002601	2-DG-1	05/15/97	1145	.1	7.4	796	11.2	11.2	3.39
413951087002601	2-DG-1	06/18/97	1020	.1	7.6	823	11.4	10.9	2.88
413951087002602	2-DG-2	12/20/94	1010	.2	7.3	802	11.5	6	3.71
413951087002602	2-DG-2	02/01/95	0915	.2	7.5	799	11.4	6	3.47
413951087002602	2-DG-2	02/28/95	1400	.2	7.6	787	10.9	6.2	3.18
413951087002602	2-DG-2	04/03/95	1445	.3	7.4	779	11.7	6.4	3.35
413951087002602	2-DG-2	04/26/95	1405	.2	7.4	781	11.3	6.9	3.04
413951087002602	2-DG-2	06/26/95	1440	.3	7.5	795	12.6	6.5	3.81
413951087002602	2-DG-2	05/31/95	0945	.3	7.3	762	12.2	6.2	3.04
413951087002602	2-DG-2	07/31/95	1530	.3	7.5	782	13.2	6.6	4.56
413951087002602	2-DG-2	09/11/95	1545	.1	7.5	811	12.4	6.5	5.41
413951087002602	2-DG-2	09/21/95	1500	.1	7.4	813	11.8	6.3	5.6
413951087002602	2-DG-2	11/01/95	1500	.1	7.2	819	13.7	6	5.17
413951087002602	2-DG-2	12/07/95	1400	.1	7.3	813	12.3	6	4.63
413951087002602	2-DG-2	01/11/96	1040	.2	7.3	806	11.8	6.1	4.71
413951087002602	2-DG-2	02/07/96	0940	.1	7.4	790	12.1	6.2	4.67
413951087002602	2-DG-2	03/14/96	1115	.1	7.3	809	12.1	6.4	3.89
413951087002602	2-DG-2	04/11/96	1025	.1	7.3	814	12.2	6.7	4.26
413951087002602	2-DG-2	05/09/96	1340	.2	7.8	789	11.9	6.7	3.66
413951087002602	2-DG-2	06/12/96	1555	.1	7.5	838	12.1	6.5	2.65
413951087002602	2-DG-2	07/11/96	1425	.1	7.5	808	12	6.8	3.78
413951087002602	2-DG-2	08/19/96	1610	--	--	--	--	6.8	4.05
413951087002602	2-DG-2	09/10/96	0955	.1	7.5	804	12.1	7	4.82
413951087002602	2-DG-2	10/10/96	1250	.1	7.4	802	12	7.3	4.24
413951087002602	2-DG-2	11/06/96	2005	.1	7.5	784	12.4	7.1	4.09
413951087002602	2-DG-2	12/11/96	1445	.1	7.4	766	12.3	7.1	3.71
413951087002602	2-DG-2	01/22/97	1315	.1	7.5	772	12	6.9	3.76
413951087002602	2-DG-2	02/19/97	0945	.1	7.3	753	11.8	6.8	3.45
413951087002602	2-DG-2	03/12/97	1755	.2	7.6	773	10.7	6.9	3.03
413951087002602	2-DG-2	04/23/97	1335	.1	7.4	764	11.2	7.2	3.3
413951087002602	2-DG-2	05/15/97	1550	.1	7.4	765	10.8	7.4	3.42

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conduct-ance (μS/cm)	Temper-ature (°C)	Chloride (mg/L)	Water level (ft BLS)
413951087002602	2-DG-2	06/18/97	1135	0.1	7.6	791	11.2	7	2.91
413951087002603	2-DG-3	12/20/94	1200	.2	6.9	463	12.2	8.7	3.71
413951087002603	2-DG-3	02/01/95	0950	.2	7.1	418	11.4	8	3.48
413951087002603	2-DG-3	02/28/95	1430	.1	7.2	436	10.4	9.3	3.18
413951087002603	2-DG-3	04/04/95	0920	.2	7.1	469	9.3	9.8	3.4
413951087002603	2-DG-3	04/26/95	1510	.2	6.9	467	10.6	10	3.02
413951087002603	2-DG-3	06/26/95	1525	.2	7.2	450	11.9	11	3.84
413951087002603	2-DG-3	05/31/95	1115	.3	7	460	11.8	11	3.04
413951087002603	2-DG-3	07/31/95	1500	.3	7.1	442	13.1	10	4.58
413951087002603	2-DG-3	09/11/95	1515	.1	7.3	433	12.9	11	5.43
413951087002603	2-DG-3	09/21/95	1425	.1	6.9	432	12.6	10	5.63
413951087002603	2-DG-3	11/01/95	1625	.1	7.1	442	13.7	11	5.17
413951087002603	2-DG-3	12/07/95	1310	.2	6.9	420	12.6	10	4.66
413951087002603	2-DG-3	01/11/96	1115	.1	7.1	435	12.1	11	4.44
413951087002603	2-DG-3	02/07/96	0830	.1	7.1	446	11.9	11	4.7
413951087002603	2-DG-3	03/14/96	1355	.1	6.9	473	11.4	12	3.92
413951087002603	2-DG-3	04/11/96	1220	.1	7.2	491	12.2	12	4.28
413951087002603	2-DG-3	05/09/96	1700	.1	7.1	508	10.7	12	3.68
413951087002603	2-DG-3	06/12/96	1520	.1	7.1	539	11.6	12	2.65
413951087002603	2-DG-3	07/11/96	1555	.1	7.3	528	11.4	12	3.81
413951087002603	2-DG-3	08/19/96	1700	--	--	--	--	12	4.09
413951087002603	2-DG-3	09/10/96	0925	.1	7	536	12.6	11	4.85
413951087002603	2-DG-3	10/10/96	1340	.1	7	542	12.6	12	4.29
413951087002603	2-DG-3	11/06/96	1520	.2	6.9	535	13.3	13	4.13
413951087002603	2-DG-3	12/11/96	1420	.2	6.9	523	12.8	13	3.74
413951087002603	2-DG-3	01/22/97	1350	.1	7.1	530	11.9	13	3.8
413951087002603	2-DG-3	02/18/97	1400	.1	6.9	522	11.9	13	3.48
413951087002603	2-DG-3	03/12/97	1820	.1	7.2	519	10.7	14	3.05
413951087002603	2-DG-3	04/23/97	1240	.1	7	508	10.2	13.4	3.33
413951087002603	2-DG-3	05/15/97	1250	.1	7	515	9.9	13.6	3.45
413951087002603	2-DG-3	06/18/97	0925	.1	7.2	536	10.3	12.3	2.93
413951087002604	2-DG-4	12/20/94	1305	1.3	4.8	85	12.4	1.9	3.97
413951087002604	2-DG-4	02/01/95	1015	.6	5	86	10.5	2	2.73

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conduct-ance (µS/cm)	Temper-ature (°C)	Chloride (mg/L)	Water level (ft BLS)
413951087002604	2-DG-4	02/28/95	1500	0.7	5.1	86	9.3	2.1	3.45
413951087002604	2-DG-4	04/03/95	1610	1.3	5.1	83	9.9	2.1	3.6
413951087002604	2-DG-4	04/26/95	1440	1.3	5	83	9.9	1.9	3.28
413951087002604	2-DG-4	05/31/95	0915	1.7	4.9	98	11.2	2.1	3.27
413951087002604	2-DG-4	06/26/95	1615	1	4.9	72	11.7	1.6	4.07
413951087002604	2-DG-4	07/31/95	1545	.5	4.9	79	14.2	1.5	4.83
413951087002604	2-DG-4	09/11/95	1500	.2	4.7	47	14.6	1.3	5.66
413951087002604	2-DG-4	09/21/95	1520	.2	4.6	47	14.1	1.4	5.87
413951087002604	2-DG-4	11/01/95	1345	.6	4.6	48	14.9	1.4	5.42
413951087002604	2-DG-4	12/07/95	1220	.5	4.6	45	12.9	1.3	4.9
413951087002604	2-DG-4	01/11/96	1020	.4	4.8	42	11.3	1.4	4.99
413951087002604	2-DG-4	02/07/96	1100	.5	4.8	41	10.7	1.3	4.94
413951087002604	2-DG-4	03/14/96	1330	.2	4.9	42	10.1	1.3	4.16
413951087002604	2-DG-4	04/11/96	1100	.2	4.8	42	10.6	1.3	4.53
413951087002604	2-DG-4	05/09/96	1405	.2	4.9	40	10.2	1.3	3.61
413951087002604	2-DG-4	06/12/96	1325	.6	4.7	139	11.1	28	2.86
413951087002604	2-DG-4	07/11/96	1445	.5	5	49	11.9	1.2	4.02
413951087002604	2-DG-4	08/19/96	1430	--	5	--	--	10	4.3
413951087002604	2-DG-4	09/10/96	1015	.1	5.2	65	14.1	8	5.07
413951087002604	2-DG-4	10/10/96	1305	.7	5	329	13.8	66	4.52
413951087002604	2-DG-4	11/06/96	1610	.2	4.9	46	14.1	1.2	4.35
413951087002604	2-DG-4	12/11/96	1600	.2	5.1	46	12.7	1.1	3.96
413951087002604	2-DG-4	01/22/97	1405	.1	4.9	41	11.3	1.2	4.01
413951087002604	2-DG-4	02/18/97	1455	.2	5	40	10.7	1.3	3.69
413951087002604	2-DG-4	03/12/97	1845	.2	5	41	9	1.2	3.26
413951087002604	2-DG-4	04/23/97	1310	.2	4.8	42	9.2	1.3	3.54
413951087002604	2-DG-4	05/15/97	1445	.5	4.6	199	9	56.2	3.66
413951087002604	2-DG-4	06/18/97	1110	1.3	5.2	440	10.1	103	3.13
413951087002605	2-DG-5	12/20/94	1425	2.3	5.9	205	10.4	37	4.04
413951087002605	2-DG-5	02/01/95	1055	2.3	6.2	176	7.7	15	3.8
413951087002605	2-DG-5	02/28/95	1530	3.4	6.3	128	5.9	7.8	3.52
413951087002605	2-DG-5	04/04/95	1245	3.1	6.9	117	6.8	7.9	3.73
413951087002605	2-DG-5	04/26/95	1615	3	6.1	345	8.8	91	2.35

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conduct-ance (μS/cm)	Temper-ature (°C)	Chloride (mg/L)	Water level (ft BLS)
413951087002605	2-DG-5	05/31/95	0845	3.9	6.1	702	12	220	2.35
413951087002605	2-DG-5	06/26/95	1710	3.7	6	625	15.2	130	4.15
413951087002605	2-DG-5	07/31/95	1600	3.8	5.7	175	17.5	32	4.91
413951087002605	2-DG-5	09/11/95	1315	3.2	5.5	51	18.4	2.6	5.75
413951087002605	2-DG-5	09/21/95	1620	3.7	5.8	54	16.5	4.4	5.97
413951087002605	2-DG-5	11/01/95	0915	4.9	5.9	263	15.1	37	5.49
413951087002605	2-DG-5	12/07/95	1330	4.9	6.2	49	10.6	3.2	4.98
413951087002605	2-DG-5	01/11/96	0915	4.9	6.3	46	8.1	2.8	5.06
413951087002605	2-DG-5	02/07/96	1035	5.2	6.1	48	7.5	3.1	5.03
413951087002605	2-DG-5	03/14/96	1045	4.8	6.3	52	7.5	4.2	4.24
413951087002605	2-DG-5	04/11/96	0930	4.4	5.7	52	9.1	2.2	4.6
413951087002605	2-DG-5	05/09/96	1635	4.7	5.7	47	9.4	2.2	4
413951087002605	2-DG-5	06/12/96	1520	6.5	5.2	1290	12.6	360	2.95
413951087002605	2-DG-5	07/11/96	1625	5.4	5.2	792	14.9	220	4.11
413951087002605	2-DG-5	08/19/96	1740	--	5.6	--	--	230	4.39
413951087002605	2-DG-5	09/10/96	0805	5.1	5.6	385	16.3	100	5.15
413951087002605	2-DG-5	10/10/96	1430	5.3	5.8	222	14.8	33	4.61
413951087002605	2-DG-5	11/06/96	1700	6.5	5.4	253	14.2	56	4.44
413951087002605	2-DG-5	12/11/96	1535	6.6	6.3	249	10.6	55	4.05
413951087002605	2-DG-5	01/22/97	1245	6.8	6.9	89	8.5	7.1	4.1
413951087002605	2-DG-5	02/19/97	1025	6.5	6.9	72	7.1	3.6	3.78
413951087002605	2-DG-5	03/12/97	1830	6.3	7	74	6.5	5.4	3.35
413951087002605	2-DG-5	04/23/97	1145	6.4	5.9	253	8.2	52.4	3.63
413951087002605	2-DG-5	05/15/97	1015	6.4	5.5	1,020	8.6	297	3.75
413951087002605	2-DG-5	06/18/97	1045	5.7	5.9	1,030	11.6	280	3.23
413951087002605	2-DG-5	08/22/97	1045	5.1	5.5	1,380	15.8	--	4.23
413951087002606	2-DG-WT	12/20/94	1600	1.9	6.9	535	8.7	62	3.62
413951087002606	2-DG-WT	02/01/95	1123	2.9	7	590	6.2	65	3.38
413951087002606	2-DG-WT	02/28/95	1600	4.4	7.1	402	4.4	24	3.07
413951087002606	2-DG-WT	04/04/95	1415	4.1	7.1	412	6.6	40	3.31
413951087002606	2-DG-WT	04/26/95	1330	4.6	6.9	468	9	57	2.92
413951087002606	2-DG-WT	05/31/95	1045	2	6.9	687	13.8	130	2.95
413951087002606	2-DG-WT	06/26/95	1555	1.7	6.8	1,160	17.1	280	3.73

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conduct-ance (µS/cm)	Temper-ature (°C)	Chloride (mg/L)	Water level (ft BLS)
413951087002606	2-DG-WT	07/31/95	1430	2.5	6.7	980	20.4	240	4.47
413951087002606	2-DG-WT	09/11/95	1335	6.3	6.2	1,020	21.1	230	5.31
413951087002606	2-DG-WT	11/01/95	1215	7.7	6.4	316	16	65	5.05
413951087002606	2-DG-WT	12/07/95	1235	<6.2	6.6	531	9.4	69	4.55
413951087002606	2-DG-WT	01/11/96	1100	10.3	7.2	299	6.4	34	4.62
413951087002606	2-DG-WT	02/07/96	1000	11.2	7.3	267	6.2	40	4.58
413951087002606	2-DG-WT	03/14/96	1130	4.5	7.2	427	6.3	44	3.8
413951087002606	2-DG-WT	04/11/96	0855	4.2	6.8	507	8.6	34	4.17
413951087002606	2-DG-WT	05/09/96	1615	4.2	6.6	387	10.1	24	3.57
413951087002606	2-DG-WT	06/12/96	1425	1.1	6.9	399	14.7	33	2.53
413951087002606	2-DG-WT	07/11/96	1500	.9	6.7	944	17.1	210	3.69
413951087002606	2-DG-WT	08/19/96	1515	--	6.7	--	--	340	3.97
413951087002606	2-DG-WT	09/10/96	0825	3.9	6.4	769	17.7	180	4.72
413951087002606	2-DG-WT	10/10/96	1320	.6	6.7	901	14.9	150	4.16
413951087002606	2-DG-WT	11/06/96	1800	.7	6.7	952	13.3	160	4.01
413951087002606	2-DG-WT	12/11/96	1540	.7	7	693	8.6	99	3.61
413951087002606	2-DG-WT	01/22/97	1325	2	7.1	551	6.4	47	3.67
413951087002606	2-DG-WT	02/19/97	1115	2.8	7	475	5.6	26	3.35
413951087002606	2-DG-WT	03/12/97	1900	4.4	7	352	5.4	14	2.92
413951087002606	2-DG-WT	04/23/97	1300	3.6	7.1	466	8.3	65.7	3.2
413951087002606	2-DG-WT	05/15/97	1345	3.1	7	688	9.6	148	3.32
413951087002606	2-DG-WT	06/18/97	0945	.6	7	820	14	177	2.81
413953087002601	3-DG-1	12/14/94	1610	.2	7.6	811	11.3	8.8	1.35
413953087002601	3-DG-1	01/31/95	1215	.2	7.4	806	11	9.2	1.34
413953087002601	3-DG-1	02/28/95	0800	.2	7.7	774	10.3	8.8	1.23
413953087002601	3-DG-1	04/05/95	1000	.1	7.2	755	9.9	8.8	1.3
413953087002601	3-DG-1	04/27/95	0945	.3	7.5	766	10.3	9.1	1.11
413953087002601	3-DG-1	06/01/95	1330	.2	7.4	755	11.3	8.8	1.27
413953087002601	3-DG-1	06/28/95	1530	.2	7.6	789	11.7	9.1	1.27
413953087002601	3-DG-1	08/03/95	1605	.2	7.5	777	12	9	1.29
413953087002601	3-DG-1	09/07/95	1205	.2	7.9	808	12.1	8.8	2.78
413953087002601	3-DG-1	09/20/95	1300	.1	7.6	798	11.7	9	3.15
413953087002601	3-DG-1	11/06/95	1750	.1	7.4	769	11.8	9.3	1.51

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conduct-ance (μS/cm)	Temper-ature (°C)	Chloride (mg/L)	Water level (ft BLS)
413953087002601	3-DG-1	12/04/95	1435	0.1	7.2	783	11.9	11	1.67
413953087002601	3-DG-1	11/01/96	1330	.1	7.3	784	11.2	9.4	1.71
413953087002601	3-DG-1	02/07/96	1430	.1	7.4	782	11.3	9.1	1.88
413953087002601	3-DG-1	03/14/96	1645	.1	7.3	784	11	9.2	1.38
413953087002601	3-DG-1	04/11/96	1915	.1	7.6	796	11.2	9	1.58
413953087002601	3-DG-1	05/06/96	1930	.1	7.5	790	10.4	9.3	1.41
413953087002601	3-DG-1	06/13/96	1020	.1	7.6	822	11.2	8.9	1.14
413953087002601	3-DG-1	07/11/96	1205	.1	7.5	799	11.2	9.3	1.75
413953087002601	3-DG-1	08/13/96	1630	.1	7.5	802	11.4	9.4	1.65
413953087002601	3-DG-1	09/10/96	1430	.1	7.6	799	11.6	9.3	2.7
413953087002601	3-DG-1	10/10/96	0955	.1	7.6	803	11.2	9.5	1.39
413953087002601	3-DG-1	11/12/96	1805	.1	7.4	781	11.1	9.6	1.31
413953087002601	3-DG-1	12/10/96	1035	.1	7.3	803	11.4	9.5	1.3
413953087002601	3-DG-1	01/23/97	0735	.1	7.5	775	11	8.4	1.3
413953087002601	3-DG-1	02/12/97	1205	.1	7.5	778	10.9	8.9	1.27
413953087002601	3-DG-1	03/11/97	1605	.1	7.5	783	10.2	8.8	1.2
413953087002601	3-DG-1	04/23/97	1520	.1	7.5	770	10.4	8.8	1.24
413953087002601	3-DG-1	05/16/97	1050	.1	7.5	789	10.2	8.7	1.27
413953087002601	3-DG-1	06/17/97	0835	.1	7.7	795	10.1	8.6	1.12
413953087002601	3-DG-1	08/21/97	1325	.1	7.5	765	11	--	1.36
413953087002602	3-DG-2	12/15/94	1015	.3	7.5	859	11.4	5	1.52
413953087002602	3-DG-2	01/31/95	1245	.2	7.4	812	11.3	6.9	1.51
413953087002602	3-DG-2	02/28/95	0845	.2	7.6	779	10	6.6	1.41
413953087002602	3-DG-2	04/05/95	1445	.2	7.2	765	10	6.3	1.47
413953087002602	3-DG-2	04/27/95	1130	.2	7.4	778	10.1	6	1.38
413953087002602	3-DG-2	06/01/95	1400	.2	7.4	773	11.1	5.7	1.45
413953087002602	3-DG-2	06/28/95	1500	.2	7.4	814	11.6	5.9	1.35
413953087002602	3-DG-2	08/03/95	1500	.2	7.4	785	11.9	6.5	1.46
413953087002602	3-DG-2	09/07/95	1415	.1	7.7	809	12.1	6.3	2.97
413953087002602	3-DG-2	09/20/95	1445	.1	7.6	795	12.1	6.3	3.32
413953087002602	3-DG-2	11/06/95	1830	.1	7.5	789	12.1	4.5	2.42
413953087002602	3-DG-2	12/04/95	1600	.2	7.3	811	12.2	4.6	1.85
413953087002602	3-DG-2	01/11/96	1400	.1	7.3	828	11.5	4.5	1.89

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994-97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conduct-ance (μS/cm)	Temper-ature (°C)	Chloride (mg/L)	Water level (ft BLS)
413953087002602	3-DG-2	02/07/96	1335	0.2	7.3	845	11.2	6.1	2.1
413953087002602	3-DG-2	03/14/96	1525	.1	7.3	998	11	65	1.55
413953087002602	3-DG-2	04/11/96	1800	.1	7.4	935	<11.0	39	1.78
413953087002602	3-DG-2	05/06/96	1630	.1	7.4	885	10.1	32	1.59
413953087002602	3-DG-2	06/12/96	1800	.3	7.6	825	10.5	6.9	1.34
413953087002602	3-DG-2	07/11/96	1030	.1	7.5	796	10.8	6.3	1.91
413953087002602	3-DG-2	08/13/96	1325	.1	7.4	794	11.5	6.6	1.82
413953087002602	3-DG-2	09/10/96	1400	.1	7.5	799	11.7	6.4	2.87
413953087002602	3-DG-2	10/10/96	0905	.1	7.5	810	11.5	6.1	1.57
413953087002602	3-DG-2	11/12/96	1500	.1	7.3	782	11.5	6.5	1.5
413953087002602	3-DG-2	12/10/96	0930	.4	7.3	813	11.6	6.1	1.48
413953087002602	3-DG-2	01/23/97	0820	.1	7.4	771	10.8	5.7	1.46
413953087002602	3-DG-2	02/12/97	1030	.1	7.3	777	10.6	6	1.45
413953087002602	3-DG-2	03/11/97	1510	.1	7.4	770	10.2	6.3	1.39
413953087002602	3-DG-2	04/23/97	1440	.1	7.5	778	9.9	6.6	1.43
413953087002602	3-DG-2	05/16/97	0915	.1	7.5	793	9.7	6.5	1.45
413953087002602	3-DG-2	06/17/97	0925	.1	7.6	803	10	5.7	1.31
413953087002603	3-DG-3	12/15/94	1225	.2	7.4	389	11.9	13	1.5
413953087002603	3-DG-3	01/31/95	1305	.2	7.2	395	10.3	11	1.49
413953087002603	3-DG-3	02/28/95	0905	.2	7.5	405	9	11	1.39
413953087002603	3-DG-3	04/05/95	1145	.2	7.2	461	8.8	18	1.43
413953087002603	3-DG-3	04/27/95	1020	.3	7.3	512	9.1	30	1.33
413953087002603	3-DG-3	06/01/95	1230	.3	7	540	11.1	40	1.43
413953087002603	3-DG-3	06/28/95	1700	.2	7.1	603	11.2	54	1.39
413953087002603	3-DG-3	08/03/95	1625	.2	7.2	812	12.9	150	1.44
413953087002603	3-DG-3	09/07/95	1230	.1	7.7	631	13.2	74	2.92
413953087002603	3-DG-3	09/20/95	1400	.1	7.1	674	13.3	96	3.3
413953087002603	3-DG-3	11/03/95	1050	<.1	7.3	693	13	98	1.66
413953087002603	3-DG-3	12/04/95	1530	.1	7	449	12.7	31	1.83
413953087002603	3-DG-3	01/11/96	1435	.1	7.2	371	11	20	1.87
413953087002603	3-DG-3	02/07/96	1400	.1	7.2	367	10.3	18	2.03
413953087002603	3-DG-3	03/14/96	1705	.1	7.4	338	9.2	14	1.52
413953087002603	3-DG-3	04/11/96	1725	.1	7.2	358	9.9	14	1.75

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conduct-ance (µS/cm)	Temper-ature (°C)	Chloride (mg/L)	Water level (ft BLS)
413953087002603	3-DG-3	05/06/96	1705	0.1	7.5	381	9.1	17	1.56
413953087002603	3-DG-3	06/12/96	1820	.2	7.6	382	10.2	8.7	1.3
413953087002603	3-DG-3	07/11/96	1135	.1	7.3	427	10.9	12	1.87
413953087002603	3-DG-3	08/13/96	1805	.1	7.3	488	11.9	24	1.79
413953087002603	3-DG-3	09/10/96	1600	.1	7.3	450	12.5	14	2.83
413953087002603	3-DG-3	10/10/96	0755	.1	7.4	443	12.5	12	1.54
413953087002603	3-DG-3	11/12/96	1620	.1	7.2	434	12.2	10	1.47
413953087002603	3-DG-3	12/10/96	1150	.1	7	440	12	10	1.45
413953087002603	3-DG-3	01/23/97	0845	.1	7.2	433	10.1	9	1.45
413953087002603	3-DG-3	02/12/97	1305	.1	7.1	447	9.8	8.6	1.42
413953087002603	3-DG-3	03/11/97	1630	.1	7	436	8.9	9.2	1.35
413953087002603	3-DG-3	04/23/97	1415	.1	7.2	432	8.9	12.2	1.39
413953087002603	3-DG-3	05/16/97	0810	.2	7.2	463	8.9	10.4	1.42
413953087002603	3-DG-3	06/17/97	0900	.1	7.3	516	9.8	14.7	1.27
413953087002604	3-DG-4	12/15/94	1400	.2	5.3	205	11	22	1.57
413953087002604	3-DG-4	01/31/95	1330	.4	5.7	92	8.3	2.1	1.57
413953087002604	3-DG-4	02/28/95	0930	.3	6.1	99	7	3.8	1.46
413953087002604	3-DG-4	04/05/95	1300	.2	5.5	107	7.9	7.1	1.52
413953087002604	3-DG-4	04/27/95	1050	.2	5.6	128	8.4	7.5	1.39
413953087002604	3-DG-4	06/01/95	1200	.3	5.5	248	11.2	60	1.5
413953087002604	3-DG-4	06/28/95	1615	.3	5	565	12.2	150	1.46
413953087002604	3-DG-4	08/03/95	1545	.2	5	348	14.1	89	1.51
413953087002604	3-DG-4	09/07/95	1250	.2	4.8	330	15.5	76	3
413953087002604	3-DG-4	09/20/95	1320	.1	5.1	148	15.4	16	3.38
413953087002604	3-DG-4	11/06/95	1655	.2	5.1	117	13.9	22	1.76
413953087002604	3-DG-4	12/04/95	1620	.1	5	294	11.8	70	1.92
413953087002604	3-DG-4	01/11/96	1450	.1	4.7	551	9.3	130	1.95
413953087002604	3-DG-4	02/07/96	1305	.2	4.8	535	8.2	130	2.11
413953087002604	3-DG-4	03/14/96	1540	.2	5.3	206	7.4	51	1.61
413953087002604	3-DG-4	04/11/96	1640	.2	5.4	162	9	33	1.84
413953087002604	3-DG-4	05/06/96	1845	.1	5	274	8.5	50	1.65
413953087002604	3-DG-4	06/13/96	1050	.1	5	305	11.4	80	1.45
413953087002604	3-DG-4	07/11/96	1115	.1	5	399	12.2	110	1.93

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conduct-ance (μS/cm)	Temper-ature (°C)	Chloride (mg/L)	Water level (ft BLS)
413953087002604	3-DG-4	08/13/96	1535	0.1	4.9	302	13.8	72	1.88
413953087002604	3-DG-4	09/10/96	1525	.2	4.7	632	14.5	170	2.93
413953087002604	3-DG-4	10/10/96	0835	.1	5.2	180	13.9	27	1.64
413953087002604	3-DG-4	11/12/96	1700	.1	5.2	80	12.6	5.2	1.56
413953087002604	3-DG-4	12/10/96	1130	.5	5.3	70	11	3.6	1.55
413953087002604	3-DG-4	01/23/97	0900	.4	5.4	116	8.4	13	1.55
413953087002604	3-DG-4	02/12/97	0915	.4	5.3	106	7.7	17	1.52
413953087002604	3-DG-4	03/11/97	1530	.2	5.4	110	7.2	14	1.45
413953087002604	3-DG-4	04/23/97	1450	.3	5.1	183	8.1	21.2	1.49
413953087002604	3-DG-4	05/16/97	0955	.2	5.2	95	8.8	16.7	1.52
413953087002604	3-DG-4	06/17/97	1025	.3	5.3	617	10.3	170	1.37
413953087002604	3-DG-4	08/21/97	1355	.1	4.8	544	13.8	--	1.61
413953087002605	3-DG-5	12/15/94	0835	12.6	6.9	523	5.8	72	1.42
413953087002605	3-DG-5	01/31/95	1400	1	6.5	514	4.2	77	1.42
413953087002605	3-DG-5	02/28/95	1015	8	6.8	484	2.1	68	1.35
413953087002605	3-DG-5	04/06/95	1230	7.6	6.2	425	9.3	65	1.4
413953087002605	3-DG-5	04/27/95	1225	8.7	6.6	391	8.9	55	1.22
413953087002605	3-DG-5	06/01/95	1245	8.4	6.4	416	15.1	57	1.37
413953087002605	3-DG-5	06/28/95	1630	5.3	6.3	448	17.5	63	1.2
413953087002605	3-DG-5	08/03/95	1515	1.4	6.3	474	20.3	63	1.41
413953087002605	3-DG-5	11/06/95	1615	11.1	6.2	510	11.6	65	1.6
413953087002605	3-DG-5	12/04/95	1500	12.3	6.2	443	7.7	47	1.78
413953087002605	3-DG-5	01/11/96	1405	11.8	6.5	394	2.8	41	1.81
413953087002605	3-DG-5	02/07/96	1445	11.8	6.6	417	4.2	48	1.99
413953087002605	3-DG-5	03/14/96	1550	9.6	6.3	539	5	69	1.48
413953087002605	3-DG-5	04/11/96	1700	11	6.5	533	9.6	66	1.69
413953087002605	3-DG-5	05/06/96	1805	8.2	6.3	491	9.5	65	1.52
413953087002605	3-DG-5	06/13/96	1105	4.1	6.2	453	16.6	62	1.26
413953087002605	3-DG-5	07/11/96	1220	<8.4	6.3	456	18.5	70	1.85
413953087002605	3-DG-5	08/13/96	1720	<7.8	6.3	481	19.1	65	1.76
413953087002605	3-DG-5	09/10/96	1445	<6.8	6.7	528	19.7	74	2.8
413953087002605	3-DG-5	10/10/96	0815	9.2	6.5	547	13.4	73	1.5
413953087002605	3-DG-5	11/12/96	1535	10.1	6.4	513	9	66	1.43

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conduct-ance (µS/cm)	Temper-ature (°C)	Chloride (mg/L)	Water level (ft BLS)
413953087002605	3-DG-5	12/10/96	0900	13.6	5.9	545	5.9	81	1.41
413953087002605	3-DG-5	01/23/97	0750	12.1	6.7	481	3.2	77	1.41
413953087002605	3-DG-5	02/12/97	1400	12.2	6.6	468	3.7	79	1.38
413953087002605	3-DG-5	03/11/97	1650	6.9	6.7	392	4.5	68	1.31
413953087002605	3-DG-5	04/23/97	1530	9.8	6.5	393	8.4	62.8	1.34
413953087002605	3-DG-5	05/16/97	1125	10.1	6.3	408	11.3	3.1	1.38
413953087002605	3-DG-5	06/17/97	0935	6.3	6.7	411	14.2	59.4	1.23
413953087002606	3-DG-WT	12/15/94	1600	.3	6.3	534	8.1	98	2.17
413953087002606	3-DG-WT	01/31/95	1420	<.1	6.2	512	5.4	91	2.18
413953087002606	3-DG-WT	02/28/95	1030	.7	6.7	406	3.7	58	2.08
413953087002606	3-DG-WT	04/06/95	1015	.4	6.1	467	7.5	83	2.16
413953087002606	3-DG-WT	04/27/95	1150	.4	6.4	449	8.8	78	2
413953087002606	3-DG-WT	06/01/95	1415	.4	6.3	366	13	53	2.13
413953087002606	3-DG-WT	06/28/95	1600	.3	6.3	437	15.9	73	2.05
413953087002606	3-DG-WT	08/03/95	1430	.4	5.9	507	17.8	99	2.15
413953087002606	3-DG-WT	09/07/95	1340	.3	6.1	486	18.4	96	3.62
413953087002606	3-DG-WT	09/20/95	1340	.3	5.9	474	17.4	91	4
413953087002606	3-DG-WT	11/06/95	1525	.4	5.9	505	13	110	2.37
413953087002606	3-DG-WT	12/04/95	1350	.3	6	532	9.4	110	2.54
413953087002606	3-DG-WT	01/11/96	1250	.2	6.8	582	5.7	130	2.58
413953087002606	3-DG-WT	02/07/96	1530	.3	6.2	495	4.9	110	2.74
413953087002606	3-DG-WT	03/14/96	1615	.4	6.3	528	5.4	99	2.24
413953087002606	3-DG-WT	04/11/96	1835	.7	6.2	469	8	81	2.45
413953087002606	3-DG-WT	05/06/96	1720	.3	6.3	490	9	90	2.28
413953087002606	3-DG-WT	06/12/96	1710	1.4	6.3	441	13.6	64	2.04
413953087002606	3-DG-WT	07/11/96	1050	.2	6.2	412	15.5	71	2.59
413953087002606	3-DG-WT	08/13/96	1430	.3	6.2	445	16.9	75	2.51
413953087002606	3-DG-WT	09/10/96	1540	.3	6.1	447	17.2	69	3.54
413953087002606	3-DG-WT	10/10/96	0920	.4	6.3	453	14.3	67	2.26
413953087002606	3-DG-WT	11/12/96	1350	.4	6.1	415	11.4	65	2.19
413953087002606	3-DG-WT	12/10/96	0955	.5	6.2	501	7.9	88	2.17
413953087002606	3-DG-WT	01/23/97	0915	2.4	6.4	192	4.4	18	2.17
413953087002606	3-DG-WT	02/12/97	1505	.5	6.2	443	4.7	82	2.14

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conduct-ance (µS/cm)	Temper-ature (°C)	Chloride (mg/L)	Water level (ft BLS)
413953087002606	3-DG-WT	03/11/97	1715	0.4	6.3	476	5.2	92	2.08
413953087002606	3-DG-WT	04/23/97	1550	.4	6.2	354	7.8	59.2	2.12
413953087002606	3-DG-WT	05/16/97	1205	.4	6.2	353	10.4	57.1	2.15
413953087002606	3-DG-WT	06/17/97	0955	.3	6.7	409	13.4	35.1	2.01
413953087002606	3-DG-WT	08/21/97	1420	.3	6	414	16.9	--	2.24
413943087003202	REP-1-UG-3	08/02/95	0915	.3	5.9	313	11.3	27	4.78
413943087003202	REP-1-UG-3	09/07/95	0840	.2	6.3	349	12.1	34	5.56
413943087003202	REP-1-UG-3	09/26/95	0830	.1	5.9	357	11.6	37	5.97
413943087003202	REP-1-UG-3	11/02/95	0940	.1	5.5	375	11.7	35	7.13
413943087003202	REP-1-UG-3	12/05/95	1540	.1	6.2	356	11.1	34	5.19
413943087003202	REP-1-UG-3	01/11/96	1825	.1	5.6	346	10.4	35	5.36
413943087003202	REP-1-UG-3	02/09/96	0850	.1	5.6	311	10	28	5.11
413943087003202	REP-1-UG-3	03/13/96	0825	.2	5.8	249	9.4	21	4.63
413943087003202	REP-1-UG-3	04/11/96	1445	.1	6	185	10.6	14	4.6
413943087003202	REP-1-UG-3	05/07/96	1105	.2	5.9	173	9.3	13	3.91
413943087003202	REP-1-UG-3	06/11/96	1755	.1	5.9	212	9.8	15	2.05
413943087003202	REP-1-UG-3	07/12/96	0930	.1	6.1	227	10.4	14	3.44
413943087003202	REP-1-UG-3	08/16/96	1050	.1	6.1	208	11	12	3.96
413943087003202	REP-1-UG-3	09/10/96	1300	.1	6.1	230	11.6	14	4.91
413943087003203	REP-1-UG-5	08/02/95	0930	2	5.7	84	16	1.3	4.88
413943087003203	REP-1-UG-5	09/07/95	0900	8.5	5.1	45	19.1	1.5	5.67
413943087003203	REP-1-UG-5	09/26/95	0930	<9.6	5.8	40	14.4	1.7	6.07
413943087003203	REP-1-UG-5	12/05/95	1515	11.7	4.5	53	8.3	2.8	5.29
413943087003203	REP-1-UG-5	01/11/96	1900	7.8	4.9	48	6.1	2.7	5.46
413943087003203	REP-1-UG-5	02/09/96	0825	12.5	5.2	44	5.2	2.3	5.22
413943087003203	REP-1-UG-5	03/13/96	0840	10.6	5.2	46	5.3	2.2	4.73
413943087003203	REP-1-UG-5	04/11/96	1500	6.9	5.3	46	9.2	2.1	5.71
413943087003203	REP-1-UG-5	05/07/96	1020	7.1	5	44	8.6	2.2	4.01
413943087003203	REP-1-UG-5	06/11/96	1645	5.5	4.9	43	11.6	2.3	3.16
413943087003203	REP-1-UG-5	07/12/96	0840	3.3	5	46	13.9	2.4	3.56
413943087003203	REP-1-UG-5	08/16/96	1000	2.2	4.7	46	15.4	2	4.08
413943087003203	REP-1-UG-5	09/10/96	1210	<4.8	4.6	47	16	2.7	5.04
413943087003201	REP-1-UG-WT	12/21/94	1715	2.6	5.3	62	9	1.6	3.81
413943087003201	REP-1-UG-WT	01/31/95	1052	2.9	5.2	71	6.9	2.1	3.32

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conduct-ance (μS/cm)	Temper-ature (°C)	Chloride (mg/L)	Water level (ft BLS)
413943087003201	REP-1-UG-WT	02/27/95	1645	3.5	5.4	74	5.6	1.9	3.31
413943087003201	REP-1-UG-WT	03/29/95	1115	3.5	5	72	6.6	2.2	3.01
413943087003201	REP-1-UG-WT	04/25/95	1530	3.4	5	78	8.5	2.5	2.4
413943087003201	REP-1-UG-WT	05/31/95	1530	3.2	5.1	85	11.1	1.9	2.46
413943087003201	REP-1-UG-WT	06/28/95	1415	1.6	4.9	70	13.4	2.3	3.29
413943087003201	REP-1-UG-WT	08/02/95	0900	1.5	5	70	15.1	2.4	4.66
413943087003201	REP-1-UG-WT	09/07/95	0820	1.6	4.8	39	15.5	2.8	5.45
413943087003201	REP-1-UG-WT	09/26/95	0815	1.5	4.9	38	14.3	3	5.85
413943087003201	REP-1-UG-WT	11/02/95	1140	5.9	5.3	100	11.4	1.8	6.02
413943087003201	REP-1-UG-WT	12/05/95	1500	2.4	4.7	43	9.8	3.8	5.07
413943087003201	REP-1-UG-WT	01/11/96	1840	2.4	4.8	41	7.6	3.7	5.24
413943087003201	REP-1-UG-WT	02/09/96	0910	2.2	4.9	43	6.5	3.2	5
413943087003201	REP-1-UG-WT	03/13/96	0900	2.8	4.9	42	6.2	3.3	4.52
413943087003201	REP-1-UG-WT	04/11/96	1415	2.4	5.1	45	8.6	3.4	4.49
413943087003201	REP-1-UG-WT	05/07/96	0945	2.7	5	41	8.3	2.8	3.79
413943087003201	REP-1-UG-WT	06/11/96	1705	3.7	5	40	11.8	2.1	1.93
413943087003201	REP-1-UG-WT	07/12/96	0905	1.4	4.9	47	12.9	3	3.31
413943087003201	REP-1-UG-WT	08/16/96	0910	.9	4.9	43	14.4	2.3	3.84
413943087003201	REP-1-UG-WT	09/10/96	1235	1	4.8	42	15	2.2	4.79
413947087003201	REP-1-DG-3	12/13/94	1530	.2	6.7	423	11.5	18	3.75
413947087003201	REP-1-DG-3	02/01/95	1625	.2	6.5	427	10.6	21	3.59
413947087003201	REP-1-DG-3	03/01/95	1545	.2	6.6	422	9.5	23	3.32
413947087003201	REP-1-DG-3	03/30/95	1445	.3	6.6	374	9.7	24	3.3
413947087003201	REP-1-DG-3	04/26/95	1100	.3	6.5	380	10.1	26	3.03
413947087003201	REP-1-DG-3	05/31/95	1330	.3	6.7	429	11.5	30	3.08
413947087003201	REP-1-DG-3	06/27/95	1400	.3	6.9	417	11.3	28	4
413947087003201	REP-1-DG-3	08/01/95	0850	.3	7.1	361	12.1	24	4.75
413947087003201	REP-1-DG-3	09/05/95	1515	.2	6.5	339	13.2	22	5.37
413947087003201	REP-1-DG-3	09/20/95	1600	.1	6.5	329	12.6	21	5.7
413947087003201	REP-1-DG-3	10/31/95	1145	.2	6.4	353	12.8	21	5.41
413947087003201	REP-1-DG-3	12/06/95	0900	.2	6.4	358	12	23	4.82
413947087003201	REP-1-DG-3	01/11/96	1705	.1	6.4	303	11.4	18	4.94

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conduct-ance (µS/cm)	Temper-ature (°C)	Chloride (mg/L)	Water level (ft BLS)
413947087003201	REP-1-DG-3	02/05/96	1630	0.1	6.5	233	11	11	4.84
413947087003201	REP-1-DG-3	03/13/96	1410	.1	6.4	173	10.5	8.1	4.06
413947087003201	REP-1-DG-3	04/08/96	1720	.1	6.4	156	9.4	6.5	4.08
413947087003201	REP-1-DG-3	05/08/96	1125	.1	6.8	141	9.9	4.9	3.92
413947087003201	REP-1-DG-3	06/12/96	1030	.1	6.5	296	11.4	19	2.48
413947087003201	REP-1-DG-3	07/17/96	1515	.1	6.7	424	11.2	24	4.13
413947087003201	REP-1-DG-3	08/14/96	1045	.1	6.3	402	12.2	19	4.1
413947087003201	REP-1-DG-3	09/11/96	1545	.1	6.2	400	12.2	20	4.97
413947087003201	REP-1-DG-3	10/10/96	1615	.1	6.2	410	12.3	21	4.48
413947087003201	REP-1-DG-3	11/09/96	1140	.1	6.2	410	12.5	24	3.83
413947087003201	REP-1-DG-3	12/10/96	1355	.1	6.2	398	12.1	23	3.85
413947087003201	REP-1-DG-3	01/22/97	1615	.1	6.3	292	10.9	14	3.94
413947087003201	REP-1-DG-3	02/14/97	1250	.1	6.3	203	10.6	8.4	3.57
413947087003201	REP-1-DG-3	03/12/97	1620	.2	6.5	176	9.8	8.5	3.03
413947087003201	REP-1-DG-3	04/24/97	1325	.1	6.3	224	9.5	12.4	3.38
413947087003201	REP-1-DG-3	05/21/97	1235	.1	6.4	316	10	19	3.47
413947087003201	REP-1-DG-3	06/18/97	1355	.1	6.5	391	10.3	23.1	2.94
413947087003202	REP-1-DG-5	12/13/94	1650	.2	6.2	176	10.4	21	3.81
413947087003202	REP-1-DG-5	02/01/95	1650	.3	6.1	104	7.3	3.3	3.65
413947087003202	REP-1-DG-5	03/01/95	1615	<.1	6.3	99	5.5	1.6	3.37
413947087003202	REP-1-DG-5	03/30/95	1600	<.1	6.2	125	7	8.1	3.36
413947087003202	REP-1-DG-5	04/26/95	1130	.3	6.2	99	8.4	1.3	3.09
413947087003202	REP-1-DG-5	05/31/95	1345	.3	6.1	111	12.3	1.3	3.12
413947087003202	REP-1-DG-5	06/27/95	1430	.3	6.4	85	14.9	1.1	4.05
413947087003202	REP-1-DG-5	08/01/95	0915	.3	6.9	105	18	1.8	4.81
413947087003202	REP-1-DG-5	09/05/95	1540	.2	5.8	82	19.1	1.7	5.42
413947087003202	REP-1-DG-5	09/20/95	1535	.1	5.9	84	18.5	1.6	5.75
413947087003202	REP-1-DG-5	10/31/95	1400	.2	5.8	102	15.1	1.1	5.46
413947087003202	REP-1-DG-5	12/06/95	0920	.2	5.9	95	10.6	.9	4.87
413947087003202	REP-1-DG-5	01/11/96	1720	.2	6.1	78	8.2	1.5	4.99
413947087003202	REP-1-DG-5	02/05/96	1655	.1	6	82	7	1.2	4.89
413947087003202	REP-1-DG-5	03/13/96	1345	.2	5.9	58	6.6	1	4.11
413947087003202	REP-1-DG-5	04/08/96	1740	.1	5.9	67	6.3	2.3	4.49
413947087003202	REP-1-DG-5	05/08/96	1145	.1	6.2	82	9.2	2.3	4.07

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conduct-ance (µS/cm)	Temper-ature (°C)	Chloride (mg/L)	Water level (ft BLS)
413947087003202	REP-1-DG-5	06/12/96	0940	0.2	5.7	2,350	13.1	720	2.53
413947087003202	REP-1-DG-5	07/17/96	1530	.1	6.1	88	15.7	4.3	4.18
413947087003202	REP-1-DG-5	08/14/96	1135	.1	5.9	150	17.7	12	4.15
413947087003202	REP-1-DG-5	09/11/96	1605	.1	6	138	17.9	6.7	5.01
413947087003202	REP-1-DG-5	10/10/96	1630	.1	5.9	100	16	4.4	4.52
413947087003202	REP-1-DG-5	11/09/96	1055	.1	6	86	14	1.7	3.88
413947087003202	REP-1-DG-5	12/10/96	1330	.2	5.9	72	10.6	.9	3.9
413947087003202	REP-1-DG-5	01/22/97	1550	.2	6.2	74	7.6	1.4	3.98
413947087003202	REP-1-DG-5	02/14/97	1145	.2	6.1	81	6.7	1.3	3.61
413947087003202	REP-1-DG-5	03/12/97	1640	.2	6.2	854	6	270	3.11
413947087003202	REP-1-DG-5	04/24/97	1300	.2	5.9	2,520	7.7	774	3.43
413947087003202	REP-1-DG-5	05/21/97	1125	.3	6.2	186	10.4	62.4	3.51
413947087003202	REP-1-DG-5	06/18/97	1330	.1	6.3	416	12.8	91.1	2.98
413948087003201	REP-2-DG-3	12/16/94	0830	.2	6.4	463	11.7	16	3.11
413948087003201	REP-2-DG-3	01/31/95	1545	.3	6.6	437	11.3	13	2.91
413948087003201	REP-2-DG-3	03/01/95	1445	.2	6.9	440	10.2	13	2.69
413948087003201	REP-2-DG-3	04/06/95	1615	.2	6.4	461	11.4	15	2.88
413948087003201	REP-2-DG-3	04/27/95	1715	.2	6.6	471	10.1	15	2.23
413948087003201	REP-2-DG-3	05/31/95	1645	.3	6.8	481	11.3	19	2.55
413948087003201	REP-2-DG-3	06/27/95	1515	.2	7.5	496	11.1	22	3.32
413948087003201	REP-2-DG-3	08/02/95	1100	.2	6.6	488	11.9	26	4.06
413948087003201	REP-2-DG-3	09/08/95	0850	.2	6.9	484	11.6	28	4.6
413948087003201	REP-2-DG-3	09/26/95	1015	.1	6.6	492	12	30	4.96
413948087003201	REP-2-DG-3	11/07/95	1430	.2	6.5	499	12	29	4.22
413948087003201	REP-2-DG-3	12/06/95	1045	.1	6.5	485	11.9	28	4
413948087003201	REP-2-DG-3	01/11/96	1605	.1	6.5	483	11.7	27	4.1
413948087003201	REP-2-DG-3	02/05/96	1505	.1	6.6	483	11.6	26	4.08
413948087003201	REP-2-DG-3	03/13/96	1255	.1	6.5	476	11.4	24	3.28
413948087003201	REP-2-DG-3	04/08/96	1825	.1	6.6	478	10.2	23	4.68
413948087003201	REP-2-DG-3	05/08/96	1025	.1	7	466	10.6	20	3.22
413948087003201	REP-2-DG-3	06/12/96	1105	.1	6.8	427	10.9	16	2.03
413948087003201	REP-2-DG-3	07/17/96	1445	.1	7.4	386	11	16	3.53
413948087003201	REP-2-DG-3	08/14/96	0830	.1	6.8	332	11.3	15	3.42

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conduct-ance (μS/cm)	Temper-ature (°C)	Chloride (mg/L)	Water level (ft BLS)
413948087003201	REP-2-DG-3	09/11/96	1655	0.1	7.1	330	11.8	16	4.19
413948087003201	REP-2-DG-3	10/10/96	1700	.1	6.7	371	11.6	20	3.64
413948087003201	REP-2-DG-3	11/09/96	1010	.1	6.6	432	11.9	23	3.05
413948087003201	REP-2-DG-3	12/10/96	1430	.1	6.5	482	12.1	23	3.14
413948087003201	REP-2-DG-3	01/22/97	1515	.2	6.6	485	11.6	19	3.21
413948087003201	REP-2-DG-3	02/14/97	1045	.2	6.5	466	11.4	18	2.9
413948087003201	REP-2-DG-3	03/12/97	1530	.2	6.7	444	10.6	16	2.49
413948087003201	REP-2-DG-3	04/24/97	1410	.1	6.5	462	10.2	19.7	2.78
413948087003201	REP-2-DG-3	05/21/97	1425	.1	6.5	458	10.2	19.3	2.85
413948087003201	REP-2-DG-3	06/18/97	1525	.1	6.6	429	10.3	18.2	2.43
413948087003202	REP-2-DG-5	12/16/94	1010	.2	6	481	10.1	94	3.15
413948087003202	REP-2-DG-5	01/31/95	1615	.2	6	298	7.9	41	2.97
413948087003202	REP-2-DG-5	03/01/95	1500	<.1	6.3	339	5.5	63	2.71
413948087003202	REP-2-DG-5	04/06/95	1500	.3	5.9	244	8.8	39	2.92
413948087003202	REP-2-DG-5	04/27/95	1645	.3	5.9	614	8.2	160	2.27
413948087003202	REP-2-DG-5	05/31/95	1710	.5	6.1	524	11.4	150	2.59
413948087003202	REP-2-DG-5	06/27/95	1530	.2	7.3	131	13.1	11	3.37
413948087003202	REP-2-DG-5	08/02/95	1030	.4	6	106	15.6	1	4.13
413948087003202	REP-2-DG-5	09/08/95	0825	.3	6.5	62	15.6	.7	4.66
413948087003202	REP-2-DG-5	09/26/95	1030	.2	6	65	15.3	2	5.02
413948087003202	REP-2-DG-5	11/07/95	1450	.2	6	71	12.7	1.8	4.28
413948087003202	REP-2-DG-5	12/06/95	1015	.3	5.9	76	9.8	3	4.06
413948087003202	REP-2-DG-5	01/11/96	1625	.1	6	82	8.1	2.7	4.17
413948087003202	REP-2-DG-5	02/05/96	1530	.1	6.1	105	7.4	5.3	4.14
413948087003202	REP-2-DG-5	03/13/96	1310	.1	5.8	201	7.2	13	3.33
413948087003202	REP-2-DG-5	04/08/96	1845	.2	5.9	119	6.6	5	4.74
413948087003202	REP-2-DG-5	05/08/96	0945	.2	6	195	9.3	39	3.27
413948087003202	REP-2-DG-5	06/12/96	1140	.1	5.9	759	11.8	200	2.09
413948087003202	REP-2-DG-5	07/17/96	1420	.1	5.7	1,250	13.8	380	3.5
413948087003202	REP-2-DG-5	08/14/96	0910	.1	5.7	2,000	14.7	580	3.48
413948087003202	REP-2-DG-5	09/11/96	1630	.1	6	543	15.4	110	4.27
413948087003202	REP-2-DG-5	10/10/96	1715	.1	6.5	146	13.8	14	3.7
413948087003202	REP-2-DG-5	11/09/96	0910	.2	6.2	128	12.3	11	3.11
413948087003202	REP-2-DG-5	12/10/96	1445	.2	6	135	9.9	7.6	3.2
413948087003202	REP-2-DG-5	01/22/97	1530	.2	6.3	86	7.8	3.1	3.28

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Calcium (mg/L)	Magne-sium (mg/L)	Sodium (mg/L)	Potas-sium (mg/L)	ANC-FET (mg/L as $CaCO_3$)	ANC-IT (mg/L as $CaCO_3$)	ANC-CO_3 (mg/L as CO_3)	ANC-HCO_3 (mg/L as HCO_3)
413946087002601	1-UG-1	12/19/94	1615	64	52	45	3.8	469	473	0	577
413946087002601	1-UG-1	03/30/95	0920	61	53	47	3.9	470	479	0	585
413946087002601	1-UG-1	11/03/95	1135	70	56	48	3.8	465	469	0	572
413946087002601	1-UG-1	02/08/96	1525	68	54	49	3.7	458	463	0	565
413946087002601	1-UG-1	05/08/96	1830	60	51	48	4.1	457	461	0	563
413946087002601	1-UG-1	08/21/96	0800	60	52	48	4	450	460	0	561
413946087002601	1-UG-1	11/13/96	0910	58	49	47	3.7	449	465	0	567
413946087002601	1-UG-1	02/13/97	0940	63	53	49	4.1	450	460	0	561
413946087002601	1-UG-1	05/14/97	0835	66.8	53.2	49.4	4.2	440	445	0	543
413946087002602	1-UG-2	12/19/94	1800	63	50	13	2.1	380	384	0	469
413946087002602	1-UG-2	03/30/95	1245	60	53	15	2.1	397	402	0	491
413946087002602	1-UG-2	11/02/95	1325	74	58	20	2.2	414	418	0	510
413946087002602	1-UG-2	02/08/96	1325	70	55	21	2.2	414	418	0	510
413946087002602	1-UG-2	05/08/96	1600	59	51	21	2.3	387	388	0	473
413946087002602	1-UG-2	08/21/96	1035	53	47	20	2.2	345	350	0	427
413946087002602	1-UG-2	11/13/96	1200	57	48	19	2.2	378	387	0	472
413946087002602	1-UG-2	02/13/97	1150	67	55	19	2.5	413	420	0	513
413946087002602	1-UG-2	05/14/97	0935	73.2	56.2	19.2	2.5	405	407	0	497
413946087002603	1-UG-3	12/21/94	1000	26	9	4.2	1.8	37	37	0	45
413946087002603	1-UG-3	03/29/95	1355	25	8.5	4	1.6	37	37	0	45
413946087002603	1-UG-3	11/02/95	1130	24	7.4	4.4	1.5	42	43	0	52
413946087002603	1-UG-3	02/08/96	0830	20	6.3	4.2	1.3	33	34	0	41
413946087002603	1-UG-3	05/09/96	0920	24	8.6	4.6	1.6	55	54	0	66
413946087002603	1-UG-3	08/20/96	1545	30	11	5.7	1.7	63	66	0	81
413946087002603	1-UG-3	11/13/96	1415	26	10	5.5	1.5	51	50	0	61
413946087002603	1-UG-3	02/13/97	1255	26	9.5	5.5	1.6	59	59	0	72
413946087002603	1-UG-3	05/13/97	1435	27.4	9.56	5.7	1.7	56	55	0	67
413946087002604	1-UG-4	12/21/94	1135	4.8	1.5	1.2	2	4	3	0	4
413946087002604	1-UG-4	03/30/95	1045	6.2	2.1	1.4	2.2	4	4	0	4
413946087002604	1-UG-4	11/02/95	1605	5.2	1.7	1.2	2	6	6	0	7

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Calcium (mg/L)	Magne-sium (mg/L)	Sodium (mg/L)	Potas-sium (mg/L)	ANC-FET (mg/L as $CaCO_3$)	ANC-IT (mg/L as $CaCO_3$)	ANC-CO_3 (mg/L as CO_3)	ANC-HCO_3 (mg/L as HCO_3)
413946087002604	1-UG-4	02/08/96	1000	6.3	2.2	1.5	2	6	6	0	7
413946087002604	1-UG-4	05/08/96	1525	5.4	1.6	1.3	1.9	5	5	0	6
413946087002604	1-UG-4	08/20/96	1310	4.5	1.4	1	1.7	4	4	0	4
413946087002604	1-UG-4	11/13/96	1500	5.2	1.8	1.2	1.7	5	4	0	5
413946087002604	1-UG-4	02/13/97	1030	5.3	1.8	1.1	1.7	5	4	0	4
413946087002604	1-UG-4	05/13/97	1555	5.28	1.67	1.3	2	6	5	0	6
413946087002605	1-UG-5	12/21/94	1325	14	5.6	1.3	<.1	37	36	0	44
413946087002605	1-UG-5	03/29/95	1630	23	9.2	1.7	<.1	75	74	0	90
413946087002605	1-UG-5	02/08/96	1245	11	5.8	1.5	<.1	39	39	0	48
413946087002605	1-UG-5	05/08/96	1745	16	7	1.3	<.1	50	48	0	59
413946087002605	1-UG-5	08/20/96	0900	15	8.5	.9	.3	73	74	0	90
413946087002605	1-UG-5	11/13/96	1330	18	12	1.7	.3	84	87	0	106
413946087002605	1-UG-5	02/13/97	1400	14	6.6	1.2	0.1	56	56	0	68
413946087002605	1-UG-5	05/14/97	1415	24.4	10.8	1.1	<.1	79	77	0	94
413946087002606	1-UG-WT	12/21/94	1525	8.9	4	1.2	.2	26	26	0	32
413946087002606	1-UG-WT	03/29/95	1520	12	6	1.5	.1	44	44	0	54
413946087002606	1-UG-WT	11/07/95	0900	5.4	2.3	1.1	.3	5	4	0	5
413946087002606	1-UG-WT	02/08/96	1030	5.8	2.5	.8	.1	8	7	0	8
413946087002606	1-UG-WT	05/09/96	1020	9	4.2	1.2	<.1	24	24	0	29
413946087002606	1-UG-WT	08/20/96	1210	10	--	.9	<.1	25	25	0	31
413946087002606	1-UG-WT	11/13/96	1100	7.1	3.2	.8	<.1	21	21	0	26
413946087002606	1-UG-WT	02/13/97	1500	11	5.5	1	<.1	37	37	0	45
413946087002606	1-UG-WT	05/14/97	1020	15.5	7.78	1.2	<.1	62	62	0	75
413947087002601	ALT-1-UG-1	11/03/95	0935	73	57	46	3.8	464	469	0	572
413947087002601	ALT-1-UG-1	02/08/96	1445	70	54	46	3.7	463	466	0	569
413947087002601	ALT-1-UG-1	05/08/96	1915	62	52	45	3.7	463	469	0	572
413947087002601	ALT-1-UG-1	08/21/96	0900	55	53	45	3.9	462	470	0	574
413947087002602	ALT-1-UG-2	11/02/95	1450	76	64	21	2.6	444	450	0	549
413947087002602	ALT-1-UG-2	02/08/96	1405	71	59	24	2.6	444	450	0	549
413947087002602	ALT-1-UG-2	05/08/96	1650	65	58	24	2.6	453	460	0	561
413947087002602	ALT-1-UG-2	08/21/96	0945	65	59	24	2.7	448	460	0	561

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	ANC-FET (mg/L as $CaCO_3$)	ANC-IT (mg/L as $CaCO_3$)	ANC-CO_3 (mg/L as CO_3)	ANC-HCO_3 (mg/L as HCO_3)
413947087002603	ALT-1-UG-3	11/02/95	1000	23	5.4	3.9	1.4	34	36	0	44
413947087002603	ALT-1-UG-3	02/08/96	0900	24	5.5	3.7	1.3	38	38	0	46
413947087002603	ALT-1-UG-3	05/09/96	0830	19	4.6	3.3	1.3	34	32	0	38
413947087002603	ALT-1-UG-3	08/20/96	1455	23	5.6	3.9	1.4	37	38	0	46
413947087002604	ALT-1-UG-4	11/02/95	1525	5.9	2.1	1.4	2.1	10	8	0	10
413947087002604	ALT-1-UG-4	02/08/96	0930	6.2	1.9	1.3	1.9	7	7	0	9
413947087002604	ALT-1-UG-4	05/08/96	1500	5.7	1.9	1.4	1.7	7	6	0	8
413947087002604	ALT-1-UG-4	08/20/96	1400	4.9	1.4	1.2	2	6	7	0	8
413947087002605	ALT-1-UG-5	11/07/95	1040	7	2.7	1.2	.1	17	17	0	20
413947087002605	ALT-1-UG-5	02/08/96	1200	6.1	2.2	1.6	<.1	11	10	0	12
413947087002605	ALT-1-UG-5	05/08/96	1725	5.2	2.3	1.5	<.1	10	8	0	10
413947087002605	ALT-1-UG-5	08/20/96	0945	4.5	2.2	3.6	<.1	11	11	0	13
413947087002605	ALT-1-UG-5	11/13/96	1245	6.3	3	1.2	<.1	8	8	0	9
413947087002605	ALT-1-UG-5	02/13/97	1620	6	3.2	1.7	<.1	7	5	0	6
413947087002605	ALT-1-UG-5	05/14/97	1255	8.03	5.53	2.3	<.1	39	39	0	47
413947087002606	ALT-1-UG-WT	11/07/95	0930	6.8	2.1	1.1	.2	10	9	0	11
413947087002606	ALT-1-UG-WT	02/08/96	1105	3.9	1.6	1.1	<.1	9	8	0	10
413947087002606	ALT-1-UG-WT	05/09/96	1000	9.3	4.2	1.4	<.1	20	20	0	24
413947087002606	ALT-1-UG-WT	08/20/96	1050	8.5	4.6	1.4	<.1	20	20	0	24
413947087002606	ALT-1-UG-WT	11/13/96	1010	7.5	3.7	1.4	<.1	18	18	0	22
413947087002606	ALT-1-UG-WT	02/13/97	1720	11	5.5	1.7	<.1	28	26	0	32
413947087002606	ALT-1-UG-WT	05/14/97	1200	13.1	7.49	1.9	<.1	31	29	0	35
413950087002601	1-DG-1	12/13/94	1050	65	54	36	3.4	466	468	0	571
413950087002601	1-DG-1	03/27/95	1550	61	55	36	3.6	459	462	0	564
413950087002601	1-DG-1	11/01/95	1225	68	57	38	3.5	450	454	0	554
413950087002601	1-DG-1	02/06/96	1145	67	57	37	3.5	445	455	0	555
413950087002601	1-DG-1	05/07/96	1905	64	54	37	3.6	460	457	0	558
413950087002601	1-DG-1	08/15/96	1140	60	53	36	3.5	445	450	0	549
413950087002601	1-DG-1	11/07/96	1435	63	54	37	3.6	458	465	0	567
413950087002601	1-DG-1	02/11/97	1615	62	52	36	3.7	470	470	0	574
413950087002601	1-DG-1	05/20/97	1400	66.8	54.1	36.9	3.6	458	465	0	567

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	ANC-FET (mg/L as $CaCO_3$)	ANC-IT (mg/L as $CaCO_3$)	ANC-CO_3 (mg/L as CO_3)	ANC-HCO_3 (mg/L as HCO_3)
413950087002602	1-DG-2	12/13/94	1235	70	57	20	2.4	457	459	0	560
413950087002602	1-DG-2	03/28/95	0925	67	60	21	2.9	444	435	0	531
413950087002602	1-DG-2	10/31/95	1535	68	57	20	2.7	462	474	0	578
413950087002602	1-DG-2	02/06/96	1455	66	57	19	2.5	404	411	0	502
413950087002602	1-DG-2	05/07/96	1630	64	54	19	2.5	400	405	0	494
413950087002602	1-DG-2	08/15/96	1040	60	52	20	2.5	396	400	0	488
413950087002602	1-DG-2	11/07/96	1135	63	52	20	2.5	392	400	0	488
413950087002602	1-DG-2	02/11/97	1710	63	51	20	2.6	411	415	0	506
413950087002602	1-DG-2	05/20/97	1705	69.9	57.8	18.7	2.5	452	455	0	555
413950087002603	1-DG-3	12/12/94	1455	30	12	4.6	1.1	94	93	0	113
413950087002603	1-DG-3	03/27/95	1410	34	16	5.1	1.2	109	107	0	131
413950087002603	1-DG-3	10/30/95	1630	36	18	5.5	1.5	99	98	0	120
413950087002603	1-DG-3	02/06/96	1735	49	25	6.3	1.4	148	152	0	185
413950087002603	1-DG-3	05/08/96	0840	46	22	6.5	1.5	146	147	0	179
413950087002603	1-DG-3	08/15/96	1515	40	18	7.2	1.4	102	104	0	127
413950087002603	1-DG-3	11/07/96	1705	43	19	7.2	.3	113	115	0	140
413950087002603	1-DG-3	02/11/97	0835	44	20	7	1.5	121	123	0	150
413950087002603	1-DG-3	05/20/97	1455	36.5	17	6	1.3	100	100	0	122
413950087002604	1-DG-4	12/12/94	1615	5	1.1	1.6	1.1	5	4	0	5
413950087002604	1-DG-4	03/28/95	1410	4.7	1	1.4	.7	4	2	0	3
413950087002604	1-DG-4	10/31/95	1315	3.6	.8	1.4	.7	7	8	0	10
413950087002604	1-DG-4	02/06/96	1705	3.7	.8	1.3	.6	0	1	0	2
413950087002604	1-DG-4	05/07/96	1820	3.2	.73	1.8	.6	3	2	0	3
413950087002604	1-DG-4	08/14/96	1540	3.7	.84	1.4	.6	2	2	0	3
413950087002604	1-DG-4	11/07/96	1745	3.8	.83	1.4	.6	2	3	0	3
413950087002604	1-DG-4	02/11/97	1505	3.5	.79	1.3	.6	4	1	0	1
413950087002604	1-DG-4	05/20/97	1605	3.74	.83	1.4	.6	3	2	0	2
413950087002605	1-DG-5	12/13/94	0920	3.8	1	1.5	<.1	2	4	0	5
413950087002605	1-DG-5	03/28/95	1100	30	9.4	110	1.3	1	1	0	1
413950087002605	1-DG-5	11/01/95	1505	3.4	1	1.6	.2	4	4	0	5
413950087002605	1-DG-5	02/06/96	1320	3.6	1	1.4	.2	2	2	0	3

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Calcium (mg/L)	Magne-sium (mg/L)	Sodium (mg/L)	Potas-sium (mg/L)	ANC-FET (mg/L as $CaCO_3$)	ANC-IT (mg/L as $CaCO_3$)	ANC-CO_3 (mg/L as CO_3)	ANC-HCO_3 (mg/L as HCO_3)
413950087002605	1-DG-5	05/07/96	1655	6	1.6	12	.4	3	2	0	2
413950087002605	1-DG-5	08/15/96	1615	2.9	.83	1.8	.2	2	1	0	1
413950087002605	1-DG-5	11/07/96	1535	3.4	1.2	1.9	.3	2	1	0	1
413950087002605	1-DG-5	02/11/97	0950	3.4	1	1.4	.2	4	2	0	3
413950087002605	1-DG-5	05/21/97	0905	2.06	.52	3.9	.2	4	3	0	3
413950087002606	1-DG-WT	12/12/94	1340	4.3	.78	60	.7	94	95	0	116
413950087002606	1-DG-WT	03/28/95	1235	68	12	480	2	95	94	0	115
413950087002606	1-DG-WT	10/31/95	0900	7.8	2.3	4.2	0.2	21	21	0	26
413950087002606	1-DG-WT	02/06/96	1520	4.3	1.3	13	.2	21	23	0	28
413950087002606	1-DG-WT	05/07/96	1350	71	16	310	1.6	43	44	0	54
413950087002606	1-DG-WT	08/14/96	1630	9.6	1.2	270	1.7	193	196	0	239
413950087002606	1-DG-WT	11/07/96	1220	2.7	.4	100	.5	158	160	0	195
413950087002606	1-DG-WT	02/11/97	1345	56	8.9	150	1	71	70	0	85
413950087002606	1-DG-WT	05/20/97	1210	55.1	8.45	541	2.9	99	100	0	122
413950087002501	ALT-1-DG-1	11/01/95	0845	140	56	39	3.5	442	445	0	543
413950087002501	ALT-1-DG-1	02/06/96	1055	66	55	39	3.4	439	460	0	561
413950087002501	ALT-1-DG-1	05/07/96	1945	63	53	37	3.5	462	468	0	571
413950087002501	ALT-1-DG-1	08/15/96	1330	54	54	37	3.4	466	470	0	574
413950087002502	ALT-1-DG-2	10/31/95	1605	62	49	15	1.9	349	355	0	433
413950087002502	ALT-1-DG-2	02/06/96	1420	61	45	14	1.8	307	315	0	384
413950087002502	ALT-1-DG-2	05/07/96	1540	51	39	13	1.5	254	254	0	310
413950087002502	ALT-1-DG-2	08/15/96	0945	53	41	13	1.7	284	290	0	354
413950087002503	ALT-1-DG-3	10/30/95	1550	22	6.3	4.4	1.4	37	38	0	46
413950087002503	ALT-1-DG-3	02/06/96	1805	36	11	5	1.7	68	70	0	85
413950087002503	ALT-1-DG-3	05/08/96	0810	32	9.1	5.1	1.7	56	55	0	67
413950087002503	ALT-1-DG-3	08/15/96	1425	20	5.9	4.7	1.3	37	36	0	44
413950087002504	ALT-1-DG-4	10/31/95	1140	3.4	.8	1.8	.4	5	4	0	5
413950087002504	ALT-1-DG-4	02/06/96	1640	3.4	1.8	1.5	.4	0	1	0	1
413950087002504	ALT-1-DG-4	05/07/96	1755	3.7	1.3	1.7	.4	2	1	0	1
413950087002504	ALT-1-DG-4	08/14/96	1445	3.5	1.1	1.6	0.4	1	0	0	0
413950087002505	ALT-1-DG-5	11/01/95	1640	3.9	1.3	1.5	.1	4	2	0	3

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Calcium (mg/L)	Magne-sium (mg/L)	Sodium (mg/L)	Potas-sium (mg/L)	ANC-FET (mg/L as $CaCO_3$)	ANC-IT (mg/L as $CaCO_3$)	ANC-CO_3 (mg/L as CO_3)	ANC-HCO_3 (mg/L as HCO_3)
413950087002505	ALT-1-DG-5	02/06/96	1345	3.7	1.4	1.3	.1	0	3	0	4
413950087002505	ALT-1-DG-5	05/07/96	1720	19	4.8	37	.5	4	3	0	4
413950087002505	ALT-1-DG-5	08/15/96	1730	2.3	.6	2.2	.2	3	2	0	3
413950087002505	ALT-1-DG-5	11/07/96	1620	3.7	1	1.7	<.1	3	2	0	3
413950087002505	ALT-1-DG-5	02/11/97	1110	3.6	1.1	1.6	<.1	6	3	0	4
413950087002505	ALT-1-DG-5	05/21/97	0950	1.87	.47	5.3	.2	3	2	0	3
413950087002506	ALT-1-DG-WT	11/07/95	1325	7.8	1.6	24	.2	53	54	0	65
413950087002506	ALT-1-DG-WT	02/06/96	1610	28	9.8	23	<.1	124	131	0	160
413950087002506	ALT-1-DG-WT	05/07/96	1435	47	11	100	.4	55	55	0	67
413950087002506	ALT-1-DG-WT	08/14/96	1750	17	2.4	270	.9	226	232	0	283
413950087002506	ALT-1-DG-WT	11/07/96	1330	4.2	.62	89	.2	165	169	0	206
413950087002506	ALT-1-DG-WT	02/11/97	1225	21	3.7	58	.3	89	89	0	109
413950087002506	ALT-1-DG-WT	05/20/97	1115	94.7	16.8	457	2.1	77	76	0	93
413951087002601	2-DG-1	12/20/94	0835	62	51	43	3.4	451	460	0	561
413951087002601	2-DG-1	04/04/95	1100	58	49	43	3.4	460	464	0	566
413951087002601	2-DG-1	11/01/95	1735	67	57	44	3.4	446	453	0	553
413951087002601	2-DG-1	02/07/96	0910	66	55	45	3.4	451	456	0	556
413951087002601	2-DG-1	05/09/96	1300	59	51	43	3.4	449	450	0	549
413951087002601	2-DG-1	08/19/96	1840	58	52	44	3.5	444	450	0	549
413951087002601	2-DG-1	11/06/96	1905	61	51	44	3.3	452	460	0	561
413951087002601	2-DG-1	02/19/97	1220	61	52	43	3.5	453	460	0	561
413951087002601	2-DG-1	05/15/97	1145	62.8	50.7	45	3.7	436	440	0	537
413951087002602	2-DG-2	12/20/94	1010	69	57	23	3.1	460	463	0	565
413951087002602	2-DG-2	04/03/95	1445	65	56	23	3.1	463	468	0	571
413951087002602	2-DG-2	11/01/95	1500	78	64	25	3.1	462	468	0	571
413951087002602	2-DG-2	02/07/96	0940	75	59	25	3	456	459	0	560
413951087002602	2-DG-2	05/09/96	1340	68	58	24	3.1	468	471	0	575
413951087002602	2-DG-2	08/19/96	1610	67	60	25	3.1	451	455	0	555
413951087002602	2-DG-2	11/06/96	2005	67	56	24	2.8	441	445	0	543
413951087002602	2-DG-2	02/19/97	0945	67	55	23	3	432	445	0	543
413951087002602	2-DG-2	05/15/97	1550	68.2	54.5	24	3.1	434	440	0	537

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	ANC-FET (mg/L as $CaCO_3$)	ANC-IT (mg/L as $CaCO_3$)	ANC-CO_3 (mg/L as CO_3)	ANC-HCO_3 (mg/L as HCO_3)
413951087002603	2-DG-3	12/20/94	1200	52	25	8	1.2	183	186	0	227
413951087002603	2-DG-3	04/04/95	0920	50	24	7.3	1.1	192	194	0	237
413951087002603	2-DG-3	11/01/95	1625	51	25	7.7	1.1	170	173	0	211
413951087002603	2-DG-3	02/07/96	0830	53	25	7.5	1.1	175	177	0	216
413951087002603	2-DG-3	05/09/96	1700	58	28	8.1	1	194	198	0	242
413951087002603	2-DG-3	08/19/96	1700	57	30	8.6	1.3	218	222	0	271
413951087002603	2-DG-3	11/06/96	1520	60	30	9.4	.2	211	215	0	262
413951087002603	2-DG-3	02/18/97	1400	59	30	9.3	1.2	214	220	0	268
413951087002603	2-DG-3	05/15/97	1250	58.8	28.2	8.9	1.2	201	204	0	249
413951087002604	2-DG-4	12/20/94	1305	4.5	1.7	1.9	.6	2	2	0	2
413951087002604	2-DG-4	04/03/95	1610	4	1.4	1.5	.5	3	3	0	4
413951087002604	2-DG-4	11/01/95	1345	4.1	1.3	1.9	0.3	2	1	0	1
413951087002604	2-DG-4	02/07/96	1100	4	1.1	1.5	.3	2	1	0	1
413951087002604	2-DG-4	05/09/96	1405	3.5	1	1.7	.3	5	3	0	3
413951087002604	2-DG-4	08/19/96	1430	6	1.7	3	.6	2	2	0	3
413951087002604	2-DG-4	11/06/96	1610	4.1	1.1	1.9	.1	2	1	0	1
413951087002604	2-DG-4	02/18/97	1455	3.7	1.2	1.4	.5	3	1	0	1
413951087002604	2-DG-4	05/15/97	1445	17.5	4.19	8.6	1.3	3	1	0	1
413951087002605	2-DG-5	12/20/94	1425	9.1	2.7	21	.3	12	12	0	14
413951087002605	2-DG-5	04/04/95	1245	1.5	.48	17	.1	18	17	0	21
413951087002605	2-DG-5	11/01/95	0915	4.2	1.2	44	.3	20	20	0	24
413951087002605	2-DG-5	02/07/96	1035	4.6	1.5	3	.1	8	6	0	7
413951087002605	2-DG-5	05/09/96	1635	4.5	1.4	2.2	<.1	8	7	0	8
413951087002605	2-DG-5	08/19/96	1740	17	4.2	130	1	7	6	0	7
413951087002605	2-DG-5	11/06/96	1700	6.8	1.8	35	.8	5	6	0	7
413951087002605	2-DG-5	02/19/97	1025	.64	.42	14	.1	14	13	0	16
413951087002605	2-DG-5	05/15/97	1015	49.7	15.4	106	1.3	6	5	0	6
413951087002606	2-DG-WT	12/20/94	1600	6.2	1.7	100	.5	119	120	0	146
413951087002606	2-DG-WT	04/04/95	1415	10	3.7	78	.4	129	129	0	157
413951087002606	2-DG-WT	11/01/95	1215	5.1	1.7	56	.4	33	33	0	40
413951087002606	2-DG-WT	02/07/96	1000	4.8	1.4	52	.2	61	59	0	72

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	ANC-FET (mg/L as $CaCO_3$)	ANC-IT (mg/L as $CaCO_3$)	ANC-CO_3 (mg/L as CO_3)	ANC-HCO_3 (mg/L as HCO_3)
413951087002606	2-DG-WT	05/09/96	1615	11	4.6	66	.3	119	119	0	145
413951087002606	2-DG-WT	08/19/96	1515	29	7.8	220	1	137	138	0	168
413951087002606	2-DG-WT	11/06/96	1800	25	7.1	170	<0.1	184	186	0	227
413951087002606	2-DG-WT	02/19/97	1115	11	5.6	94	.3	190	195	0	238
413951087002606	2-DG-WT	05/15/97	1345	18.1	6.7	115	.4	106	108	0	132
413953087002601	3-DG-1	12/14/94	1610	63	53	33	3.1	444	449	0	548
413953087002601	3-DG-1	04/05/95	1000	61	52	30	3.2	452	457	0	558
413953087002601	3-DG-1	11/06/95	1750	69	56	34	3.2	433	435	0	531
413953087002601	3-DG-1	02/07/96	1430	67	55	36	3.1	437	444	0	542
413953087002601	3-DG-1	05/06/96	1930	63	53	34	3.3	437	435	0	531
413953087002601	3-DG-1	08/13/96	1630	63	55	32	3.1	437	444	0	542
413953087002601	3-DG-1	11/12/96	1805	60	51	31	3	442	451	0	550
413953087002601	3-DG-1	02/12/97	1205	64	54	32	3.2	439	450	0	549
413953087002601	3-DG-1	05/16/97	1050	65.8	53.5	32.3	3.3	449	455	0	555
413953087002602	3-DG-2	12/15/94	1015	74	61	23	3.4	483	487	0	594
413953087002602	3-DG-2	04/05/95	1445	66	55	23	2.8	452	455	0	555
413953087002602	3-DG-2	11/06/95	1830	80	64	20	2.9	452	456	0	556
413953087002602	3-DG-2	02/07/96	1335	85	68	19	2.8	454	460	0	561
413953087002602	3-DG-2	05/06/96	1630	69	57	41	3	397	394	0	481
413953087002602	3-DG-2	08/13/96	1325	66	57	24	2.8	425	429	0	523
413953087002602	3-DG-2	11/12/96	1500	70	58	23	3	431	440	0	537
413953087002602	3-DG-2	02/12/97	1030	68	57	23	2.8	428	430	0	525
413953087002602	3-DG-2	05/16/97	0915	70.7	56.1	22.5	2.8	449	455	0	555
413953087002603	3-DG-3	12/15/94	1225	40	16	12	1.8	138	139	0	170
413953087002603	3-DG-3	04/05/95	1145	53	21	7.5	1.3	180	184	0	225
413953087002603	3-DG-3	11/03/95	1050	45	22	59	1.7	155	154	0	188
413953087002603	3-DG-3	02/07/96	1400	32	14	28	1.4	126	126	0	154
413953087002603	3-DG-3	05/06/96	1705	37	16	18	1.3	138	138	0	168
413953087002603	3-DG-3	08/13/96	1805	54	24	7.1	1.3	165	166	0	203
413953087002603	3-DG-3	11/12/96	1620	47	21	9.9	1.3	166	168	0	205
413953087002603	3-DG-3	02/12/97	1305	54	23	6.8	1.2	173	180	0	220
413953087002603	3-DG-3	05/16/97	0810	58.1	21.8	6.9	1.3	179	180	0	220

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Calcium (mg/L)	Magne-sium (mg/L)	Sodium (mg/L)	Potas-sium (mg/L)	ANC-FET (mg/L as $CaCO_3$)	ANC-IT (mg/L as $CaCO_3$)	ANC-CO_3 (mg/L as CO_3)	ANC-HCO_3 (mg/L as HCO_3)
413953087002604	3-DG-4	12/15/94	1400	1.5	.29	32	.4	9	9	0	11
413953087002604	3-DG-4	04/05/95	1300	.54	.09	15	.2	10	8	0	10
413953087002604	3-DG-4	11/06/95	1655	3.1	.5	21	.3	2	4	0	4
413953087002604	3-DG-4	02/07/96	1305	17	4	78	.7	3	4	0	5
413953087002604	3-DG-4	05/06/96	1845	5.4	1.2	44	.4	6	5	0	6
413953087002604	3-DG-4	08/13/96	1535	11	2.4	40	.7	3	1	0	1
413953087002604	3-DG-4	11/12/96	1700	.72	.15	15	.2	9	9	0	11
413953087002604	3-DG-4	02/12/97	0915	1.4	.34	19	.2	7	6	0	7
413953087002604	3-DG-4	05/16/97	0955	3.55	.81	12.5	.3	5	5	0	6
413953087002605	3-DG-5	12/15/94	0835	33	11	48	3.5	126	128	0	156
413953087002605	3-DG-5	04/06/95	1230	25	7.8	42	2.7	89	90	0	110
413953087002605	3-DG-5	11/06/95	1615	36	10	52	3.2	78	78	0	95
413953087002605	3-DG-5	02/07/96	1445	35	11	34	2.1	96	98	0	120
413953087002605	3-DG-5	05/06/96	1805	34	11	44	2.4	86	86	0	105
413953087002605	3-DG-5	08/13/96	1720	30	8.6	50	2.8	104	108	0	132
413953087002605	3-DG-5	11/12/96	1535	37	12	48	2.2	122	125	0	153
413953087002605	3-DG-5	02/12/97	1400	28.5	8.96	52.5	1.5	75	76	0	93
413953087002605	3-DG-5	05/16/97	1125	9.07	2.85	21.9	1.1	74	77	0	94
413953087002606	3-DG-WT	12/15/94	1600	20	4.8	76	1.6	77	81	0	99
413953087002606	3-DG-WT	04/06/95	1015	18	4.6	67	1.6	80	82	0	100
413953087002606	3-DG-WT	11/06/95	1525	28	8.1	60	1.9	55	55	0	67
413953087002606	3-DG-WT	02/07/96	1530	23	5.6	68	1.4	48	50	0	61
413953087002606	3-DG-WT	05/06/96	1720	25	6.4	60	1.8	61	60	0	73
413953087002606	3-DG-WT	08/13/96	1430	3.8	3.8	62	1.4	50	51	0	62
413953087002606	3-DG-WT	11/12/96	1350	21	5.5	47	1.6	65	66	0	81
413953087002606	3-DG-WT	02/12/97	1505	22	4.9	59	1.6	47	48	0	59
413953087002606	3-DG-WT	05/16/97	1205	15.3	3.79	49.7	1.3	51	52	0	63
413943087003202	REP-1-UG-3	11/02/95	0940	33	13	19	.7	85	80	0	98
413943087003202	REP-1-UG-3	02/09/96	0850	32	11	18	.6	66	71	0	87
413943087003202	REP-1-UG-3	05/07/96	1105	15	5.3	12	.4	47	49	0	60
413943087003202	REP-1-UG-3	08/16/96	1050	20	7	10	.5	67	68	0	83

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Calcium (mg/L)	Magne-sium (mg/L)	Sodium (mg/L)	Potas-sium (mg/L)	ANC-FET (mg/L as $CaCO_3$)	ANC-IT (mg/L as $CaCO_3$)	ANC-CO_3 (mg/L as CO_3)	ANC-HCO_3 (mg/L as HCO_3)
413943087003203	REP-1-UG-5	02/09/96	0825	4	1.6	1.5	.1	3	2	0	3
413943087003203	REP-1-UG-5	05/07/96	1020	3.6	1.4	1.3	<.1	3	2	0	3
413943087003203	REP-1-UG-5	08/16/96	1000	3.3	1.3	1.8	<.1	3	2	0	2
413943087003201	REP-1-UG-WT	12/21/94	1715	3.6	1.2	1.4	.3	6	5	0	5
413943087003201	REP-1-UG-WT	03/29/95	1115	3.6	1.1	1.5	.2	3	1	0	1
413943087003201	REP-1-UG-WT	11/02/95	1140	3.1	1.7	1.7	0.6	3	3	0	3
413943087003201	REP-1-UG-WT	02/09/96	0910	4	1.2	1.8	.3	2	1	0	1
413943087003201	REP-1-UG-WT	05/07/96	0945	3.7	1	1.5	.3	4	2	0	3
413943087003201	REP-1-UG-WT	08/16/96	0910	2.1	1	2	.5	3	2	0	2
413947087003201	REP-1-DG-3	12/13/94	1530	46	17	8.6	6.1	161	163	0	199
413947087003201	REP-1-DG-3	03/30/95	1445	40	16	6.5	4.7	132	139	0	170
413947087003201	REP-1-DG-3	10/31/95	1145	32	15	13	4.2	126	130	0	159
413947087003201	REP-1-DG-3	02/05/96	1630	24	11	9.6	3	85	89	0	109
413947087003201	REP-1-DG-3	05/08/96	1125	13	5.7	7.7	2.3	57	56	0	68
413947087003201	REP-1-DG-3	08/14/96	1045	40	19	6.6	3.6	157	159	0	194
413947087003201	REP-1-DG-3	11/09/96	1140	39	17	17	3.7	149	150	0	183
413947087003201	REP-1-DG-3	02/14/97	1250	19	8.1	9.6	2.4	80	83	0	101
413947087003201	REP-1-DG-3	05/21/97	1235	28.8	12.5	11.1	3.1	107	108	0	132
413947087003202	REP-1-DG-5	12/13/94	1650	11	5	6.5	.6	36	35	0	43
413947087003202	REP-1-DG-5	03/30/95	1600	4.9	2.2	11	.3	33	32	0	39
413947087003202	REP-1-DG-5	10/31/95	1400	9.5	3.2	1.8	.4	23	22	0	27
413947087003202	REP-1-DG-5	02/05/96	1655	7.7	2.8	1.5	.3	22	22	0	27
413947087003202	REP-1-DG-5	05/08/96	1145	5.5	2.5	4	.5	39	40	0	49
413947087003202	REP-1-DG-5	08/14/96	1135	13	4.3	2.3	1	10	10	0	12
413947087003202	REP-1-DG-5	11/09/96	1055	8.2	2	4	1.1	28	28	0	34
413947087003202	REP-1-DG-5	02/14/97	1145	7.2	2	1.4	1	28	28	0	34
413947087003202	REP-1-DG-5	05/21/97	1125	22.1	6.53	48.5	1.6	72	73	0	89
413948087003201	REP-2-DG-3	12/16/94	0830	51	20	9.5	3.3	187	193	0	236
413948087003201	REP-2-DG-3	04/06/95	1615	53	21	9.8	2.7	197	198	0	242
413948087003201	REP-2-DG-3	11/07/95	1430	57	22	9.4	2.8	176	178	0	217
413948087003201	REP-2-DG-3	02/05/96	1505	55	21	11	2.7	182	183	0	223
413948087003201	REP-2-DG-3	05/08/96	1025	52	20	12	2.8	189	187	0	228

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS Station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Sulfate (mg/L)	Fluoride (mg/L)	Bromide (mg/L)	Iodide (mg/L)	Silica (mg/L)	Nitrite (mg/L as N)	Nitrite plus nitrate (mg/L as N)	Iron (μg/L)	Manga-nese (μg/L)
413946087002601	1-UG-1	12/19/94	1615	<0.1	0.4	0.12	0.006	20	<0.01	<0.05	1,200	11
413946087002601	1-UG-1	03/30/95	0920	<.1	.5	.12	.006	21	--	--	1,100	10
413946087002601	1-UG-1	11/03/95	1135	<.1	.4	--	.005	19	--	--	880	10
413946087002601	1-UG-1	02/08/96	1525	<.1	.6	--	.006	--	--	--	--	--
413946087002601	1-UG-1	05/08/96	1830	<.1	.5	--	.006	--	--	--	--	--
413946087002601	1-UG-1	08/21/96	0800	<.1	.5	--	.005	--	--	--	--	--
413946087002601	1-UG-1	11/13/96	0910	<.1	.5	--	.006	--	--	--	--	--
413946087002601	1-UG-1	02/13/97	0940	<.1	.5	--	.007	20	--	--	1,100	10
413946087002601	1-UG-1	05/14/97	0835	<.1	.5	--	.006	20.4	--	--	1,110	10
413946087002602	1-UG-2	12/19/94	1800	1.9	.4	.06	.005	18	<.01	<.05	490	49
413946087002602	1-UG-2	03/30/95	1245	1.6	.5	.06	.005	19	--	--	370	46
413946087002602	1-UG-2	11/02/95	1325	<.1	.3	--	.006	18	--	--	320	40
413946087002602	1-UG-2	02/08/96	1325	1.3	.6	--	.006	--	--	--	--	--
413946087002602	1-UG-2	05/08/96	1600	3.3	.5	--	.006	--	--	--	--	--
413946087002602	1-UG-2	08/21/96	1035	3.9	.5	--	.005	--	--	--	--	--
413946087002602	1-UG-2	11/13/96	1200	.6	.5	--	.005	--	--	--	--	--
413946087002602	1-UG-2	02/13/97	1150	.6	.4	--	.006	18	--	--	330	35
413946087002602	1-UG-2	05/14/97	0935	<.1	.5	--	.006	18.7	--	--	350	39
413946087002603	1-UG-3	12/21/94	1000	54	<.1	.01	.003	12	<.01	<.05	2,100	53
413946087002603	1-UG-3	03/29/95	1355	47	<.1	<.01	.002	12	--	--	2,000	140
413946087002603	1-UG-3	11/02/95	1130	39	<0.1	--	.004	11	--	--	1,900	50
413946087002603	1-UG-3	02/08/96	0830	25	<.1	--	.003	--	--	--	--	--
413946087002603	1-UG-3	05/09/96	0920	35	.1	--	.002	--	--	--	--	--
413946087002603	1-UG-3	08/20/96	1545	45	<.1	--	.003	--	--	--	--	--
413946087002603	1-UG-3	11/13/96	1415	42	<.1	--	.003	--	--	--	--	--
413946087002603	1-UG-3	02/13/97	1255	37	<.1	--	.004	10	--	--	1,600	49
413946087002603	1-UG-3	05/13/97	1435	35.9	<.1	--	.003	11.1	--	--	1,670	53
413946087002604	1-UG-4	12/21/94	1135	15	<.1	<.01	.001	6.4	<.01	.06	10	6
413946087002604	1-UG-4	03/30/95	1045	20	<.1	<.01	.001	6.6	--	--	10	9
413946087002604	1-UG-4	11/02/95	1605	15	<.1	--	.004	6.6	--	--	10	<10
413946087002604	1-UG-4	02/08/96	1000	18	<.1	--	.004	--	--	--	--	--

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS Station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Sulfate (mg/L)	Fluoride (mg/L)	Bromide (mg/L)	Iodide (mg/L)	Silica (mg/L)	Nitrite (mg/L as N)	Nitrite plus nitrate (mg/L as N)	Iron (µg/L)	Manga-nese (µg/L)
413946087002604	1-UG-4	05/08/96	1525	17	<0.1	--	0.003	--	--	--	--	--
413946087002604	1-UG-4	08/20/96	1310	14	<.1	--	<.001	--	--	--	--	--
413946087002604	1-UG-4	11/13/96	1500	17	<.1	--	.005	--	--	--	--	--
413946087002604	1-UG-4	02/13/97	1030	16	<.1	--	.002	6.6	--	--	10	8
413946087002604	1-UG-4	05/13/97	1555	17.2	<.1	--	.001	6.5	--	--	10	8
413946087002605	1-UG-5	12/21/94	1325	12	<.1	<.01	.003	5.2	<.01	<.05	20	<1
413946087002605	1-UG-5	03/29/95	1630	17	<.1	.01	.003	6.7	--	--	10	<1
413946087002605	1-UG-5	02/08/96	1245	10	<.1	--	.003	--	--	--	--	--
413946087002605	1-UG-5	05/08/96	1745	16	<.1	--	.004	--	--	--	--	--
413946087002605	1-UG-5	08/20/96	0900	13	<.1	--	.009	--	--	--	--	--
413946087002605	1-UG-5	11/13/96	1330	12	<.1	--	.007	--	--	--	--	--
413946087002605	1-UG-5	02/13/97	1400	12	<.1	--	.004	5.1	--	--	210	1
413946087002605	1-UG-5	05/14/97	1415	15.8	<.1	--	.006	4.2	--	--	310	2
413946087002606	1-UG-WT	12/21/94	1525	13	<.1	.01	.002	7.3	<.01	<.05	20	2
413946087002606	1-UG-WT	03/29/95	1520	12	<.1	<.01	.002	6.6	--	--	10	<1
413946087002606	1-UG-WT	11/07/95	0900	14	<.1	--	.001	9.8	--	--	<10	<10
413946087002606	1-UG-WT	02/08/96	1030	13	<.1	--	.001	--	--	--	--	--
413946087002606	1-UG-WT	05/09/96	1020	15	<.1	--	.002	--	--	--	--	--
413946087002606	1-UG-WT	08/20/96	1210	16	<.1	--	.003	--	--	--	--	--
413946087002606	1-UG-WT	11/13/96	1100	14	<.1	--	.002	--	--	--	--	--
413946087002606	1-UG-WT	02/13/97	1500	12	<.1	--	.002	4.7	--	--	40	<1
413946087002606	1-UG-WT	05/14/97	1020	15	<.1	--	.003	4.6	--	--	30	<1
413947087002601	ALT-1-UG-1	11/03/95	0935	<.1	.4	--	.006	19	--	--	1,000	<10
413947087002601	ALT-1-UG-1	02/08/96	1445	<.1	.5	--	.006	--	--	--	--	--
413947087002601	ALT-1-UG-1	05/08/96	1915	<.1	.5	--	.005	--	--	--	--	--
413947087002601	ALT-1-UG-1	08/21/96	0900	<.1	.4	--	.007	--	--	--	--	--
413947087002602	ALT-1-UG-2	11/02/95	1450	<.1	.4	--	.007	18	--	--	260	20
413947087002602	ALT-1-UG-2	02/08/96	1405	<.1	.6	--	.007	--	--	--	--	--
413947087002602	ALT-1-UG-2	05/08/96	1650	<.1	.5	--	.006	--	--	--	--	--
413947087002602	ALT-1-UG-2	08/21/96	0945	<.1	.5	--	.007	--	--	--	--	--
413947087002603	ALT-1-UG-3	11/02/95	1000	40	<.1	--	.003	11	--	--	2,000	50
413947087002603	ALT-1-UG-3	02/08/96	0900	37	<.1	--	.003	--	--	--	--	--
413947087002603	ALT-1-UG-3	05/09/96	0830	32	<.1	--	.002	--	--	--	--	--

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS Station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Sulfate (mg/L)	Fluoride (mg/L)	Bromide (mg/L)	Iodide (mg/L)	Silica (mg/L)	Nitrite (mg/L as N)	Nitrite plus nitrate (mg/L as N)	Iron (µg/L)	Manga-nese (µg/L)
413947087002603	ALT-1-UG-3	08/20/96	1455	34	<0.1	--	0.002	--	--	--	--	--
413947087002604	ALT-1-UG-4	11/02/95	1525	21	<.1	--	.003	7	--	--	180	10
413947087002604	ALT-1-UG-4	02/08/96	0930	16	<.1	--	.006	--	--	--	--	--
413947087002604	ALT-1-UG-4	05/08/96	1500	19	<.1	--	.004	--	--	--	--	--
413947087002604	ALT-1-UG-4	08/20/96	1400	14	<.1	--	.003	--	--	--	--	--
413947087002605	ALT-1-UG-5	11/07/95	1040	11	<.1	--	.001	10	--	--	<10	10
413947087002605	ALT-1-UG-5	02/08/96	1200	12	<.1	--	.001	--	--	--	--	--
413947087002605	ALT-1-UG-5	05/08/96	1725	14	<.1	--	.001	--	--	--	--	--
413947087002605	ALT-1-UG-5	08/20/96	0945	14	<.1	--	<.001	--	--	--	--	--
413947087002605	ALT-1-UG-5	11/13/96	1245	22	<.1	--	.001	--	--	--	--	--
413947087002605	ALT-1-UG-5	02/13/97	1620	15	<.1	--	.001	7	--	--	10	<1
413947087002605	ALT-1-UG-5	05/14/97	1255	16.8	<.1	--	.003	6.4	--	--	30	<1
413947087002606	ALT-1-UG-WT	11/07/95	0930	13	<.1	--	.001	8.6	--	--	<10	<10
413947087002606	ALT-1-UG-WT	02/08/96	1105	12	<.1	--	.001	--	--	--	--	--
413947087002606	ALT-1-UG-WT	05/09/96	1000	18	<.1	--	.001	--	--	--	--	--
413947087002606	ALT-1-UG-WT	08/20/96	1050	21	<.1	--	<.001	--	--	--	--	--
413947087002606	ALT-1-UG-WT	11/13/96	1010	17	<.1	--	.002	--	--	--	--	--
413947087002606	ALT-1-UG-WT	02/13/97	1720	17	<.1	--	.002	7	--	--	20	2
413947087002606	ALT-1-UG-WT	05/14/97	1200	19.4	<.1	--	.002	6.6	--	--	20	1
413950087002601	1-DG-1	12/13/94	1050	<.1	.5	.09	.006	20	<.01	<.05	1,500	23
413950087002601	1-DG-1	03/27/95	1550	<.1	.5	.14	.006	20	--	--	1,500	16
413950087002601	1-DG-1	11/01/95	1225	<.1	.4	--	.006	19	--	--	1,500	10
413950087002601	1-DG-1	02/06/96	1145	<0.1	0.5	--	.007	--	--	--	--	--
413950087002601	1-DG-1	05/07/96	1905	<.1	.5	--	.006	--	--	--	--	--
413950087002601	1-DG-1	08/15/96	1140	<.1	.5	--	.006	--	--	--	--	--
413950087002601	1-DG-1	11/07/96	1435	<.1	.5	--	.006	--	--	--	--	--
413950087002601	1-DG-1	02/11/97	1615	<.1	.5	--	.007	20	--	--	1,400	14
413950087002601	1-DG-1	05/20/97	1400	<.1	.5	--	.007	19.7	--	--	1,520	15
413950087002602	1-DG-2	12/13/94	1235	1.7	.4	.08	.004	19	<.01	<.05	680	32
413950087002602	1-DG-2	03/28/95	0925	1.7	.4	.07	.005	19	--	--	500	28
413950087002602	1-DG-2	10/31/95	1535	3	.3	--	.005	18	--	--	540	20
413950087002602	1-DG-2	02/06/96	1455	7.3	.5	--	.004	--	--	--	--	--

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS Station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Sulfate (mg/L)	Fluoride (mg/L)	Bromide (mg/L)	Iodide (mg/L)	Silica (mg/L)	Nitrite (mg/L as N)	Nitrite plus nitrate (mg/L as N)	Iron (µg/L)	Manga-nese (µg/L)
413950087002602	1-DG-2	05/07/96	1630	13	0.4	--	0.005	--	--	--	--	--
413950087002602	1-DG-2	08/15/96	1040	11	.4	--	.004	--	--	--	--	--
413950087002602	1-DG-2	11/07/96	1135	14	.4	--	.004	--	--	--	--	--
413950087002602	1-DG-2	02/11/97	1710	9.5	.4	--	.005	19	--	--	350	26
413950087002602	1-DG-2	05/20/97	1705	1.2	.4	--	.005	19.4	--	--	470	29
413950087002603	1-DG-3	12/12/94	1455	33	<.1	.04	.003	10	<.01	<.05	2,400	63
413950087002603	1-DG-3	03/27/95	1410	38	<.1	.03	.002	11	--	--	2,600	69
413950087002603	1-DG-3	10/30/95	1630	54	<.1	--	.003	10	--	--	2,500	70
413950087002603	1-DG-3	02/06/96	1735	62	<.1	--	.004	--	--	--	--	--
413950087002603	1-DG-3	05/08/96	0840	59	.1	--	.003	--	--	--	--	--
413950087002603	1-DG-3	08/15/96	1515	59	<.1	--	.003	--	--	--	--	--
413950087002603	1-DG-3	11/07/96	1705	63	<.1	--	.002	--	--	--	--	--
413950087002603	1-DG-3	02/11/97	0835	62	<.1	--	.004	12	--	--	3,100	86
413950087002603	1-DG-3	05/20/97	1455	48	<.1	--	.003	11.9	--	--	3,160	77
413950087002604	1-DG-4	12/12/94	1615	14	<.1	.02	.001	9.6	<.01	<.05	120	9
413950087002604	1-DG-4	03/28/95	1410	14	<.1	<.01	<.001	9	--	--	100	7
413950087002604	1-DG-4	10/31/95	1315	11	<.1	--	.001	9.7	--	--	120	<10
413950087002604	1-DG-4	02/06/96	1705	11	<.1	--	<.001	--	--	--	--	--
413950087002604	1-DG-4	05/07/96	1820	13	<.1	--	<.001	--	--	--	--	--
413950087002604	1-DG-4	08/14/96	1540	14	<.1	--	<.001	--	--	--	--	--
413950087002604	1-DG-4	11/07/96	1745	13	<.1	--	<.001	--	--	--	--	--
413950087002604	1-DG-4	02/11/97	1505	12	<.1	--	.001	9.1	--	--	80	5
413950087002604	1-DG-4	05/20/97	1605	12.1	<.1	--	<.001	9.4	--	--	130	5
413950087002605	1-DG-5	12/13/94	0920	12	<.1	<.01	.001	6.8	<.01	<.05	10	3
413950087002605	1-DG-5	03/28/95	1100	12	.1	.06	.001	6.9	--	--	10	9
413950087002605	1-DG-5	11/01/95	1505	9.8	<.1	--	<.001	7.8	--	--	20	<10
413950087002605	1-DG-5	02/06/96	1320	10	<.1	--	.001	--	--	--	--	--
413950087002605	1-DG-5	05/07/96	1655	15	<.1	--	<.001	--	--	--	--	--
413950087002605	1-DG-5	08/15/96	1615	9.1	<.1	--	<.001	--	--	--	--	--
413950087002605	1-DG-5	11/07/96	1535	11	<.1	--	<.001	--	--	--	--	--
413950087002605	1-DG-5	02/11/97	0950	11	<.1	--	.001	6.5	--	--	10	1
413950087002605	1-DG-5	05/21/97	0905	9.6	<.1	--	<.001	6.8	--	--	--	<1
413950087002606	1-DG-WT	12/12/94	1340	17	<.1	<.01	.002	6.9	<.01	1.1	30	5

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS Station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Sulfate (mg/L)	Fluoride (mg/L)	Bromide (mg/L)	Iodide (mg/L)	Silica (mg/L)	Nitrite (mg/L as N)	Nitrite plus nitrate (mg/L as N)	Iron (μg/L)	Manga-nese (μg/L)
413950087002606	1-DG-WT	03/28/95	1235	63	<0.1	.11	0.002	9.1	--	--	10	5
413950087002606	1-DG-WT	10/31/95	0900	12	<.1	--	.001	9.6	--	--	<10	<10
413950087002606	1-DG-WT	02/06/96	1520	11	<.1	--	.001	--	--	--	--	--
413950087002606	1-DG-WT	05/07/96	1350	50	<.1	--	.001	--	--	--	--	--
413950087002606	1-DG-WT	08/14/96	1630	53	.1	--	.005	--	--	--	--	--
413950087002606	1-DG-WT	11/07/96	1220	21	<.1	--	.004	--	--	--	--	--
413950087002606	1-DG-WT	02/11/97	1345	21	<.1	--	.001	8.3	--	--	10	1
413950087002606	1-DG-WT	05/20/97	1210	51.4	<.1	--	.001	10.3	--	--	<10	<3
413950087002501	ALT-1-DG-1	11/01/95	0845	<.1	.4	--	.006	19	--	--	1,700	20
413950087002501	ALT-1-DG-1	02/06/96	1055	<.1	.5	--	.006	--	--	--	--	--
413950087002501	ALT-1-DG-1	05/07/96	1945	<.1	.5	--	.006	--	--	--	--	--
413950087002501	ALT-1-DG-1	08/15/96	1330	<.1	.5	--	.006	--	--	--	--	--
413950087002502	ALT-1-DG-2	10/31/95	1605	25	.3	--	.004	15	--	--	1,600	110
413950087002502	ALT-1-DG-2	02/06/96	1420	32	.3	--	.004	--	--	--	--	--
413950087002502	ALT-1-DG-2	05/07/96	1540	47	.3	--	.003	--	--	--	--	--
413950087002502	ALT-1-DG-2	08/15/96	0945	37	.3	--	.003	--	--	--	--	--
413950087002503	ALT-1-DG-3	10/30/95	1550	37	<.1	--	.002	10	--	--	1,700	40
413950087002503	ALT-1-DG-3	02/06/96	1805	60	<.1	--	.003	--	--	--	--	--
413950087002503	ALT-1-DG-3	05/08/96	0810	61	<.1	--	.003	--	--	--	--	--
413950087002503	ALT-1-DG-3	08/15/96	1425	38	<.1	--	.002	--	--	--	--	--
413950087002504	ALT-1-DG-4	10/31/95	1140	7.9	<.1	--	.001	8.6	--	--	40	<10
413950087002504	ALT-1-DG-4	02/06/96	1640	21	<.1	--	<.001	--	--	--	--	--
413950087002504	ALT-1-DG-4	05/07/96	1755	21	<.1	--	<.001	--	--	--	--	--
413950087002504	ALT-1-DG-4	08/14/96	1445	20	.1	--	<.001	--	--	--	--	--
413950087002505	ALT-1-DG-5	11/01/95	1640	11	<.1	--	.001	8.4	--	--	20	<10
413950087002505	ALT-1-DG-5	02/06/96	1345	11	<.1	--	.001	--	--	--	--	--
413950087002505	ALT-1-DG-5	05/07/96	1720	13	<.1	--	.001	--	--	--	--	--
413950087002505	ALT-1-DG-5	08/15/96	1730	8	<.1	--	<.001	--	--	--	--	--
413950087002505	ALT-1-DG-5	11/07/96	1620	9.8	<.1	--	<.001	--	--	--	--	--
413950087002505	ALT-1-DG-5	02/11/97	1110	11	<.1	--	.001	7.2	--	--	<1	3
413950087002505	ALT-1-DG-5	05/21/97	0950	11.6	<.1	--	<.001	7.3	--	--	<1	<1
413950087002506	ALT-1-DG-WT	11/07/95	1325	14	<.1	--	<.001	9.2	--	--	<10	<10

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS Station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Sulfate (mg/L)	Fluoride (mg/L)	Bromide (mg/L)	Iodide (mg/L)	Silica (mg/L)	Nitrite (mg/L as N)	Nitrite plus nitrate (mg/L as N)	Iron (µg/L)	Manga-nese (µg/L)
413950087002506	ALT-1-DG-WT	02/06/96	1610	19	<0.1	--	0.001	--	--	--	--	--
413950087002506	ALT-1-DG-WT	05/07/96	1435	15	<.1	--	<.001	--	--	--	--	--
413950087002506	ALT-1-DG-WT	08/14/96	1750	70	<.1	--	.006	--	--	--	--	--
413950087002506	ALT-1-DG-WT	11/07/96	1330	23	<.1	--	.003	--	--	--	--	--
413950087002506	ALT-1-DG-WT	02/11/97	1225	18	<.1	--	.001	13	--	--	10	<1
413950087002506	ALT-1-DG-WT	05/20/97	1115	32.6	<.1	--	.001	14	--	--	30	<3
413951087002601	2-DG-1	12/20/94	0835	<.1	.5	.12	.007	19	<.01	<.05	1,200	16
413951087002601	2-DG-1	04/04/95	1100	.4	.5	.13	.003	19	--	--	1,000	16
413951087002601	2-DG-1	11/01/95	1735	<.1	.4	--	.008	18	--	--	950	20
413951087002601	2-DG-1	02/07/96	0910	<.1	.7	--	.008	--	--	--	--	--
413951087002601	2-DG-1	05/09/96	1300	<.1	.6	--	.007	--	--	--	--	--
413951087002601	2-DG-1	08/19/96	1840	<.1	.5	--	.007	--	--	--	--	--
413951087002601	2-DG-1	11/06/96	1905	<.1	.6	--	.007	--	--	--	--	--
413951087002601	2-DG-1	02/19/97	1220	<0.1	.6	--	.009	19	--	--	1,100	14
413951087002601	2-DG-1	05/15/97	1145	<.1	.5	--	.008	18.9	--	--	1,120	16
413951087002602	2-DG-2	12/20/94	1010	.7	.4	.09	.005	20	<.01	<.05	670	19
413951087002602	2-DG-2	04/03/95	1445	.3	.4	.11	.004	20	--	--	530	20
413951087002602	2-DG-2	11/01/95	1500	<.1	.3	--	.005	19	--	--	580	20
413951087002602	2-DG-2	02/07/96	0940	<.1	.5	--	.005	--	--	--	--	--
413951087002602	2-DG-2	05/09/96	1340	<.1	.4	--	.005	--	--	--	--	--
413951087002602	2-DG-2	08/19/96	1610	.1	.5	--	.004	--	--	--	--	--
413951087002602	2-DG-2	11/06/96	2005	2.6	.5	--	.005	--	--	--	--	--
413951087002602	2-DG-2	02/19/97	0945	5.1	.4	--	.006	20	--	--	480	18
413951087002602	2-DG-2	05/15/97	1550	3.7	.4	--	.005	20.2	--	--	560	20
413951087002603	2-DG-3	12/20/94	1200	39	<.1	.06	.003	13	<.01	<.05	3,300	120
413951087002603	2-DG-3	04/04/95	0920	47	<.1	<.01	.002	12	--	--	3,000	110
413951087002603	2-DG-3	11/01/95	1625	46	.1	--	.003	12	--	--	2,500	110
413951087002603	2-DG-3	02/07/96	0830	54	.1	--	.004	--	--	--	--	--
413951087002603	2-DG-3	05/09/96	1700	57	<.1	--	.004	--	--	--	--	--
413951087002603	2-DG-3	08/19/96	1700	51	.1	--	.004	--	--	--	--	--
413951087002603	2-DG-3	11/06/96	1520	52	.1	--	.002	--	--	--	--	--
413951087002603	2-DG-3	02/18/97	1400	55	.1	--	.005	13	--	--	3,100	130

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS Station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Sulfate (mg/L)	Fluoride (mg/L)	Bromide (mg/L)	Iodide (mg/L)	Silica (mg/L)	Nitrite (mg/L as N)	Nitrite plus nitrate (mg/L as N)	Iron (µg/L)	Manga-nese (µg/L)
413951087002603	2-DG-3	05/15/97	1250	55	<0.1	--	0.003	12.7	--	--	3,330	126
413951087002604	2-DG-4	12/20/94	1305	19	<.1	.01	<.001	10	<.01	<.05	10	8
413951087002604	2-DG-4	04/03/95	1610	14	<.1	<.01	<.001	8.7	--	--	10	6
413951087002604	2-DG-4	11/01/95	1345	14	<.1	--	<.001	10	--	--	10	10
413951087002604	2-DG-4	02/07/96	1100	14	<.1	--	.001	--	--	--	--	--
413951087002604	2-DG-4	05/09/96	1405	14	<.1	--	<.001	--	--	--	--	--
413951087002604	2-DG-4	08/19/96	1430	14	<.1	--	<.001	--	--	--	--	--
413951087002604	2-DG-4	11/06/96	1610	15	<.1	--	<.001	--	--	--	--	--
413951087002604	2-DG-4	02/18/97	1455	13	<.1	--	<.001	9.6	--	--	10	6
413951087002604	2-DG-4	05/15/97	1445	8.8	.2	--	<.001	9.2	--	--	10	38
413951087002605	2-DG-5	12/20/94	1425	17	<.1	.02	.001	8.8	<.01	.24	60	28
413951087002605	2-DG-5	04/04/95	1245	12	<.1	.02	.001	5.9	--	--	--	1
413951087002605	2-DG-5	11/01/95	0915	33	<.1	--	.001	7.1	--	--	20	<10
413951087002605	2-DG-5	02/07/96	1035	10	<.1	--	.001	--	--	--	--	--
413951087002605	2-DG-5	05/09/96	1635	13	<.1	--	<.001	--	--	--	--	--
413951087002605	2-DG-5	08/19/96	1740	34	<.1	--	<.001	--	--	--	--	--
413951087002605	2-DG-5	11/06/96	1700	16	<.1	--	<.001	--	--	--	--	--
413951087002605	2-DG-5	02/19/97	1025	14	<.1	--	.001	5.3	--	--	--	<1
413951087002605	2-DG-5	05/15/97	1015	9.1	<.1	--	.001	6.9	--	--	--	8
413951087002606	2-DG-WT	12/20/94	1600	31	.1	<.01	.004	5.6	<.01	.36	10	<1
413951087002606	2-DG-WT	04/04/95	1415	24	.1	<.01	.002	5.2	--	--	10	<1
413951087002606	2-DG-WT	11/01/95	1215	8.1	<.1	--	.041	5.1	--	--	60	40
413951087002606	2-DG-WT	02/07/96	1000	17	<.1	--	.002	--	--	--	--	--
413951087002606	2-DG-WT	05/09/96	1615	24	.1	--	.004	--	--	--	--	--
413951087002606	2-DG-WT	08/19/96	1515	26	<.1	--	.002	--	--	--	--	--
413951087002606	2-DG-WT	11/06/96	1800	50	<.1	--	.003	--	--	--	--	--
413951087002606	2-DG-WT	02/19/97	1115	24	<.1	--	.005	4.4	--	--	10	<1
413951087002606	2-DG-WT	05/15/97	1345	13.4	<.1	--	.003	4.5	--	--	10	<1
413953087002601	3-DG-1	12/14/94	1610	<.1	.5	.12	.005	19	<.01	<.05	1,000	32
413953087002601	3-DG-1	04/05/95	1000	.2	.5	.14	.004	18	--	--	970	30
413953087002601	3-DG-1	11/06/95	1750	<.1	.4	--	.004	19	--	--	870	30
413953087002601	3-DG-1	02/07/96	1430	<.1	.6	--	.005	--	--	--	--	--

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS Station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Sulfate (mg/L)	Fluoride (mg/L)	Bromide (mg/L)	Iodide (mg/L)	Silica (mg/L)	Nitrite (mg/L as N)	Nitrite plus nitrate (mg/L as N)	Iron (µg/L)	Manga-nese (µg/L)
413953087002601	3-DG-1	05/06/96	1930	<.1	0.5	--	0.005	--	--	--	--	--
413953087002601	3-DG-1	08/13/96	1630	<.1	.5	--	.005	--	--	--	--	--
413953087002601	3-DG-1	11/12/96	1805	<.1	.5	--	.006	--	--	--	--	--
413953087002601	3-DG-1	02/12/97	1205	.1	.5	--	.006	18	--	--	1,000	32
413953087002601	3-DG-1	05/16/97	1050	<.1	.5	--	.006	18.9	--	--	1,060	33
413953087002602	3-DG-2	12/15/94	1015	13	.4	.1	.004	20	<.01	<.05	930	23
413953087002602	3-DG-2	04/05/95	1445	8.3	.4	.13	.003	20	--	--	640	20
413953087002602	3-DG-2	11/06/95	1830	18	.4	--	.003	20	--	--	730	20
413953087002602	3-DG-2	02/07/96	1335	18	.5	--	.004	--	--	--	--	--
413953087002602	3-DG-2	05/06/96	1630	9.6	.4	--	.003	--	--	--	--	--
413953087002602	3-DG-2	08/13/96	1325	11	.4	--	.004	--	--	--	--	--
413953087002602	3-DG-2	11/12/96	1500	12	.4	--	.005	--	--	--	--	--
413953087002602	3-DG-2	02/12/97	1030	14	.4	--	.004	20	--	--	620	20
413953087002602	3-DG-2	05/16/97	0915	7.9	.4	--	.005	20.2	--	--	660	20
413953087002603	3-DG-3	12/15/94	1225	30	<.1	.02	.002	16	<.01	<.05	1,900	70
413953087002603	3-DG-3	04/05/95	1145	40	<.1	<.01	0.002	14	--	--	2,600	92
413953087002603	3-DG-3	11/03/95	1050	42	<.1	--	.003	14	--	--	2,600	100
413953087002603	3-DG-3	02/07/96	1400	30	.1	--	.003	--	--	--	--	--
413953087002603	3-DG-3	05/06/96	1705	37	<.1	--	.003	--	--	--	--	--
413953087002603	3-DG-3	08/13/96	1805	50	<.1	--	.004	--	--	--	--	--
413953087002603	3-DG-3	11/12/96	1620	47	<.1	--	.003	--	--	--	--	--
413953087002603	3-DG-3	02/12/97	1305	47	<.1	--	.003	14	--	--	2,600	120
413953087002603	3-DG-3	05/16/97	0810	54.8	<.1	--	.003	13.9	--	--	3,400	117
413953087002604	3-DG-4	12/15/94	1400	32	<.1	<.01	.002	9.4	<.01	<.05	80	3
413953087002604	3-DG-4	04/05/95	1300	15	<.1	<.01	.001	8.1	--	--	50	1
413953087002604	3-DG-4	11/06/95	1655	14	<.1	--	.001	8.6	--	--	40	<10
413953087002604	3-DG-4	02/07/96	1305	50	<.1	--	.001	--	--	--	--	--
413953087002604	3-DG-4	05/06/96	1845	39	<.1	--	.001	--	--	--	--	--
413953087002604	3-DG-4	08/13/96	1535	24	<.1	--	<.001	--	--	--	--	--
413953087002604	3-DG-4	11/12/96	1700	20	<.1	--	.001	--	--	--	--	--
413953087002604	3-DG-4	02/12/97	0915	15	<.1	--	<.001	9.3	--	--	20	2
413953087002604	3-DG-4	05/16/97	0955	11.9	<.1	--	<.001	8.9	--	--	120	9
413953087002605	3-DG-5	12/15/94	0835	18	<.1	.13	.006	10	<.01	<.05	7,600	97

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS Station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Sulfate (mg/L)	Fluoride (mg/L)	Bromide (mg/L)	Iodide (mg/L)	Silica (mg/L)	Nitrite (mg/L as N)	Nitrite plus nitrate (mg/L as N)	Iron (µg/L)	Manga-nese (µg/L)
413953087002605	3-DG-5	04/06/95	1230	17	<0.1	<0.01	0.003	9.9	--	--	5,400	60
413953087002605	3-DG-5	11/06/95	1615	74	<.1	--	.002	11	--	--	2,800	110
413953087002605	3-DG-5	02/07/96	1445	41	<.1	--	.003	--	--	--	--	--
413953087002605	3-DG-5	05/06/96	1805	57	.1	--	.003	--	--	--	--	--
413953087002605	3-DG-5	08/13/96	1720	27	<.1	--	0.01	--	--	--	--	--
413953087002605	3-DG-5	11/12/96	1535	32	<.1	--	.005	--	--	--	--	--
413953087002605	3-DG-5	02/12/97	1400	35.4	<.1	--	.004	11	--	--	4,390	86
413953087002605	3-DG-5	05/16/97	1125	16.2	<.1	--	.012	7.5	--	--	5,300	148
413953087002606	3-DG-WT	12/15/94	1600	19	<.1	.05	.012	8.6	<.01	.72	2,800	58
413953087002606	3-DG-WT	04/06/95	1015	22	<.1	<.01	.005	7.6	--	--	1,900	30
413953087002606	3-DG-WT	11/06/95	1525	34	<.1	--	.003	7.9	--	--	1,200	40
413953087002606	3-DG-WT	02/07/96	1530	24	<.1	--	.006	--	--	--	--	--
413953087002606	3-DG-WT	05/06/96	1720	41	<.1	--	.005	--	--	--	--	--
413953087002606	3-DG-WT	08/13/96	1430	35	<.1	--	.004	--	--	--	--	--
413953087002606	3-DG-WT	11/12/96	1350	37	<.1	--	.004	--	--	--	--	--
413953087002606	3-DG-WT	02/12/97	1505	36	<.1	--	.005	7.6	--	--	970	35
413953087002606	3-DG-WT	05/16/97	1205	27.2	<.1	--	.005	8.3	--	--	1,630	25
413943087003202	REP-1-UG-3	11/02/95	0940	37	<.1	--	.008	16	--	--	4,300	50
413943087003202	REP-1-UG-3	02/09/96	0850	35	<.1	--	.008	--	--	--	--	--
413943087003202	REP-1-UG-3	05/07/96	1105	17	<.1	--	.003	--	--	--	--	--
413943087003202	REP-1-UG-3	08/16/96	1050	17	<.1	--	.004	--	--	--	--	--
413943087003203	REP-1-UG-5	02/09/96	0825	14	<.1	--	.001	--	--	--	--	--
413943087003203	REP-1-UG-5	05/07/96	1020	14	<.1	--	<.001	--	--	--	--	--
413943087003203	REP-1-UG-5	08/16/96	1000	14	<.1	--	<.001	--	--	--	--	--
413943087003201	REP-1-UG-WT	12/21/94	1715	11	<.1	<.01	.001	8.9	<.01	<.05	10	6
413943087003201	REP-1-UG-WT	03/29/95	1115	10	<.1	.01	.001	9	--	--	10	5
413943087003201	REP-1-UG-WT	11/02/95	1140	22	<0.1	--	<.001	10	--	--	20	<10
413943087003201	REP-1-UG-WT	02/09/96	0910	11	<.1	--	.001	--	--	--	--	--
413943087003201	REP-1-UG-WT	05/07/96	0945	12	<.1	--	<.001	--	--	--	--	--
413943087003201	REP-1-UG-WT	08/16/96	0910	12	<.1	--	<.001	--	--	--	--	--
413947087003201	REP-1-DG-3	12/13/94	1530	25	<.1	.1	.003	13	.01	.07	3,400	120
413947087003201	REP-1-DG-3	03/30/95	1445	21	<.1	.08	.003	9.9	--	--	3,800	120

Table 11. Ground-water-quality and water-level data at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

USGS Station identification number	Well name	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Sulfate (mg/L)	Fluoride (mg/L)	Bromide (mg/L)	Iodide (mg/L)	Silica (mg/L)	Nitrite (mg/L as N)	Nitrite plus nitrate (mg/L as N)	Iron (µg/L)	Manga-nese (µg/L)
413947087003201	REP-1-DG-3	10/31/95	1145	18	0.1	--	0.003	11	--	--	4,800	100
413947087003201	REP-1-DG-3	02/05/96	1630	12	.1	--	.004	--	--	--	--	--
413947087003201	REP-1-DG-3	05/08/96	1125	13	.2	--	.003	--	--	--	--	--
413947087003201	REP-1-DG-3	08/14/96	1045	21	<.1	--	.005	--	--	--	--	--
413947087003201	REP-1-DG-3	11/09/96	1140	24	<.1	--	.006	--	--	--	--	--
413947087003201	REP-1-DG-3	02/14/97	1250	13	<.1	--	.006	13	--	--	5,300	47
413947087003201	REP-1-DG-3	05/21/97	1235	15.5	<.1	--	.005	12.2	--	--	7,770	65
413947087003202	REP-1-DG-5	12/13/94	1650	10	<.1	.11	.011	5.9	<.01	<.05	8,100	200
413947087003202	REP-1-DG-5	03/30/95	1600	7.2	<.1	.05	.006	5.6	--	--	4,700	91
413947087003202	REP-1-DG-5	10/31/95	1400	18	<.1	--	.009	6.9	--	--	6,100	170
413947087003202	REP-1-DG-5	02/05/96	1655	15	<.1	--	.006	--	--	--	--	--
413947087003202	REP-1-DG-5	05/08/96	1145	1.6	.2	--	.008	--	--	--	--	--
413947087003202	REP-1-DG-5	08/14/96	1135	34	<.1	--	.002	--	--	--	--	--
413947087003202	REP-1-DG-5	11/09/96	1055	15	<.1	--	.005	--	--	--	--	--
413947087003202	REP-1-DG-5	02/14/97	1145	9.6	<.1	--	.009	6.7	--	--	7,400	240
413947087003202	REP-1-DG-5	05/21/97	1125	27.9	<.1	--	.005	11.8	--	--	3,770	61
413948087003201	REP-2-DG-3	12/16/94	0830	24	<.1	0.12	.003	12	<0.01	<0.05	4,300	270
413948087003201	REP-2-DG-3	04/06/95	1615	27	<.1	<.01	.004	14	--	--	3,900	280
413948087003201	REP-2-DG-3	11/07/95	1430	35	<.1	--	.004	13	--	--	6,500	360
413948087003201	REP-2-DG-3	02/05/96	1505	29	.1	--	.004	--	--	--	--	--
413948087003201	REP-2-DG-3	05/08/96	1025	26	.2	--	.004	--	--	--	--	--
413948087003201	REP-2-DG-3	08/14/96	0830	15	.1	--	.004	--	--	--	--	--
413948087003201	REP-2-DG-3	11/09/96	1010	18	.1	--	.004	--	--	--	--	--
413948087003201	REP-2-DG-3	02/14/97	1045	22	.1	--	.01	15	--	--	12,000	220
413948087003201	REP-2-DG-3	05/21/97	1425	23.2	<.1	--	.004	17	--	--	12,300	184
413948087003202	REP-2-DG-5	12/16/94	1010	18	<.1	.08	.016	7.2	<.01	<.05	6,700	230
413948087003202	REP-2-DG-5	04/06/95	1500	12	<.1	.13	.005	5.6	--	--	5,300	170
413948087003202	REP-2-DG-5	11/07/95	1450	5.1	<.1	--	.006	7.4	--	--	1,400	60
413948087003202	REP-2-DG-5	02/05/96	1530	19	<.1	--	.01	--	--	--	--	110
413948087003202	REP-2-DG-5	05/08/96	0945	17	<.1	--	.007	--	--	--	--	--
413948087003202	REP-2-DG-5	08/14/96	0910	31	<.1	--	.008	--	--	--	--	--
413948087003202	REP-2-DG-5	11/09/96	0910	22	<.1	--	.003	--	--	--	--	--
413948087003202	REP-2-DG-5	02/14/97	0935	18	<.1	--	.007	6.6	--	--	1,200	55
413948087003202	REP-2-DG-5	05/21/97	1330	8	<.1	--	.01	6.9	--	--	9,170	386

Table 12. Quality-assurance data for ground-water samples from Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1995–97

[USGS, U.S. Geological Survey; mm/dd/yy, month/day/year; hhmm, hours and minutes; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; Duplicate indicates sequential duplicate sample; Equipment indicates equipment rinsate blank sample; --, not measured; ANC, acid-neutralizing capacity; FET, field-equivalent titration; $CaCO_3$, calcium carbonate; IT, incremental titration; CO_3, carbonate ion; HCO_3, bicarbonate ion; µg/L, micrograms per liter; all concentrations are reported as dissolved constituents]

USGS station identification number	Well name	Type of quality-assurance sample	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Specific conductance (µS/cm)	Chloride (mg/L)
413946087002601	1-UG-1	Duplicate	02/27/95	1346	793	13
413946087002601	1-UG-1	Duplicate	04/09/96	1621	816	13
413946087002601	1-UG-1	Duplicate	07/17/96	1146	828	13
413946087002602	1-UG-2	Duplicate	08/02/95	1336	698	6.6
413946087002602	1-UG-2	Duplicate	05/08/96	1606	708	8.3
413946087002602	1-UG-2	Duplicate	06/10/96	1706	795	6.5
413946087002602	1-UG-2	Duplicate	09/11/96	1356	660	7
413946087002603	1-UG-3	Duplicate	11/02/95	1131	207	9.8
413946087002603	1-UG-3	Duplicate	01/12/96	0941	170	7.8
413946087002604	1-UG-4	Duplicate	03/30/95	1046	103	2
413946087002604	1-UG-4	Duplicate	04/26/95	0946	108	1.5
413946087002604	1-UG-4	Duplicate	09/06/95	0921	70	1.2
413946087002604	1-UG-4	Duplicate	11/13/96	1501	58	2.1
413946087002605	1-UG-5	Duplicate	02/13/97	1401	116	2
413946087002605	1-UG-5	Duplicate	04/23/97	1026	174	1.1
413946087002606	1-UG-WT	Duplicate	12/05/95	1041	59	2.9
413946087002606	1-UG-WT	Duplicate	10/09/96	0751	61	1.2
413946087002606	1-UG-WT	Duplicate	05/14/97	1021	134	2
413947087002601	ALT-1-UG-1	Duplicate	09/06/95	1531	847	13
413947087002601	ALT-1-UG-1	Duplicate	09/25/95	1511	835	13
413947087002601	ALT-1-UG-1	Duplicate	03/11/96	1531	829	12
413947087002603	ALT-1-UG-3	Duplicate	08/03/95	1046	199	8.9
413947087002605	ALT-1-UG-5	Duplicate	06/16/97	1511	81	2.7
413947087002606	ALT-1-UG-WT	Duplicate	02/08/96	1106	52	1.8
413947087002606	ALT-1-UG-WT	Duplicate	08/20/96	1051	95	1.8
413947087002606	ALT-1-UG-WT	Duplicate	09/11/96	0851	71	1.9
413947087002606	ALT-1-UG-WT	Duplicate	12/12/96	1011	79	2.4

Table 12. Quality-assurance data for ground-water samples from Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1995–97—Continued

USGS station identification number	Well name	Type of quality-assurance sample	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Specific conductance (µS/cm)	Chloride (mg/L)
413947087002606	ALT-1-UG-WT	Duplicate	03/12/97	1206	131	2.7
413950087002601	1-DG-1	Duplicate	03/01/95	1116	793	9.9
413950087002601	1-DG-1	Duplicate	03/27/95	1551	786	9.5
413950087002601	1-DG-1	Duplicate	09/11/95	1131	814	9.7
413950087002601	1-DG-1	Duplicate	11/01/95	1226	827	9.9
413950087002601	1-DG-1	Duplicate	03/12/96	1811	804	8.9
413950087002601	1-DG-1	Duplicate	05/07/96	1906	815	10
413950087002603	1-DG-3	Duplicate	04/25/95	1116	274	7.2
413950087002603	1-DG-3	Duplicate	01/22/97	1006	404	15
413950087002603	1-DG-3	Duplicate	02/11/97	0836	399	15
413950087002604	1-DG-4	Duplicate	07/10/96	1131	41	1.4
413950087002604	1-DG-4	Duplicate	09/09/96	1626	42	1.3
413950087002604	1-DG-4	Duplicate	05/20/97	1606	40	1.3
413950087002605	1-DG-5	Duplicate	12/07/95	0846	42	2.6
413950087002605	1-DG-5	Duplicate	02/06/96	1321	36	1.7
413950087002605	1-DG-5	Duplicate	04/24/97	1036	1,920	592
413950087002606	1-DG-WT	Equipment	02/01/95	1505	27	<.1
413950087002606	1-DG-WT	Equipment	03/01/95	1330	27	1.1
413950087002606	1-DG-WT	Equipment	03/28/95	1236	34	2
413950087002606	1-DG-WT	Equipment	04/25/95	1001	28	.3
413950087002606	1-DG-WT	Duplicate	05/30/95	1646	1,730	430
413950087002606	1-DG-WT	Equipment	05/30/95	1701	54	.2
413950087002606	1-DG-WT	Equipment	06/28/95	0931	31	.4
413950087002606	1-DG-WT	Equipment	08/01/95	1146	27	<.1
413950087002606	1-DG-WT	Equipment	09/08/95	1046	3	.5
413950087002606	1-DG-WT	Equipment	10/31/95	0901	13	<.1
413950087002606	1-DG-WT	Equipment	01/10/96	1511	1	<.1
413950087002606	1-DG-WT	Equipment	02/06/96	1531	1	<.1
413950087002606	1-DG-WT	Equipment	05/07/96	1351	24	<.1
413950087002606	1-DG-WT	Equipment	07/10/96	1536	1	<0.1
413950087002606	1-DG-WT	Equipment	09/09/96	1741	3	.2
413950087002606	1-DG-WT	Duplicate	11/07/96	1221	537	56

Table 12. Quality-assurance data for ground-water samples from Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1995–97—Continued

USGS station identification number	Well name	Type of quality-assurance sample	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Specific conductance (μS/cm)	Chloride (mg/L)
413950087002606	1-DG-WT	Equipment	11/07/96	1236	1	<0.1
413950087002606	1-DG-WT	Equipment	01/22/97	1031	2	.2
413950087002606	1-DG-WT	Equipment	05/20/97	1231	16	2
413950087002501	ALT-1-DG-1	Duplicate	09/21/95	0941	798	9.3
413950087002502	ALT-1-DG-2	Duplicate	04/10/96	1401	564	9.5
413950087002503	ALT-1-DG-3	Duplicate	08/01/95	1516	149	5.6
413950087002503	ALT-1-DG-3	Duplicate	03/12/96	1401	304	11
413950087002504	ALT-1-DG-4	Duplicate	01/10/96	1556	59	1.9
413950087002504	ALT-1-DG-4	Duplicate	06/13/96	1506	58	1.4
413950087002504	ALT-1-DG-4	Duplicate	08/14/96	1446	57	1.2
413950087002506	ALT-1-DG-WT	Equipment	12/06/95	1416	2	<.1
413950087002506	ALT-1-DG-WT	Equipment	03/12/96	1526	2	<.1
413950087002506	ALT-1-DG-WT	Equipment	08/14/96	1751	2	.2
413950087002506	ALT-1-DG-WT	Equipment	10/09/96	1136	2	<.1
413950087002506	ALT-1-DG-WT	Equipment	12/11/96	1301	1	<.1
413950087002506	ALT-1-DG-WT	Equipment	02/11/97	1316	1	<.1
413950087002506	ALT-1-DG-WT	Equipment	04/24/97	0811	6	2.3
413950087002506	ALT-1-DG-WT	Equipment	06/17/97	1506	17	.9
413951087002601	2-DG-1	Equipment	06/26/95	1646	799	11
413951087002601	2-DG-1	Duplicate	07/31/95	1701	788	11
413951087002601	2-DG-1	Duplicate	12/07/95	1436	800	11
413951087002601	2-DG-1	Duplicate	05/09/96	1301	803	11
413951087002602	2-DG-2	Duplicate	09/11/95	1546	811	6.4
413951087002602	2-DG-2	Duplicate	09/21/95	1501	813	6.7
413951087002602	2-DG-2	Duplicate	02/07/96	0941	790	6.4
413951087002602	2-DG-2	Duplicate	03/14/96	1116	809	6.4
413951087002602	2-DG-2	Duplicate	04/11/96	1031	814	6.4
413951087002602	2-DG-2	Duplicate	12/11/96	1446	766	7.1
413951087002603	2-DG-3	Duplicate	06/18/97	0926	536	12.4
413951087002604	2-DG-4	Duplicate	09/10/96	1016	65	8.1
413951087002604	2-DG-4	Duplicate	10/10/96	1306	329	63

Table 12. Quality-assurance data for ground-water samples from Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1995–97—Continued

USGS station identification number	Well name	Type of quality-assurance sample	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Specific conductance (μS/cm)	Chloride (mg/L)
413951087002604	2-DG-4	Duplicate	11/06/96	1611	46	1.2
413951087002605	2-DG-5	Duplicate	02/01/95	1056	176	--
413951087002605	2-DG-5	Duplicate	07/11/96	1626	792	230
413951087002605	2-DG-5	Duplicate	01/22/97	1246	89	6.6
413951087002605	2-DG-5	Duplicate	03/12/97	1836	74	5.4
413953087002601	3-DG-1	Duplicate	04/05/95	1001	755	8.8
413953087002601	3-DG-1	Duplicate	06/28/95	1531	789	8.8
413953087002601	3-DG-1	Duplicate	11/06/95	1751	769	9
413953087002601	3-DG-1	Duplicate	01/11/96	1331	784	9.6
413953087002602	3-DG-2	Duplicate	09/07/95	1416	809	6.4
413953087002602	3-DG-2	Duplicate	04/11/96	1801	935	37
413953087002602	3-DG-2	Duplicate	08/13/96	1326	794	6.7
413953087002602	3-DG-2	Duplicate	03/11/97	1516	770	6.4
413953087002603	3-DG-3	Duplicate	01/31/95	1306	395	11
413953087002603	3-DG-3	Duplicate	04/27/95	1021	512	30
413953087002603	3-DG-3	Duplicate	06/12/96	1826	382	8.7
413953087002603	3-DG-3	Duplicate	10/10/96	0756	443	12
413953087002603	3-DG-3	Duplicate	11/12/96	1621	434	10
413953087002603	3-DG-3	Duplicate	05/16/97	0811	463	10.5
413953087002604	3-DG-4	Duplicate	02/28/95	0931	99	3.8
413953087002604	3-DG-4	Duplicate	06/01/95	1201	248	60
413953087002604	3-DG-4	Duplicate	04/23/97	1451	183	21
413953087002605	3-DG-5	Duplicate	02/07/96	1446	417	48
413953087002606	3-DG-WT	Equipment	01/31/95	1430	27	.3
413953087002606	3-DG-WT	Equipment	02/28/95	1045	25	<.1
413953087002606	3-DG-WT	Equipment	04/06/95	1100	36	.4
413953087002606	3-DG-WT	Equipment	04/27/95	1201	33	.3
413953087002606	3-DG-WT	Equipment	06/01/95	1431	47	.2
413953087002606	3-DG-WT	Equipment	06/28/95	1601	19	<.1
413953087002606	3-DG-WT	Equipment	08/03/95	1431	28	.4
413953087002606	3-DG-WT	Equipment	09/07/95	1341	2	.2

Table 12. Quality-assurance data for ground-water samples from Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1995–97—Continued

USGS station identification number	Well name	Type of quality-assurance sample	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Specific conductance (μS/cm)	Chloride (mg/L)
413953087002606	3-DG-WT	Equipment	09/20/95	1351	1	0.1
413953087002606	3-DG-WT	Equipment	11/06/95	1541	1	<.1
413953087002606	3-DG-WT	Equipment	12/04/95	1351	2	.2
413953087002606	3-DG-WT	Equipment	01/11/96	1251	1	<.1
413953087002606	3-DG-WT	Equipment	03/14/96	1616	1	<.1
413953087002606	3-DG-WT	Duplicate	07/11/96	1051	412	70
413953087002606	3-DG-WT	Equipment	07/11/96	1106	2	<.1
413953087002606	3-DG-WT	Equipment	08/13/96	1431	2	.2
413953087002606	3-DG-WT	Equipment	09/10/96	1541	2	.1
413953087002606	3-DG-WT	Equipment	10/10/96	0926	1	<.1
413953087002606	3-DG-WT	Equipment	11/12/96	1356	3	.2
413953087002606	3-DG-WT	Equipment	12/10/96	1001	1	<.1
413953087002606	3-DG-WT	Equipment	01/23/97	0921	2	<.1
413953087002606	3-DG-WT	Equipment	02/12/97	1531	1	<.1
413953087002606	3-DG-WT	Equipment	04/23/97	1556	2	.2
413953087002606	3-DG-WT	Equipment	05/16/97	1206	1	<.1
413953087002606	3-DG-WT	Duplicate	06/17/97	1001	2	<.1
413953087002606	3-DG-WT	Equipment	06/17/97	0956	409	34.5
413943087003203	REP-1-UG-5	Duplicate	05/07/96	1021	44	2.2
413943087003201	REP-1-UG-WT	Duplicate	08/16/96	0911	43	2.4
413947087003201	REP-1-DG-3	Duplicate	12/06/95	0901	358	22
413947087003201	REP-1-DG-3	Duplicate	04/08/96	1726	156	6.7
413947087003202	REP-1-DG-5	Duplicate	05/31/95	1346	111	1.4
413947087003202	REP-1-DG-5	Duplicate	02/14/97	1146	81	1.5
413948087003201	REP-2-DG-3	Duplicate	06/27/95	1516	496	21
413948087003201	REP-2-DG-3	Duplicate	01/11/96	1606	483	28
413948087003201	REP-2-DG-3	Duplicate	01/22/97	1516	485	20
413948087003202	REP-2-DG-5	Duplicate	05/31/95	1711	524	140
413948087003202	REP-2-DG-5	Duplicate	09/26/95	1031	65	2
413948087003202	REP-2-DG-5	Duplicate	06/12/96	1146	759	200
413948087003202	REP-2-DG-5	Duplicate	12/10/96	1446	135	7.2

Table 12. Quality-assurance data for ground-water samples from Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1995–97—Continued

USGS station identification number	Well name	Type of quality-assurance sample	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	ANC-FET (mg/L as $CaCO_3$)	ANC-IT (mg/L as $CaCO_3$)	ANC-CO_3 (mg/L as CO_3)	ANC-HCO_3 (mg/L as HCO_3)
413946087002602	1-UG-2	Duplicate	05/08/96	1606	59	50	21	2.2	387	388	0	473
413946087002603	1-UG-3	Duplicate	11/02/95	1131	23	7.3	4.7	1.5	42	43	0	52
413946087002604	1-UG-4	Duplicate	03/30/95	1046	6.8	2.1	1.4	2.2	4	4	0	4
413946087002604	1-UG-4	Duplicate	11/13/96	1501	5.2	1.7	1.1	1.7	5	4	0	5
413946087002605	1-UG-5	Duplicate	02/13/97	1401	14	6.6	1.1	<.1	56	56	0	68
413946087002606	1-UG-WT	Duplicate	05/14/97	1021	15.5	7.8	1.2	<.1	62	62	0	75
413947087002606	ALT-1-UG-WT	Duplicate	02/08/96	1106	6.6	2.1	1.1	<.1	9	8	0	10
413947087002606	ALT-1-UG-WT	Duplicate	08/20/96	1051	9	5	1.4	<.1	20	20	0	24
413950087002601	1-DG-1	Duplicate	03/27/95	1551	61	55	37	3.6	459	462	0	564
413950087002601	1-DG-1	Duplicate	11/01/95	1226	65	56	38	3.6	450	454	0	554
413950087002601	1-DG-1	Duplicate	05/07/96	1906	63	54	37	3.5	460	457	0	558
413950087002603	1-DG-3	Duplicate	02/11/97	0836	43	20	7.2	1.5	121	123	0	150
413950087002604	1-DG-4	Duplicate	05/20/97	1606	3.69	.83	1.4	.6	3	2	0	2
413950087002605	1-DG-5	Duplicate	02/06/96	1321	3.6	1.1	1.4	<.1	2	2	0	3
413950087002606	1-DG-WT	Equipment	03/28/95	1236	.24	.05	1.4	<.1	0	0	0	0
413950087002606	1-DG-WT	Equipment	10/31/95	0901	.2	<.10	<.1	<.1	--	--	--	--
413950087002606	1-DG-WT	Equipment	02/06/96	1526	<.10	<.10	<.1	<.1	--	--	--	--
413950087002606	1-DG-WT	Equipment	02/06/96	1531	.2	.1	.1	<.1	--	--	--	--
413950087002606	1-DG-WT	Equipment	05/07/96	1351	.04	<.01	<.2	<.1	--	--	--	--
413950087002606	1-DG-WT	Duplicate	11/07/96	1221	2.8	.41	120	.1	158	160	0	195
413950087002606	1-DG-WT	Equipment	11/07/96	1236	.03	.01	<.2	<.1	--	--	--	--
413950087002606	1-DG-WT	Equipment	05/20/97	1231	.21	.03	1.6	<.1	--	--	--	--
413950087002504	ALT-1-DG-4	Duplicate	08/14/96	1446	3.4	1.1	1.6	.5	1	0	0	0
413950087002506	ALT-1-DG-WT	Equipment	08/14/96	1751	.73	.02	.3	<.1	--	--	--	--

Table 12. Quality-assurance data for ground-water samples from Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1995–97—Continued

USGS station identification number	Well name	Type of quality-assurance sample	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	ANC-FET (mg/L as $CaCO_3$)	ANC-IT (mg/L as $CaCO_3$)	ANC-CO_3 (mg/L as CO_3)	ANC-HCO_3 (mg/L as HCO_3)
413950087002506	ALT-1-DG-WT	Equipment	02/11/97	1316	0.05	<0.01	<0.2	<0.1	--	--	--	--
413951087002601	2-DG-1	Duplicate	05/09/96	1301	61	52	45	3.3	449	450	0	549
413951087002602	2-DG-2	Duplicate	02/07/96	0941	74	60	25	3.1	456	459	0	560
413951087002602	2-DG-2	Duplicate	02/19/97	0946	67	53	23	3	--	--	--	--
413951087002604	2-DG-4	Duplicate	11/06/96	1611	4.1	1.2	1.7	.5	2	1	0	1
413953087002601	3-DG-1	Duplicate	04/05/95	1001	61	52	30	3.2	452	457	0	558
413953087002601	3-DG-1	Duplicate	11/06/95	1751	69	57	35	3.2	433	435	0	531
413953087002602	3-DG-2	Duplicate	08/13/96	1326	65	57	24	2.8	425	429	0	523
413953087002603	3-DG-3	Duplicate	11/12/96	1621	46	21	9.9	1.3	166	168	0	205
413953087002603	3-DG-3	Duplicate	05/16/97	0811	57.3	21.6	6.8	1.3	179	180	0	220
413953087002605	3-DG-5	Duplicate	02/07/96	1446	35	11	35	2.1	96	98	0	120
413953087002606	3-DG-WT	Equipment	04/06/95	1100	.1	.03	.3	<.1	0	0	0	0
413953087002606	3-DG-WT	Equipment	11/06/95	1541	<.10	<.10	<.1	<.1	--	--	--	--
413953087002606	3-DG-WT	Equipment	05/06/96	1726	.17	.03	<.2	<.1	--	--	--	--
413953087002606	3-DG-WT	Equipment	08/13/96	1431	.2	.98	.4	<.1	--	--	--	--
413953087002606	3-DG-WT	Equipment	11/12/96	1356	.1	.02	<.2	<.1	--	--	--	--
413953087002606	3-DG-WT	Equipment	02/12/97	1531	.04	<.01	<.2	<.1	--	--	--	--
413953087002606	3-DG-WT	Equipment	05/16/97	1206	.09	.02	<.2	<.1	--	--	--	--
413943087003203	REP-1-UG-5	Duplicate	05/07/96	1021	3.7	1.4	1.3	<.1	3	2	0	3
413943087003201	REP-1-UG-WT	Duplicate	08/16/96	0911	3.4	.94	1.8	.3	3	2	0	2
413947087003202	REP-1-DG-5	Duplicate	02/14/97	1146	7	1.9	1.3	1	28	28	0	34

Table 12. Quality-assurance data for ground-water samples from Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1995–97—Continued

USGS station identification number	Well name	Type of quality-assurance sample	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Sulfate (mg/L)	Fluoride (mg/L)	Bromide (mg/L)	Iodide (mg/L)	Silica (mg/L)	Iron (µg/L)	Manga-nese (µg/L)
413946087002602	1-UG-2	Duplicate	05/08/96	1606	3.1	0.5	--	0.006	--	--	--
413946087002603	1-UG-3	Duplicate	11/02/95	1131	39	<.1	--	.003	11	1,800	40
413946087002604	1-UG-4	Duplicate	03/30/95	1046	20	<.1	<.01	.001	6.6	10	9
413946087002604	1-UG-4	Duplicate	11/13/96	1501	17	<.1	--	.003	--	--	--
413946087002605	1-UG-5	Duplicate	02/13/97	1401	12	<.1	--	.004	5.1	210	<1
413946087002606	1-UG-WT	Duplicate	05/14/97	1021	14.7	<.1	--	.003	4.7	30	<1
413947087002606	ALT-1-UG-WT	Duplicate	02/08/96	1106	12	<.1	--	.001	--	--	--
413947087002606	ALT-1-UG-WT	Duplicate	08/20/96	1051	21	<.1	--	.002	--	--	--
413950087002601	1-DG-1	Duplicate	03/27/95	1551	<.1	.5	.14	.007	20	1,500	15
413950087002601	1-DG-1	Duplicate	11/01/95	1226	<.1	.4	--	.006	18	1,500	10
413950087002601	1-DG-1	Duplicate	05/07/96	1906	<.1	.5	--	.007	--	--	--
413950087002603	1-DG-3	Duplicate	02/11/97	0836	62	<.1	--	.003	12	3,100	85
413950087002604	1-DG-4	Duplicate	05/20/97	1606	12.1	<.1	--	<.001	9.3	100	6
413950087002605	1-DG-5	Duplicate	02/06/96	1321	10	<.1	--	<.001	--	--	--
413950087002606	1-DG-WT	Equipment	03/28/95	1236	<.1	<.1	<.01	<.001	--	10	<1
413950087002606	1-DG-WT	Equipment	10/31/95	0901	<.1	<.1	--	.001	<.1	<10	<10
413950087002606	1-DG-WT	Equipment	02/06/96	1526	<.1	<.1	--	.001	--	--	--
413950087002606	1-DG-WT	Equipment	02/06/96	1531	<.1	<.1	--	.001	--	--	--
413950087002606	1-DG-WT	Equipment	05/07/96	1351	<.1	<.1	--	<.001	--	--	--
413950087002606	1-DG-WT	Duplicate	11/07/96	1221	21	.1	--	.004	--	--	--
413950087002606	1-DG-WT	Equipment	11/07/96	1236	<.1	<.1	--	<.001	--	--	--
413950087002606	1-DG-WT	Equipment	05/20/97	1231	<.1	<.1	--	<.001	0.2	<1	<1
413950087002504	ALT-1-DG-4	Duplicate	08/14/96	1446	21	.1	--	<.001	--	--	--

Table 12. Quality-assurance data for ground-water samples from Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1995–97—Continued

USGS station identification number	Well name	Type of quality-assurance sample	Date sampled (mm/dd/yy)	Time sampled (hhmm)	Sulfate (mg/L)	Fluoride (mg/L)	Bromide (mg/L)	Iodide (mg/L)	Silica (mg/L)	Iron (µg/L)	Manga-nese (µg/L)
413950087002506	ALT-1-DG-WT	Equipment	08/14/96	1751	<0.1	<0.1	--	<0.001	--	--	--
413950087002506	ALT-1-DG-WT	Equipment	02/11/97	1316	<.1	<.1	--	.001	.2	<1	<1
413951087002601	2-DG-1	Duplicate	05/09/96	1301	<.1	.6	--	.007	--	--	--
413951087002602	2-DG-2	Duplicate	02/07/96	0941	<.1	.5	--	.005	--	--	--
413951087002602	2-DG-2	Duplicate	02/19/97	0946	5.1	.5	--	.005	20	470	19
413951087002604	2-DG-4	Duplicate	11/06/96	1611	16	<.1	--	<.001	--	--	--
413953087002601	3-DG-1	Duplicate	04/05/95	1001	.1	.5	.17	.004	18	970	30
413953087002601	3-DG-1	Duplicate	11/06/95	1751	<.1	.4	--	.005	17	860	40
413953087002602	3-DG-2	Duplicate	08/13/96	1326	11	.4	--	.004	--	--	--
413953087002603	3-DG-3	Duplicate	11/12/96	1621	47	<.1	--	.003	--	--	--
413953087002603	3-DG-3	Duplicate	05/16/97	0811	54.9	<.1	--	.003	13.9	3,380	115
413953087002605	3-DG-5	Duplicate	02/07/96	1446	41	<.1	--	.003	--	--	--
413953087002606	3-DG-WT	Equipment	04/06/95	1100	.1	<.1	<.01	<.001	--	20	<1
413953087002606	3-DG-WT	Equipment	11/06/95	1541	<.1	<.1	--	<.001	<.1	<10	<10
413953087002606	3-DG-WT	Equipment	05/06/96	1726	<.1	<.1	--	<.001	--	--	--
413953087002606	3-DG-WT	Equipment	08/13/96	1431	<.1	<.1	--	<.001	--	--	--
413953087002606	3-DG-WT	Equipment	11/12/96	1356	.2	<.1	--	<.001	--	--	--
413953087002606	3-DG-WT	Equipment	02/12/97	1531	<.1	<.1	--	<.001	<.1	10	<1
413953087002606	3-DG-WT	Equipment	05/16/97	1206	<.1	<.1	--	<.001	.2	20	<1
413943087003203	REP-1-UG-5	Duplicate	05/07/96	1021	14	<.1	--	.001	--	--	--
413943087003201	REP-1-UG-WT	Duplicate	08/16/96	0911	13	<.1	--	<.001	--	--	--
413947087003202	REP-1-DG-5	Duplicate	02/14/97	1146	13	<.1	--	.009	6.5	7,400	250

Table 13. Data for calculations of horizontal hydraulic conductivity by use of the method of Bouwer and Rice (1976) from slug tests done in monitoring wells at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, December 1996

[A, B, and C are dimensionless aquifer coefficients related to L/r_w ; D, saturated thickness of aquifer; H, depth of penetration of well into aquifer, L, effective length of well screen; r_c , nominal inside radius of well casing: r_w , distance from center of well to undisturbed aquifer; y_0 , water level at start of test; y_t , water level at time, t; t, time; K, hydraulic conductivity; R_e , effective radius over which head loss is dissipated]

Well name and slug test identifier	A	B	C	D (feet)	H (feet)	L (feet)	r_c (feet)	r_w (feet)	y_0 (feet)	y_t (feet)	t (minutes)	K (feet per minute)	$ln\left(\frac{R_e}{r_w}\right)$	K (feet per day)
1-UG-1(a)	1.78	0.26	1.11	29.90	29.90	0.670	0.083	0.083	1.210	0.552	0.800	$1.56x10^{-2}$	3.09	22.4
1-UG-1(b)	1.78	.26	1.11	29.90	29.90	.670	.083	.083	1.280	.524	.900	$1.57x10^{-2}$	3.09	22.7
1-UG-2(a)	1.78	.26	1.11	29.90	21.50	.670	.083	.083	.952	.193	.750	$1.93x10^{-2}$	1.77	27.8
1-UG-2(b)	1.78	.26	1.11	29.90	21.50	.670	.083	.083	.742	.341	.367	$1.92x10^{-2}$	1.77	27.7
1-UG-3(a)	1.78	.26	1.11	29.90	14.90	.670	.083	.083	.717	.116	.700	$2.24x10^{-2}$	1.67	32.2
1-UG-3(b)	1.78	.26	1.11	29.90	14.90	.670	.083	.083	1.074	.114	.850	$2.27x10^{-2}$	1.67	32.6
1-UG-4(a)	1.78	.26	1.11	29.90	7.70	.670	.083	.083	.356	.031	1.800	$1.09x10^{-2}$	1.56	15.6
1-UG-4(b)	1.78	.26	1.11	29.90	7.70	.670	.083	.083	1.088	.342	.350	$2.65x10^{-2}$	1.56	38.1
1-DG-1(a)	1.78	.26	1.11	29.90	26.50	.670	.083	.083	1.241	.016	3.150	$1.34x10^{-2}$	1.89	19.3
1-DG-1(b)	1.78	.26	1.11	29.90	26.50	.670	.083	.083	1.379	.395	.950	$1.28x10^{-2}$	1.89	18.4
1-DG-1(c)	1.78	.26	1.11	29.90	26.50	.670	.083	.083	1.019	.379	.720	$1.33x10^{-2}$	1.89	19.2
1-DG-1(d)	1.78	.26	1.11	29.90	26.50	.670	.083	.083	1.202	.015	3.060	$1.39x10^{-2}$	1.89	20.0
1-DG-2(a)	1.78	.26	1.11	29.90	21.40	.670	.083	.083	.867	.285	.666	$1.52x10^{-2}$	1.77	21.8
1-DG-2(b)	1.78	.26	1.11	29.90	21.40	.670	.083	.083	.907	.281	.700	$1.52x10^{-2}$	1.77	21.9
1-DG-2(c)	1.78	0.26	1.11	29.90	21.40	.670	0.083	0.083	.762	0.281	.600	$1.51x10^{-2}$	1.77	21.7
1-DG-3(a)	1.78	.26	1.11	29.90	16.40	.670	.083	.083	.900	.171	.567	$2.54x10^{-2}$	1.69	36.7
1-DG-3(b)	1.78	.26	1.11	29.90	16.40	.670	.083	.083	1.126	.085	.900	$2.50x10^{-2}$	1.69	36.0
1-DG-4(a)	1.78	.26	1.11	29.90	11.40	.670	.083	.083	1.003	.085	.810	$2.54x10^{-2}$	1.62	36.6
1-DG-4(b)	1.78	.26	1.11	29.90	11.40	.670	.083	.083	1.000	.538	.216	$2.39x10^{-2}$	1.62	34.5

Table 13. Data for calculations of horizontal hydraulic conductivity by use of the method of Bouwer and Rice (1976) from slug tests done in monitoring wells at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, December 1996—Continued

Well name and slug test identifier	A	B	C	D (feet)	H (feet)	L (feet)	r_c (feet)	r_w (feet)	y_0 (feet)	y_t (feet)	t (minutes)	K (feet per minute)	$ln\left(\frac{R_e}{r_w}\right)$	K (feet per day)
1-DG-4(c)	1.78	0.26	1.11	29.90	11.40	0.670	0.083	0.083	0.880	0.082	0.783	$2.53x10^{-2}$	1.62	36.4
1-DG-4(d)	1.78	.26	1.11	29.90	11.40	.670	.083	.083	1.329	.490	.350	$2.38x10^{-2}$	1.62	34.2
1-DG-5(a)	1.78	.26	1.11	29.90	8.40	.670	.083	.083	1.208	.392	.333	$2.73x10^{-2}$	1.57	39.3
1-DG-5(b)	1.78	.26	1.11	29.90	8.40	.670	.083	.083	.818	.104	.600	$2.78x10^{-2}$	1.57	40.0
1-DG-5(c)	1.78	.26	1.11	29.90	8.40	.670	.083	.083	.859	.104	.600	$2.84x10^{-2}$	1.57	41.0
1-DG-5(d)	1.78	.26	1.11	29.90	8.40	.670	.083	.083	1.083	.101	.700	$2.74x10^{-2}$	1.57	39.4
1-DG-WT	3.20	.52	2.91	29.90	3.40	4.670	.083	.083	.315	.110	.250	$7.64x10^{-3}$	2.46	11.0
2-DG-1(a)	1.78	.26	1.11	29.50	26.80	.670	.083	.083	1.299	.446	.850	$1.24x10^{-2}$	1.92	17.8
2-DG-1(b)	1.78	.26	1.11	29.50	26.80	.670	.083	.083	1.184	.032	2.700	$1.32x10^{-2}$	1.92	19.0
2-DG-2(a)	1.78	.26	1.11	29.50	21.70	.670	.083	.083	1.170	.278	.850	$1.54x10^{-2}$	1.78	22.2
2-DG-2(b)	1.78	.26	1.11	29.50	21.70	.670	.083	.083	1.199	.319	.750	$1.61x10^{-2}$	1.78	23.2
2-DG-3(a)	1.78	.26	1.11	29.50	16.60	.670	.083	.083	.964	.094	.650	$3.12x10^{-2}$	1.70	45.0
2-DG-3(b)	1.78	.26	1.11	29.50	16.60	.670	.083	.083	.946	.072	.700	$3.21x10^{-2}$	1.70	46.2
2-DG-3(c)	1.78	.26	1.11	29.50	16.60	.670	.083	.083	1.114	.095	.680	$3.16x10^{-2}$	1.70	45.5
2-DG-4(a)	1.78	.26	1.11	29.50	11.60	.670	.083	.083	.838	.050	.800	$2.95x10^{-2}$	1.63	42.4
2-DG-4(b)	1.78	.26	1.11	29.50	11.60	.670	.083	.083	.825	.151	.470	$3.02x10^{-2}$	1.63	43.5
2-DG-5(a)	1.78	.26	1.11	29.50	4.50	.670	.083	.083	1.020	.224	.600	$1.92x10^{-2}$	1.47	27.6
2-DG-5(b)	1.78	.26	1.11	29.50	4.50	.670	.083	.083	1.200	.240	.630	$1.94x10^{-2}$	1.47	27.9
2-DG-WT	3.20	.52	2.91	29.50	4.50	4.670	.083	.083	.511	.091	.350	$9.45x10^{-3}$	2.60	13.6
3-DG-1(a)	1.78	.26	1.11	25.80	22.90	.670	.083	.083	1.189	.440	.700	$1.38x10^{-2}$	1.89	19.8
3-DG-1(b)	1.78	.26	1.11	25.80	22.90	.670	.083	.083	1.366	.424	.900	$1.26x10^{-2}$	1.89	18.2
3-DG-1(c)	1.78	.26	1.11	25.80	22.90	.670	.083	.083	1.144	.402	.800	$1.27x10^{-2}$	1.89	18.3
3-DG-1(d)	1.78	.26	1.11	25.80	22.90	.670	.083	.083	1.337	.434	.900	$1.21x10^{-2}$	1.89	17.5

Table 13. Data for calculations of horizontal hydraulic conductivity by use of the method of Bouwer and Rice (1976) from slug tests done in monitoring wells at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, December 1996

Well name and slug test identifier	A	B	C	D (feet)	H (feet)	L (feet)	r_c (feet)	r_w (feet)	y_0 (feet)	y_t (feet)	t (minutes)	K (feet per minute)	$ln\left(\frac{R_e}{r_w}\right)$	K (feet per day)
3-DG-2(a)	1.78	0.26	1.11	25.80	20.20	0.670	0.083	0.083	1.314	0.399	0.890	$1.24x10^{-2}$	1.80	17.9
3-DG-2(b)	1.78	.26	1.11	25.80	20.20	.670	.083	.083	1.271	.418	.800	$1.29x10^{-2}$	1.80	18.5
3-DG-2(c)	1.78	.26	1.11	25.80	20.20	.670	.083	.083	1.314	.396	.900	$1.23x10^{-2}$	1.80	17.8
3-DG-2(d)	1.78	.26	1.11	25.80	20.20	.670	.083	.083	1.252	.409	.800	$1.30x10^{-2}$	1.80	18.6
3-DG-3(a)	1.78	.26	1.11	25.80	14.70	.670	.083	.083	1.327	.129	.940	$2.16x10^{-2}$	1.70	31.2
3-DG-3(b)	1.78	.26	1.11	25.80	14.70	.670	.083	.083	1.058	.139	.800	$2.21x10^{-2}$	1.70	31.9
3-DG-3(c)	1.78	.26	1.11	25.80	14.70	.670	.083	.083	1.365	.133	.950	$2.14x10^{-2}$	1.70	30.8
3-DG-3(d)	1.78	.26	1.11	25.80	14.70	.670	.083	.083	1.126	.368	.476	$2.05x10^{-2}$	1.70	29.5
3-DG-4(a)	1.78	.26	1.11	25.80	9.60	.670	.083	.083	1.186	.142	.900	$1.95x10^{-2}$	1.61	28.1
3-DG-4(b)	1.78	.26	1.11	25.80	9.60	.670	.083	.083	1.086	.151	.800	$2.04x10^{-2}$	1.61	29.4
3-DG-4(c)	1.78	.26	1.11	25.80	9.60	.670	.083	.083	1.186	.139	.900	$1.98x10^{-2}$	1.61	28.4
3-DG-4(d)	1.78	.26	1.11	25.80	9.60	.670	.083	.083	1.064	.158	.780	$2.03x10^{-2}$	1.61	29.2
3-DG-5(a)	1.78	.26	1.11	25.80	2.20	.670	.083	.083	.571	.284	.900	$5.42x10^{-3}$	1.36	7.80
3-DG-5(b)	1.78	.26	1.11	25.80	2.20	.670	.083	.083	.564	.078	2.500	$5.52x10^{-3}$	1.36	7.95
3-DG-5(c)	1.78	.26	1.11	25.80	2.20	.670	.083	.083	.574	.284	.920	$5.34x10^{-3}$	1.36	7.69
3-DG-5(d)	1.78	.26	1.11	25.80	2.20	.670	.083	.083	.568	.284	.900	$5.38x10^{-3}$	1.36	7.74
3-DG-WT (a)	3.20	.52	2.91	25.80	5.80	4.670	.083	.083	1.127	.088	.900	$5.70x10^{-3}$	2.73	8.21
3-DG-WT (b)	3.20	.52	2.91	25.80	5.80	4.670	.083	.083	1.067	.082	.900	$5.74x10^{-3}$	2.73	8.26

Table 14. Average linear ground-water-velocity calculations and hydraulic-property information for wells 2-DG-WT, 2-DG-5, and 2-DG-4 at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97 data

[mm/dd/yy, month/day/year; Water levels are reported in feet above sea level. Hydraulic gradient = (water level in 1-DG well – Water level in 3-DG well) / 406 feet (the distance from well nest 1-DG to 3-DG). Specific velocity = Hydraulic conductivity × Hydraulic gradient / porosity (assumed to be 0.3 for computations)]

Date (mm/dd/yy)	Water level in 1-DG-WT	Water level in 3-DG-WT	Hydraulic gradient (foot per foot)	Minimum hydraulic conductivity (feet per day)	Mean hydraulic conductivity (feet per day)	Maximum hydraulic conductivity (feet per day)	Minimum average linear ground-water velocity (feet per day)	Mean average linear ground-water velocity (feet per day)	Maximum average linear ground-water velocity (feet per day)
Well 2-DG-WT									
12/15/94	616.68	612.54	0.0102	8	11	14	0.27	0.37	0.48
01/31/95	616.87	612.53	.0107	8	11	14	.29	.39	.50
02/28/95	617.12	612.63	.0111	8	11	14	.29	.41	.52
04/05/95	617.25	612.55	.0116	8	11	14	.31	.42	.54
04/27/95	617.5	612.71	.0118	8	11	14	.31	.43	.55
06/01/95	617.51	612.58	.0121	8	11	14	.32	.45	.57
06/28/95	616.61	612.66	.0097	8	11	14	.26	.36	.45
08/03/95	615.71	612.56	.0078	8	11	14	.21	.28	.36
09/07/95	614.94	611.09	.0095	8	11	14	.25	.35	.44
11/06/95	614.84	612.34	.0062	8	11	14	.16	.23	.29
12/04/95	615.58	612.17	.0084	8	11	14	.22	.31	.39
01/11/96	615.73	612.13	.0089	8	11	14	.24	.33	.41
02/07/96	615.55	611.97	.0088	8	11	14	.24	.32	.41
03/14/96	616.27	612.47	.0094	8	11	14	.25	.34	.44
04/11/96	616.00	612.26	.0092	8	11	14	.25	.34	.43
05/06/96	616.58	612.43	.0102	8	11	14	.27	.37	.48
06/13/96	617.72	612.67	.0124	8	11	14	.33	.46	.58
07/11/96	616.74	612.12	.0114	8	11	14	.30	.42	.53
08/13/96	616.4	612.2	.0103	8	11	14	.28	.38	.48
09/10/96	615.5	611.17	.0107	8	11	14	.28	.39	.50
10/10/96	615.9	612.45	.0085	8	11	14	.23	.31	.40
11/12/96	616.26	612.52	.0092	8	11	14	.25	.34	.43
12/10/96	616.59	612.54	.0100	8	11	14	.27	.37	.47
01/23/97	616.53	612.54	.0098	8	11	14	.26	.36	.46
02/12/97	616.92	612.57	.0107	8	11	14	.29	.39	.50
03/11/97	617.52	612.63	.0120	8	11	14	.32	.44	.56
04/23/97	617.13	612.59	.0112	8	11	14	.30	.41	.52
05/16/97	617.09	612.56	.0112	8	11	14	.30	.41	.52
06/17/97	617.69	612.7	.0123	8	11	14	.33	.45	.57

Table 14. Average linear ground-water-velocity calculations and hydraulic-property information for wells 2-DG-WT, 2-DG-5, and 2-DG-4 at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97 data—Continued

Date (mm/dd/yy)	Water level in 1-DG-5	Water level in 3-DG-5	Hydraulic gradient (foot per foot)	Minimum hydraulic conductivity (feet per day)	Mean hydraulic conductivity (feet per day)	Maximum hydraulic conductivity (feet per day)	Minimum average linear ground-water velocity (feet per day)	Mean average linear ground-water velocity (feet per day)	Maximum average linear ground-water velocity (feet per day)
					Well 2-DG-5				
12/15/94	616.66	612.88	0.0093	8	25	40	0.25	0.78	1.24
01/31/95	616.86	612.88	.0098	8	25	40	.26	.82	1.31
02/28/95	617.12	612.95	.0103	8	25	40	.27	.86	1.37
04/05/95	617.24	612.9	.0107	8	25	40	.29	.89	1.43
04/27/95	617.5	613.08	.0109	8	25	40	.29	.91	1.45
06/01/95	617.51	612.93	.0113	8	25	40	.30	.94	1.50
06/28/95	616.61	613.1	.0086	8	25	40	.23	.72	1.15
08/03/95	615.67	612.89	.0068	8	25	40	.18	.57	.91
11/06/95	614.97	612.7	.0056	8	25	40	.15	.47	.75
12/04/95	615.57	612.52	.0075	8	25	40	.20	.63	1.00
01/11/96	615.44	612.49	.0073	8	25	40	.19	.61	.97
02/07/96	615.54	612.31	.0080	8	25	40	.21	.66	1.06
03/14/96	616.25	612.82	.0084	8	25	40	.23	.70	1.13
04/11/96	615.99	612.61	.0083	8	25	40	.22	.69	1.11
05/06/96	616.57	612.78	.0093	8	25	40	.25	.78	1.24
06/13/96	617.71	613.04	.0115	8	25	40	.31	.96	1.53
07/11/96	616.73	612.45	.0105	8	25	40	.28	.88	1.41
08/13/96	616.38	612.54	.0095	8	25	40	.25	.79	1.26
09/10/96	615.49	611.5	.0098	8	25	40	.26	.82	1.31
10/10/96	615.87	612.8	.0076	8	25	40	.20	.63	1.01
11/12/96	616.24	612.87	.0083	8	25	40	.22	.69	1.11
12/10/96	616.56	612.89	.0090	8	25	40	.24	.75	1.21
01/23/97	616.5	612.89	.0089	8	25	40	.24	.74	1.19
02/12/97	616.89	612.92	.0098	8	25	40	.26	.81	1.30
03/11/97	617.49	612.99	.0111	8	25	40	.30	.92	1.48
04/23/97	617.1	612.96	.0102	8	25	40	.27	.85	1.36
05/16/97	617.05	612.92	.0102	8	25	40	.27	.85	1.36
06/17/97	617.66	613.07	.0113	8	25	40	.30	.94	1.51

Table 14. Average linear ground-water-velocity calculations and hydraulic-property information for wells 2-DG-WT, 2-DG-5, and 2-DG-4 at Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97 data—Continued

Date (mm/dd/yy)	Water level in 1-DG-4	Water level in 3-DG-4	Hydraulic gradient (foot per foot)	Minimum hydraulic conductivity (feet per day)	Mean hydraulic conductivity (feet per day)	Maximum hydraulic conductivity (feet per day)	Minimum average linear ground-water velocity (feet per day)	Mean average linear ground-water velocity (feet per day)	Maximum average linear ground-water velocity (feet per day)
					Well 2-DG-4				
12/15/94	616.69	612.99	0.0091	27	34	43	0.82	1.03	1.31
01/31/95	616.85	612.99	.0095	27	34	43	.86	1.08	1.36
02/28/95	617.12	613.1	.0099	27	34	43	.89	1.12	1.42
04/05/95	617.25	613.04	.0104	27	34	43	.93	1.18	1.49
04/27/95	617.48	613.17	.0106	27	34	43	.96	1.20	1.52
06/01/95	617.51	613.06	.0110	27	34	43	.99	1.24	1.57
06/28/95	616.6	613.1	.0086	27	34	43	.78	.98	1.24
08/03/95	615.67	613.05	.0065	27	34	43	.58	.73	.92
09/07/95	614.97	611.56	.0084	27	34	43	.76	.95	1.20
09/20/95	614.64	611.18	.0085	27	34	43	.77	.97	1.22
11/06/95	614.83	612.8	.0050	27	34	43	.45	.57	.72
12/04/95	615.57	612.64	.0072	27	34	43	.65	.82	1.03
01/11/96	615.43	612.61	.0069	27	34	43	.63	.79	1.00
02/07/96	615.53	612.45	.0076	27	34	43	.68	.86	1.09
03/14/96	616.26	612.95	.0082	27	34	43	.73	.92	1.17
04/11/96	615.98	612.72	.0080	27	34	43	.72	.91	1.15
05/06/96	616.57	612.91	.0090	27	34	43	.81	1.02	1.29
06/13/96	617.71	613.11	.0113	27	34	43	1.02	1.28	1.62
07/11/96	616.72	612.63	.0101	27	34	43	.91	1.14	1.44
08/13/96	616.39	612.68	.0091	27	34	43	.82	1.04	1.31
09/10/96	615.49	611.63	.0095	27	34	43	.86	1.08	1.36
10/10/96	615.88	612.92	.0073	27	34	43	.66	.83	1.04
11/12/96	616.25	613	.0080	27	34	43	.72	.91	1.15
12/10/96	616.56	613	.0088	27	34	43	.79	.99	1.26
01/23/97	617.23	613.01	.0104	27	34	43	.94	1.18	1.49
02/12/97	616.9	613.04	.0095	27	34	43	.86	1.08	1.36
03/11/97	617.5	613.11	.0108	27	34	43	.97	1.23	1.55
04/23/97	617.11	613.07	.0100	27	34	43	.90	1.13	1.43
05/16/97	617.07	613.04	.0099	27	34	43	.89	1.12	1.42
06/17/97	617.67	613.19	.0110	27	34	43	.99	1.25	1.58
08/21/97	616.35	612.95	.0084	27	34	43	.75	.95	1.20

Table 15. Statistical summary of ground-water-quality data from Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97

[^{o}C, degree Celsius; µS/cm, microsiemens per centimeter; Number, number of measurements or determinations used in computations; Min, minimum value; Q1, 25th percentile or first quartile; Med, median value; Q3, 75th percentile or third quartile; Max, maximum value; --, not measured; mg/L, milligrams per liter; <, less than; µg/L, micrograms per liter]

Well name	Temperature (^{o}C)						Specific conductance (µS/cm)					
	Number	Min	Q1	Med	Q3	Max	Number	Min	Q1	Med	Q3	Max
1-UG-1	30	10.1	10.8	11.1	11.6	12.7	30	783	807	818	825	894
1-UG-2	30	10.2	10.8	11.0	11.4	12.3	30	660	685	720	728	795
1-UG-3	30	9.8	10.4	10.9	11.2	12.2	30	153	207	239	251	270
1-UG-4	30	8.8	9.5	10.4	11.6	13.2	30	47	56	59	75	121
1-UG-5	23	7.5	8.3	9.2	10.9	14.8	23	98	121	158	186	228
1-UG-WT	30	7.7	8.8	10.6	11.9	14.6	30	49	63	94	124	164
ALT-1-UG-1	15	10.3	11.0	11.4	11.6	12.2	15	814	828	834	840	849
ALT-1-UG-2	14	10.6	10.9	11.0	11.2	11.9	14	689	778	788	796	806
ALT-1-UG-3	14	9.7	10.7	11.3	11.7	12.4	14	158	180	192	195	240
ALT-1-UG-4	15	8.7	10.1	11.7	12.4	13.1	15	53	57	63	71	104
ALT-1-UG-5	23	7.3	8.2	10.8	13.3	17.6	23	55	61	64	81	158
ALT-1-UG-WT	23	7.5	8.7	10.9	13.1	14.7	23	52	61	79	108	137
1-DG-1	31	9.7	11.4	11.6	12.0	14.0	31	770	799	808	814	835
1-DG-2	30	9.6	10.9	11.7	12.1	13.7	30	720	736	754	774	808
1-DG-3	30	9.3	10.3	11.5	12.8	13.7	30	236	305	378	404	462
1-DG-4	31	7.9	9.6	11.4	14.2	15.9	31	38	39	42	69	99
1-DG-5	31	5.3	7.8	10.7	16.2	19.9	31	34	38	42	74	1,920
1-DG-WT	29	4.1	6.7	9.7	15.6	21.2	29	72	537	1,170	2,740	4,530
ALT-1-DG-1	14	10.9	11.5	11.8	12.3	14.2	14	722	794	801	811	833
ALT-1-DG-2	14	10.5	11.5	11.9	12.1	12.8	14	564	604	622	634	679
ALT-1-DG-3	14	9.6	11.1	12.2	13.1	13.7	14	143	188	228	282	329
ALT-1-DG-4	14	8.9	10.1	12.5	14.8	16.5	14	53	58	60	62	229
ALT-1-DG-5	31	5.3	8.3	11.1	16.5	19.9	31	34	39	41	55	679
ALT-1-DG-WT	21	5.3	6.4	9.4	15.9	21.5	21	120	349	557	1,900	3,240
2-DG-1	29	10.5	11.4	11.8	12.4	13.6	29	770	791	803	809	840
2-DG-2	30	10.7	11.5	12.0	12.3	13.7	30	753	779	791	808	838
2-DG-3	29	9.3	10.7	11.9	12.6	13.7	29	418	442	473	523	542
2-DG-4	29	9.0	10.1	11.2	12.9	14.9	29	40	42	48	85	440
2-DG-5	30	5.9	8.1	10.5	14.9	18.4	30	46	59	191	375	1,380
2-DG-WT	28	4.4	6.4	9.2	14.8	21.1	28	267	410	533	782	1,160
3-DG-1	31	9.9	10.7	11.2	11.4	12.1	31	755	776	784	799	822
3-DG-2	29 (1)	9.7	10.2	11.2	11.6	12.2	30	765	780	798	814	998
3-DG-3	30	8.8	9.4	10.6	12.2	13.3	30	338	398	442	506	812
3-DG-4	31	7.0	8.4	11.0	13.2	15.5	31	92	113	205	339	632
3-DG-5	28	2.1	4.9	9.2	14.4	20.3	28	391	417	471	513	547
3-DG-WT	31	3.7	6.6	9.4	14.9	18.4	31	192	414	451	498	582

Table 15. Statistical summary of ground-water-quality data from Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994-97—Continued

Well name	Temperature (°C)						Specific conductance (µS/cm)					
	Number	Min	Q1	Med	Q3	Max	Number	Min	Q1	Med	Q3	Max
REP-1-UG-3	14	9.3	10.1	10.8	11.5	12.1	14	173	216	280	348	375
REP-1-UG-5	13	5.2	8.3	11.6	15.4	19.1	13	40	44	46	47	84
REP-1-UG-WT	21	5.6	7.6	9.8	13.4	15.5	21	38	42	45	71	100
REP-1-DG-3	30	9.4	10.2	11.3	12.1	13.2	30	141	293	360	408	429
REP-1-DG-5	30	5.5	7.4	10.5	15.1	19.1	30	58	82	99	135	2,520
REP-2-DG-3	30	10.1	10.7	11.4	11.7	12.1	30	330	438	466	483	499
REP-2-DG-5	30	5.5	7.8	9.9	13.0	15.6	30	62	94	141	513	2,000

Well name	pH (standard units)						Dissolved oxygen (mg/L)					
	Number	Min	Q1	Med	Q3	Max	Number	Min	Q1	Med	Q3	Max
1-UG-1	30	7.3	7.4	7.5	7.6	8.3	30	0.1	0.1	0.1	0.2	0.3
1-UG-2	30	7.0	7.4	7.5	7.6	7.9	30	.1	.1	.1	.2	.3
1-UG-3	30	5.9	6.1	6.2	6.3	7.7	30	.1	.1	.2	.2	.4
1-UG-4	30	4.8	5.0	5.2	5.2	5.4	30	.1	.2	.4	.8	2.6
1-UG-5	24	5.8	6.5	6.7	6.8	7.8	23	.1	1.5	2.6	3.5	11.8
1-UG-WT	30	5.3	5.8	6.2	6.5	6.9	30	.8	3.5	4.4	5.6	9.5
ALT-1-UG-1	15	7.3	7.3	7.6	7.7	8.0	15	.1	.1	.1	.1	.2
ALT-1-UG-2	14	7.3	7.3	7.5	7.6	7.8	14	.1	.1	.1	.1	.2
ALT-1-UG-3	14	5.9	6.0	6.0	6.2	6.9	14	.1	.1	.2	.2	.4
ALT-1-UG-4	15	4.9	5.0	5.1	5.2	5.5	15	.1	.2	.3	.4	.9
ALT-1-UG-5	24	5.3	5.7	5.9	6.2	7.3	23	.5	3.2	5.2	6.8	10.0
ALT-1-UG-WT	23	5.6	5.7	6.0	6.2	6.5	22	2.9	3.8	4.9	5.5	6.4
1-DG-1	31	7.3	7.4	7.5	7.6	7.9	31	<.1	.1	.1	.1	.2
1-DG-2	30	7.2	7.4	7.4	7.5	7.7	30	<.1	.1	.1	.2	.2
1-DG-3	30	6.4	6.6	6.7	6.7	7.1	30	<.1	.1	.1	.2	.3
1-DG-4	31	4.6	4.8	4.8	5.0	5.4	31	.1	.1	.2	.2	.4
1-DG-5	31	4.3	4.9	5.2	5.3	5.8	31	3.7	4.1	6.0	6.6	8.0
1-DG-WT	29	5.9	6.5	6.8	7.0	7.4	28 (1)	3.8	6.7	7.5	8.4	12
ALT-1-DG-1	14	7.2	7.4	7.6	7.7	7.9	12 (2)	<.1	.1	.1	.1	.2
ALT-1-DG-2	14	7.2	7.3	7.4	7.5	7.6	14	<.1	.1	.1	.1	.2
ALT-1-DG-3	14	6.0	6.1	6.2	6.2	6.5	14	.1	.1	.1	.1	.2
ALT-1-DG-4	14	4.3	4.4	4.6	4.6	4.9	14	1.5	1.9	2.2	2.6	3.3
ALT-1-DG-5	31	4.7	5.1	5.2	5.3	5.9	23	2.6	4.2	5.1	5.8	8.0
ALT-1-DG-WT	21	6.1	6.5	6.6	6.8	7.1	20 (1)	.4	3.9	6.3	7.9	12.5
2-DG-1	29	7.3	7.4	7.5	7.6	8.0	29	.1	.1	.1	.2	.2

Table 15. Statistical summary of ground-water-quality data from Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

Well name	pH (standard units)						Dissolved oxygen (mg/L)					
	Number	Min	Q1	Med	Q3	Max	Number	Min	Q1	Med	Q3	Max
2-DG-2	31	7.2	7.3	7.4	7.5	7.8	29	0.1	0.1	0.1	0.2	0.3
2-DG-3	29	6.9	6.9	7.1	7.1	7.3	29	.1	.1	.1	.2	.3
2-DG-4	30	4.6	4.8	4.9	5.0	5.2	29	.1	.2	.5	.7	1.7
2-DG-5	31	5.2	5.7	5.9	6.3	7.0	30	2.3	3.7	4.9	6.2	6.8
2-DG-WT	29	6.2	6.7	6.9	7.1	7.3	27 (1)	.6	1.8	3.1	4.4	11.2
3-DG-1	31	7.2	7.4	7.5	7.6	7.9	31	.1	.1	.1	.2	.3
3-DG-2	30	7.2	7.3	7.4	7.5	7.7	30	.1	.1	.1	.2	.4
3-DG-3	30	7.0	7.2	7.2	7.3	7.7	30	<.1	.1	.1	.2	.3
3-DG-4	31	4.7	5.0	5.1	5.5	6.1	31	.1	.1	.2	.3	.5
3-DG-5	28	5.9	6.3	6.5	6.6	6.9	25 (3)	1.0	7.6	9.6	11.8	13.6
3-DG-WT	31	5.9	6.1	6.2	6.3	6.8	31	<.1	.3	.4	.4	2.4
REP-1-UG-3	14	5.5	5.8	5.9	6.1	6.3	14	.1	.1	.1	.2	.3
REP-1-UG-5	13	4.5	4.8	5.0	5.3	5.8	11	2.0	4.4	7.1	9.6	12.5
REP-1-UG-WT	21	4.7	4.9	5.0	5.1	5.4	21	.9	1.6	2.4	3.2	5.9
REP-1-DG-3	30	6.2	6.3	6.5	6.6	7.1	30	.1	.1	.1	.2	.3
REP-1-DG-5	30	5.7	5.9	6.1	6.2	6.9	30	<.1	.1	.2	.2	.3
REP-2-DG-3	30	6.4	6.5	6.6	6.8	7.5	30	.1	.1	.1	.2	.3
REP-2-DG-5	30	5.7	5.9	6.0	6.1	7.3	30	<.1	.1	.2	.3	.5

Well name	Sodium (mg/L)						Chloride (mg/L)					
	Number	Min	Q1	Med	Q3	Max	Number	Min	Q1	Med	Q3	Max
1-UG-1	9	45	47	48	49	49	30	12	12	13	14	14
1-UG-2	9	13	19	19	20	21	30	6.2	6.6	6.9	7.3	8.4
1-UG-3	9	4.0	4.2	4.6	5.5	5.7	30	6.6	10	11	12	13
1-UG-4	9	1.0	1.2	1.2	1.3	1.5	30	1.0	1.4	1.6	2.0	2.7
1-UG-5	8	.9	1.2	1.3	1.6	1.7	25	1.2	1.9	2.2	2.6	4.6
1-UG-WT	9	.8	.9	1.1	1.2	1.5	30	1.3	1.9	2.0	2.7	4.8
ALT-1-UG-1	4	4.5	--	4.6	--	4.6	14	12	12	13	13	13
ALT-1-UG-2	4	21	--	24	--	24	14	6.3	6.7	6.9	7.1	8.0
ALT-1-UG-3	4	3.3	--	3.8	--	3.9	14	7.0	8.9	9.9	10.3	13
ALT-1-UG-4	4	1.2	--	1.4	--	1.4	14	1.0	1.2	1.4	1.6	1.7
ALT-1-UG-5	7	1.2	1.4	1.6	2.0	3.6	23	1.6	1.8	2.4	2.8	3.8
ALT-1-UG-WT	7	1.1	1.3	1.4	1.6	1.9	23	1.6	1.8	2.0	2.5	3.8
1-DG-1	9	36	36	37	37	38	30	9.3	9.5	9.6	9.9	10
1-DG-2	9	19	19	20	20	21	25	4.8	5.7	6.4	7.4	7.9

Table 15. Statistical summary of ground-water-quality data from Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

Well name	Sodium (mg/L)						Chloride (mg/L)					
	Number	Min	Q1	Med	Q3	Max	Number	Min	Q1	Med	Q3	Max
1-DG-3	9	4.6	5.5	6.3	7.0	7.2	30	5.7	8.7	12	13	15
1-DG-4	9	1.3	1.4	1.4	1.4	1.8	30	1.2	1.3	1.6	1.9	11
1-DG-5	9	1.4	1.5	1.8	3.9	110	30	1.3	2.0	2.5	3.1	600
1-DG-WT	9	4.2	60	150	310	541	29	3.2	44	310	765	1,400
ALT-1-DG-1	4	37	--	38	--	39	14	9.0	9.2	9.3	9.7	10
ALT-1-DG-2	4	13	--	14	--	15	14	7.7	7.9	8.5	8.9	10
ALT-1-DG-3	4	4.4	--	4.9	--	5.1	14	5.7	8.3	9.7	11	31
ALT-1-DG-4	4	1.5	--	1.7	--	1.8	14	1.2	1.4	1.6	1.9	49
ALT-1-DG-5	9	1.3	1.6	1.7	3.8	3.7	30	1.3	1.8	2.3	3.3	200
ALT-1-DG-WT	7	23	41	89	185	457	21	2.8	14	74	575	860
2-DG-1	9	43	43	44	44	45	29	9.2	11	11	11	12
2-DG-2	9	23	23	24	25	25	30	6	6.2	6.7	6.9	7.4
2-DG-3	9	7.3	7.7	8.1	8.9	9.4	30	8	10	12	12	14
2-DG-4	9	1.4	1.5	1.9	1.9	8.6	30	1.1	1.3	1.4	2.1	100
2-DG-5	9	2.2	14	21	44	130	30	2.2	4.3	33	98	360
2-DG-WT	9	52	66	94	115	220	29	14	40	65	160	340
3-DG-1	9	30	32	32	34	36	30	8.4	8.8	9.1	9.3	11
3-DG-2	9	19	23	23	23	41	30	4.5	5.9	6.3	6.6	65
3-DG-3	9	6.8	7	9.9	18	59	30	8.6	11	14	29	150
3-DG-4	9	13	15	21	40	78	30	2.1	15	30	79	170
3-DG-5	9	22	42	48	50	53	28	3.1	61	65	71	81
3-DG-WT	9	47	59	60	67	76	30	18	66	82	95	130
REP-1-UG-3	4	10	--	15	--	19	14	12	14	24	34	37
REP-1-UG-5	3	1.3	--	--	--	1.8	13	1.3	2.0	2.2	2.4	2.8
REP-1-UG-WT	6	1.4	1.5	1.6	1.8	2.0	21	1.6	2.1	2.4	3.0	3.8
REP-1-DG-3	9	6.5	7.7	9.6	11	17	30	4.9	15	21	23	30
REP-1-DG-5	9	1.4	1.8	4.0	6.5	49	30	.9	1.3	1.8	7.8	770
REP-2-DG-3	9	8.8	9.5	10	12	15	30	13	16	20	24	30
REP-2-DG-5	9	2.7	7.3	21	67	250	30	.7	3.0	12	106	580

Well name	Bicarbonate (mg/L)						Calcium (mg/L)					
	Number	Min	Q1	Med	Q3	Max	Number	Min	Q1	Med	Q3	Max
1-UG-1	9	543	561	565	572	585	9	58	60	63	67	70
1-UG-2	9	427	472	491	510	513	9	53	59	63	70	74
1-UG-3	9	41	45	61	67	81	9	20	24	26	26	30

Table 15. Statistical summary of ground-water-quality data from Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

Well name	Bicarbonate (mg/L)						Calcium (mg/L)					
	Number	Min	Q1	Med	Q3	Max	Number	Min	Q1	Med	Q3	Max
1-UG-4	9	4.0	4.0	5.0	6.0	7.0	9	4.5	5.2	5.3	5.4	6.3
1-UG-5	8	44	56	79	91	106	8	11	14	16	19	24
1-UG-WT	9	5.0	26	31	45	75	9	5.4	7.1	9.0	11	16
ALT-1-UG-1	4	569	--	572	--	574	4	55	--	66	--	73
ALT-1-UG-2	4	549	--	555	--	561	4	65	--	68	--	76
ALT-1-UG-3	4	38	--	45	--	46	4	19	--	23	--	24
ALT-1-UG-4	4	8	--	8.5	--	10	4	4.9	--	5.8	--	6.2
ALT-1-UG-5	7	6.0	9.5	12	17	47	7	4.5	5.6	6.1	6.7	8.0
ALT-1-UG-WT	7	10	17	24	28	35	7	3.9	7.2	8.5	10	13
1-DG-1	9	549	555	564	567	574	9	60	62	64	67	68
1-DG-2	9	488	494	506	555	578	9	60	63	66	68	70
1-DG-3	9	113	122	131	150	185	9	30	36	40	44	49
1-DG-4	9	1.0	2.0	3.0	3.0	10	9	3.2	3.6	3.7	3.8	5.0
1-DG-5	9	1.0	1.0	3.0	3.0	5.0	9	2.1	3.4	3.4	3.8	30
1-DG-WT	9	26	54	115	122	239	9	2.7	4.3	9.6	56	71
ALT-1-DG-1	4	543	--	566	--	574	4	54	--	65	--	140
ALT-1-DG-2	4	310	--	369	--	433	4	51	--	57	--	62
ALT-1-DG-3	4	44	--	57	--	85	4	20	--	27	--	36
ALT-1-DG-4	4	0	--	1.0	--	5.0	4	3.4	--	3.5	--	3.7
ALT-1-DG-5	9	3.0	3.0	3.0	4.0	4.0	9	1.9	3.0	3.7	3.8	19
ALT-1-DG-WT	7	65	80	109	183	283	7	4.2	12	21	38	95
2-DG-1	9	537	549	556	561	566	9	58	59	61	63	67
2-DG-2	9	537	543	560	571	575	9	65	67	68	69	78
2-DG-3	9	211	227	242	262	271	9	50	52	57	59	60
2-DG-4	9	1.0	1.0	1.0	3.0	4.0	9	3.5	4.0	4.1	4.5	18
2-DG-5	9	6.0	7.0	8.0	16	24	9	.6	4.2	4.6	9.1	50
2-DG-WT	9	40	132	146	168	238	9	4.8	6.2	11	18	29
3-DG-1	9	531	542	548	550	558	9	60	63	63	66	69
3-DG-2	9	481	524	555	556	594	9	66	68	70	74	85
3-DG-3	9	154	170	203	220	225	9	32	40	47	54	58
3-DG-4	9	1.0	5.0	6.0	10	11	9	.5	1.4	3.1	5.4	17
3-DG-5	9	93	95	110	132	156	9	9.1	29	33	35	37
3-DG-WT	9	59	62	67	81	100	9	3.8	18	21	23	28
REP-1-UG-3	4	60	--	85	--	98	4	15	--	26	--	33
REP-1-UG-5	3	2.0	--	--	--	3.0	3	3.3	--	--	--	4.0
REP-1-UG-WT	6	1.0	--	2.5	--	5.0	6	2.1	--	3.6	--	4.0

Table 15. Statistical summary of ground-water-quality data from Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

Well name	Bicarbonate (mg/L)						Calcium (mg/L)					
	Number	Min	Q1	Med	Q3	Max	Number	Min	Q1	Med	Q3	Max
REP-1-DG-3	9	68	109	159	183	199	9	13	24	32	40	46
REP-1-DG-5	9	12	27	34	43	89	9	4.9	7.2	8.2	11	22
REP-2-DG-3	9	145	217	225	236	262	9	34	46	51	53	57
REP-2-DG-5	9	21	24	28	34	67	9	4.0	7.9	9.6	12	61

Well name	Magnesium (mg/L)						Potassium (mg/L)					
	Number	Min	Q1	Med	Q3	Max	Number	Min	Q1	Med	Q3	Max
1-UG-1	9	49	52	53	53	56	9	3.7	3.8	3.9	4.1	4.2
1-UG-2	9	47	50	53	55	58	9	2.1	2.2	2.2	2.3	2.5
1-UG-3	9	6.3	8.5	9.0	9.6	11	9	1.3	1.5	1.6	1.7	1.8
1-UG-4	9	1.4	1.6	1.7	1.8	2.2	9	1.7	1.7	2.0	2.0	2.2
1-UG-5	8	6.4	6.0	7.8	9.6	12	8	<.1	<.1	<.1	.2	.3
1-UG-WT	8	2.3	3.0	4.1	5.6	7.8	9	<.1	<.1	<.1	.1	.3
ALT-1-UG-1	4	52	--	54	--	57	4	3.7	--	3.8	--	3.9
ALT-1-UG-2	4	58	--	59	--	64	4	2.6	--	2.6	--	2.7
ALT-1-UG-3	4	4.6	--	5.5	--	5.6	4	1.3	--	1.4	--	1.4
ALT-1-UG-4	--	--	--	--	--	--	4	1.7	--	2.0	--	2.1
ALT-1-UG-5	7	2.2	2.3	2.7	3.1	5.5	7	<.1	<.1	<.1	<.1	.1
ALT-1-UG-WT	7	1.6	2.9	4.2	5.1	7.5	7	<.1	<.1	<.1	<.1	.2
1-DG-1	9	52	54	54	55	57	9	3.4	3.5	3.6	3.6	3.7
1-DG-2	9	51	52	57	57	60	9	2.4	2.5	2.5	2.6	2.9
1-DG-3	9	12	17	18	20	25	9	.3	1.2	1.4	1.5	1.5
1-DG-4	9	.7	.8	.8	.8	1.1	9	.6	.6	.6	.7	1.1
1-DG-5	9	.5	1.0	1.0	1.2	9.4	9	<.1	.2	.2	.3	1.3
1-DG-WT	9	.4	1.2	2.3	8.9	16	9	.2	.5	1.0	1.7	2.9
ALT-1-DG-1	4	53	--	55	--	56	4	3.4	--	3.5	--	3.5
ALT-1-DG-2	4	39	--	43	--	49	4	1.5	--	1.8	--	1.9
ALT-1-DG-3	4	5.9	--	7.7	--	11	4	1.3	--	1.6	--	1.7
ALT-1-DG-4	4	.8	--	1.2	--	1.8	4	.4	--	.4	--	.4
ALT-1-DG-5	9	.5	.8	1.1	1.4	4.8	9	<.1	<.1	.1	.2	.5
ALT-1-DG-WT	7	.6	2.0	3.7	10	17	7	<.1	.2	.3	.7	2.1
2-DG-1	9	49	51	51	52	57	9	3.3	3.4	3.4	3.5	3.7
2-DG-2	9	55	56	57	59	64	9	2.8	3.0	3.1	3.1	3.1
2-DG-3	9	24	25	28	30	30	9	.2	1.1	1.1	1.2	1.3
2-DG-4	9	1.0	1.1	1.3	1.7	4.2	9	.1	.3	.5	.6	1.3
2-DG-5	9	.4	1.2	1.5	2.7	15	9	<.1	.1	.3	.8	1.3

Table 15. Statistical summary of ground-water-quality data from Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

Well name	Magnesium (mg/L)						Potassium (mg/L)					
	Number	Min	Q1	Med	Q3	Max	Number	Min	Q1	Med	Q3	Max
2-DG-WT	9	1.4	1.7	4.6	6.7	7.8	9	<0.1	0.3	0.4	0.4	1.0
3-DG-1	9	51	53	54	55	56	9	3.0	3.1	3.2	3.2	3.3
3-DG-2	9	55	57	57	61	68	9	2.8	2.8	2.8	3.0	3.4
3-DG-3	9	14	16	21	22	24	9	1.2	1.3	1.3	1.4	1.8
3-DG-4	9	.1	.3	.5	1.2	4.0	9	.2	.2	.3	.4	.7
3-DG-5	9	2.9	8.6	10	11	12	9	1.1	2.1	2.4	2.8	3.5
3-DG-WT	9	3.8	4.6	4.9	5.6	8.1	9	1.3	1.4	1.6	1.6	1.9
REP-1-UG-3	4	5.3	--	9.0	--	13	4	.4	--	.6	--	.7
REP-1-UG-5	3	1.3	--	--	--	1.6	3	<.1	--	--	--	.1
REP-1-UG-WT	6	1.0	--	1.2	--	1.7	6	.2	.3	.3	.5	.6
REP-1-DG-3	9	5.7	11	15	17	19	9	2.3	3.0	3.6	4.2	6.1
REP-1-DG-5	9	2.0	2.2	2.8	4.7	6.5	9	.3	.4	.6	1.0	1.6
REP-2-DG-3	9	14	20	20	21	22	9	2.1	2.6	2.7	2.8	3.3
REP-2-DG-5	9	1.2	2.0	2.8	4.1	21	9	<.1	.2	.2	.3	1.6

Well name	Sulfate (mg/L)						Fluoride (mg/L)					
	Number	Min	Q1	Med	Q3	Max	Number	Min	Q1	Med	Q3	Max
1-UG-1	9	<0.1	<0.1	<0.1	<0.1	<0.1	9	0.4	0.5	0.5	0.5	0.6
1-UG-2	9	<.1	.6	1.3	1.9	3.9	9	.3	.4	.5	.5	.6
1-UG-3	9	25	36	39	45	54	9	<.1	<.1	<.1	<.1	.1
1-UG-4	9	14	15	17	17	20	9	<.1	<.1	<.1	<.1	<.1
1-UG-5	9	10	12	13	16	17	8	<.1	<.1	<.1	<.1	<.1
1-UG-WT	9	12	13	14	15	16	9	<.1	<.1	<.1	<.1	<.1
ALT-1-UG-1	4	<.1	--	<.1	--	<.1	4	.4	--	.5	--	.5
ALT-1-UG-2	4	<.1	--	<.1	--	<.1	4	.4	--	.5	--	.6
ALT-1-UG-3	4	32	--	36	--	40	4	<.1	--	<.1	--	<.1
ALT-1-UG-4	4	14	--	18	--	21	4	<.1	--	<.1	--	<.1
ALT-1-UG-5	7	11	13	14	16	22	7	<.1	<.1	<.1	<.1	<.1
ALT-1-UG-WT	7	12	15	17	19	21	7	<.1	<.1	<.1	<.1	<.1
1-DG-1	9	<.1	<.1	<.1	<.1	<.1	9	.4	.5	.5	.5	.5
1-DG-2	9	1.2	1.7	7.3	11	14	9	.3	.4	.4	.4	.5
1-DG-3	9	33	48	59	62	63	9	<.1	<.1	<.1	<.1	.1
1-DG-4	9	11	12	13	14	14	9	<.1	<.1	<.1	<.1	<.1
1-DG-5	9	9.1	9.8	11	12	15	9	<.1	<.1	<.1	<.1	.1
1-DG-WT	9	11	17	21	51	63	9	<.1	<.1	<.1	<.1	.1

Table 15. Statistical summary of ground-water-quality data from Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

Well name	Sulfate (mg/L)						Fluoride (mg/L)					
	Number	Min	Q1	Med	Q3	Max	Number	Min	Q1	Med	Q3	Max
ALT-1-DG-1	4	<0.1	--	<0.1	--	<0.1	4	0.4	--	0.5	--	0.5
ALT-1-DG-2	4	25	--	35	--	47	4	.3	--	.3	--	.3
ALT-1-DG-3	4	37	--	49	--	61	4	<.1	--	<.1	--	<.1
ALT-1-DG-4	4	7.9	--	21	--	21	4	<.1	--	<.1	--	<.1
ALT-1-DG-5	7	8	10	11	11	13	7	<.1	<.1	<.1	<.1	.1
ALT-1-DG-WT	7	14	17	19	28	70	7	<.1	<.1	<.1	<.1	<.1
2-DG-1	9	<.1	<.1	<.1	<.1	.4	9	.4	.5	.5	.6	.7
2-DG-2	9	<.1	<.1	.3	2.6	5.1	9	.3	.4	.4	.5	.5
2-DG-3	9	39	47	52	55	57	9	<.1	<.1	.1	.1	.1
2-DG-4	9	8.8	14	14	14	19	9	<.1	<.1	<.1	<.1	.2
2-DG-5	9	9.1	12	14	17	34	9	<.1	<.1	<.1	<.1	<.1
2-DG-WT	9	8.1	17	24	26	50	9	<.1	<.1	<.1	.1	.1
3-DG-1	9	<.1	<.1	<.1	<.1	.2	9	.4	.5	.5	.5	.6
3-DG-2	9	7.9	9.6	12	14	18	9	.4	.4	.4	.4	.5
3-DG-3	9	30	37	42	47	55	9	<.1	<.1	<.1	<.1	.1
3-DG-4	9	12	15	20	32	50	9	<.1	<.1	<.1	<.1	<.1
3-DG-5	9	16	18	32	41	74	9	<.1	<.1	<.1	<.1	.1
3-DG-WT	9	19	24	34	36	41	9	<.1	<.1	<.1	<.1	<.1
REP-1-UG-3	4	17	--	26	--	37	4	<.1	--	<.1	--	<.1
REP-1-UG-5	3	14	--	--	--	14	4	<.1	--	<.1	--	<.1
REP-1-UG-WT	6	10	11	12	12	22	6	<.1	<.1	<.1	<.1	<.1
REP-1-DG-3	9	12	13	18	21	25	9	<.1	<.1	<.1	.1	.2
REP-1-DG-5	9	1.6	9.6	15	19	34	9	<.1	<.1	<.1	<.1	.2
REP-2-DG-3	9	15	22	24	27	35	9	<.1	<.1	.1	.1	.2
REP-2-DG-5	9	5.1	10	18	21	31	9	<.1	<.1	<.1	<.1	<.1

Well name	Iodide (mg/L)						Bromide (mg/L)			
	Number	Min	Q1	Med	Q3	Max	Number	Min	Med	Max
1-UG-1	9	0.005	0.006	0.006	0.006	0.007	2	0.12	--	0.12
1-UG-2	9	.005	.005	.006	.006	.006	2	.06	--	.06
1-UG-3	9	.002	.003	.003	.003	.004	2	<.01	--	.01
1-UG-4	9	<.001	.001	.002	.004	.005	2	<.01	--	<.01
1-UG-5	9	.003	.003	.004	.006	.009	2	<.01	--	.01
1-UG-WT	9	.001	.002	.002	.002	.003	2	<.01	--	.01

Table 15. Statistical summary of ground-water-quality data from Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

Well name	Iodide (mg/L) Number	Min	Q1	Med	Q3	Max	Bromide (mg/L) Number	Min	Med	Max
ALT-1-UG-1	4	0.005	--	0.006	--	0.007	0	--	--	--
ALT-1-UG-2	4	.006	--	.007	--	.007	0	--	--	--
ALT-1-UG-3	4	.002	--	.003	--	.003	0	--	--	--
ALT-1-UG-4	4	.003	--	.004	--	.006	0	--	--	--
ALT-1-UG-5	7	<.001	.001	.001	.001	.003	0	--	--	--
ALT-1-UG-WT	7	<.001	.001	.001	.002	.002	0	--	--	--
1-DG-1	9	.006	.006	.006	.007	.007	2	.09	--	.14
1-DG-2	9	.004	.004	.005	.005	.005	2	.07	--	.08
1-DG-3	9	.002	.003	.003	.003	.004	2	.03	--	.04
1-DG-4	9	<.001	<.001	<.001	.001	.001	2	<.01	--	.02
1-DG-5	9	<.001	<.001	<.001	.001	.001	2	<.01	--	.06
1-DG-WT	9	.001	.001	.002	.004	.005	2	<.01	--	.11
ALT-1-DG-1	4	.006	--	.006	--	.006	0	--	--	--
ALT-1-DG-2	4	.003	--	.004	--	.004	0	--	--	--
ALT-1-DG-3	4	.002	--	.003	--	.003	0	--	--	--
ALT-1-DG-4	4	<.001	--	<.001	--	.001	0	--	--	--
ALT-1-DG-5	7	<.001	<.001	.001	.001	.001	0	--	--	--
ALT-1-DG-WT	7	<.001	.001	.001	.002	.006	0	--	--	--
2-DG-1	9	.003	.007	.007	.008	.009	2	.12	--	.13
2-DG-2	9	.004	.005	.005	.005	.006	2	.09	--	.11
2-DG-3	9	.002	.003	.003	.004	.005	2	<.01	--	.06
2-DG-4	9	<.001	<.001	<.001	<.001	.001	2	<.01	--	.01
2-DG-5	9	<.001	<.001	.001	.001	.001	2	.02	--	.02
2-DG-WT	9	.002	.002	.003	.004	.041	2	<.01	--	<.01
3-DG-1	9	.004	.005	.005	.006	.006	2	.12	--	.14
3-DG-2	9	.003	.003	.004	.004	.005	2	.1	--	.13
3-DG-3	9	.002	.003	.003	.003	.004	2	<.01	--	.02
3-DG-4	9	<.001	<.001	.001	.001	.002	2	<.01	--	<.01
3-DG-5	9	.002	.003	.004	.006	.012	2	<.01	--	.13
3-DG-WT	9	.003	.004	.005	.005	.012	2	<.01	--	.05
REP-1-UG-3	4	0.003	--	0.006	--	0.008	0	--	--	--
REP-1-UG-5	3	<.001	--	<.001	--	.001	0	--	--	--
REP-1-UG-WT	6	<.001	--	.001	--	.001	2	<.01	--	.01
REP-1-DG-3	9	.003	.003	.004	.005	.006	2	.08	--	.1
REP-1-DG-5	9	.002	.005	.006	.009	.011	2	.05	--	.11
REP-2-DG-3	9	.003	.004	.004	.004	.01	2	<.01	--	.12
REP-2-DG-5	9	.003	.006	.007	.010	.016	2	.08	--	.13

Table 15. Statistical summary of ground-water-quality data from Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

Well name	Iron (µg/L)			Manganese (µg/L)			Silica (mg/L)			
	Number	Min	Max	Number	Min	Max	Number	Min	Med	Max
1-UG-1	5	880	1,200	5	10	11	5	19	20	21
1-UG-2	5	320	490	5	35	49	5	18	18	19
1-UG-3	5	1,600	2,100	5	49	140	5	10	11	12
1-UG-4	5	10	10	5	6	9	5	6.4	6.6	6.6
1-UG-5	4	10	310	5	<1	2	4	4.2	5.2	6.7
1-UG-WT	5	<10	40	5	<1	2	5	4.6	6.6	9.8
ALT-1-UG-1	1	1,000	--	1	20	--	1	--	19	--
ALT-1-UG-2	1	260	--	1	110	--	1	--	18	--
ALT-1-UG-3	1	2,000	--	1	40	--	1	--	11	--
ALT-1-UG-4	1	180	--	1	<10	--	1	--	7	--
ALT-1-UG-5	3	<10	30	3	<1	10	3	6.4	--	10
ALT-1-UG-WT	3	<10	20	3	<1	2	3	6.6	--	8.6
1-DG-1	5	1,400	1,500	5	10	23	5	19	20	20
1-DG-2	5	350	680	5	20	32	5	18	19	19
1-DG-3	5	2,400	3,200	5	63	86	5	10	11	12
1-DG-4	5	80	130	5	5	9	5	9.0	9.4	9.7
1-DG-5	5	10	20	5	<1	5	5	6.5	6.8	7.8
1-DG-WT	--	--	--	5	<3	5	5	6.9	9.1	10
ALT-1-DG-1	1	1,700	--	1	20	--	1	--	19	--
ALT-1-DG-2	1	1,600	--	1	110	--	1	--	15	--
ALT-1-DG-3	1	1,700	--	1	40	--	1	--	10	--
ALT-1-DG-4	1	40	--	1	<10	--	1	--	8.6	--
ALT-1-DG-5	3	<1	20	3	<1	3	3	7.2	--	8.4
ALT-1-DG-WT	3	<10	30	3	<1	--	3	9.2	--	14
2-DG-1	5	950	1,200	5	14	20	5	18	19	19
2-DG-2	5	480	670	5	18	20	5	19	20	20
2-DG-3	5	2,500	3,300	5	110	130	5	12	13	13
2-DG-4	5	10	10	5	6	38	5	8.7	9.6	10
2-DG-5	5	20	60	5	1	28	5	5.3	6.9	8.8
2-DG-WT	5	10	60	5	<1	40	5	4.4	5.1	5.6
3-DG-1	5	870	1,100	5	30	33	5	18	19	19
3-DG-2	5	620	930	5	20	30	5	20	20	20
3-DG-3	5	1,900	3,400	5	70	120	5	14	14	16
3-DG-4	5	20	120	5	1	9	5	8.1	8.9	9.4
3-DG-5	5	2,800	7,600	5	60	148	5	7.5	10	11
3-DG-WT	5	970	2,800	5	25	58	5	7.6	7.9	8.6

Table 15. Statistical summary of ground-water-quality data from Indiana Dunes National Lakeshore near Beverly Shores, Indiana, 1994–97—Continued

Well name	Iron (µg/L)			Manganese (µg/L)			Silica (mg/L)			
	Number	Min	Max	Number	Min	Max	Number	Min	Med	Max
REP-1-UG-3	1	4,300	--	1	50	--	1	--	16	--
REP-1-UG-5	0	--	--	0	--	--	0	--	--	--
REP-1-UG-WT	3	10	20	3	5	6	3	8.9	--	10
REP-1-DG-3	5	3,400	7,800	5	47	120	5	9.9	12	13
REP-1-DG-5	5	3,800	8,100	5	61	240	5	5.6	6.7	12
REP-2-DG-3	5	3,900	12,300	5	184	360	5	12	14	17
REP-2-DG-5	5	1,200	9,200	5	55	386	5	5.6	6.9	7.4