USE OF GIS TO IDENTIFY AND DELINEATE AREAS OF FLUORIDE, SULFATE, CHLORIDE, AND NITRATE LEVELS IN THE WOODBINE AQUIFER, NORTH CENTRAL TEXAS, IN THE 1950S, 1960S, 1970S, 1980S, AND 1990S

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ArcView and ArcInfo were used to identify and delineate areas contaminated by fluoride, sulfate, chloride, and nitrate in the Woodbine Aquifer. Water analysis data were obtained from the TWDB from the 1950s to 1990s covering 9 counties. 1990s land use data were obtained to determine the relationship with each contaminant. Spearman's rank correlation coefficients and Kruskal-Wallis tests were used to calculate relationships between variables. Land uses had little effect on distributions of contaminants. Sulfate and fluoride levels were most problematic in the aquifer. Depth and lithology controlled the distributions of each contaminant. Nitrate patterns were controlled mainly by land use rather than geology, but were below the maximum contaminant level. In general, contaminant concentrations have decreased since the 1950s.

ACKNOWLEDGEMENTS

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CHAPTER 1

INTRODUCTION

1.1 General Statements

Although one-third of the earth's surface covered by water, less than one percent is fresh water available for our use (US EPA, 1999a). It has been estimated that approximately 96 percent of fresh water is groundwater. As a natural resource, people utilize groundwater in many ways, such as drinking, bathing, agriculture, and industry. In the last decade, groundwater supplied around 50 percent of the drinking water for the United States of America (US EPA, 1999a).

Since people consume large amounts of groundwater, there have been many studies about groundwater quality and its effect on human health. Naturally, groundwater has more mineral constituents than has surface water. Longer residence times and rock-water interaction contribute to elevate chemical concentrations. Thus, utilizing groundwater without any treatment can cause health problems in some cases.

Four anions, fluoride, sulfate, nitrate, and chloride, were selected for this study. These four elements are widely found in groundwater and have many effects on human health. For example, sulfate can cause diarrhea (US EPA, 1999b). Sudden exposure to and intake of nitrate causes blue baby syndrome among infants (Mitchell et al., 1996). Chloride in drinking water can cause cosmetic problems, such as skin or tooth discoloration, and aesthetic effects, such as deterioration of taste, odor, or color. Lastly, even though fluoride is known as an important element in drinking water for reducing dental caries, it can have adverse effects on teeth and bones at high concentrations.

The selected study area is the Woodbine Aquifer located in north-central Texas. Its area extends from Grayson, Fannin, Lamar, and Red River Counties in the north to McLennan County in the south. Grayson, Cooke, Denton, Collin, Tarrant, Dallas, Johnson, Ellis, and Hill Counties were studied (Figure 1).

There were some previous reports about the amount of fluoride, nitrate, sulfate, and chloride in the region, such as Hopkins (1996), and Hudak (1999, 2000). Hopkins studied chloride, sulfate, fluoride, iron, magnesium, and boron levels in the Woodbine Aquifer. That study used 78 wells sampled from 1993 through 1995 by the Texas Water Development Board (TWDB). The resulting maps of chloride, sulfate, and fluoride showed that some areas in the aquifer had higher concentrations than the drinking water standards. Hudak (1999, 2000) studied fluoride, sulfate, and chloride levels in Texas groundwater. Water chemistry data obtained from TWDB were collected from 1990-1998. The results showed that some counties in north-central Texas had median fluoride concentrations above the secondary drinking water standard of 2.0 mg/L. Counties in north-central Texas had median sulfate and chloride levels ranging from 51 to 250 mg /L, and from 0 to 250 mg/L, respectively.

To better understand whether there is any relationship between land use and concentrations of the four contaminants in groundwater, land use, well location and contaminant concentrations were investigated over the last five decades, 1950 to 1999

(Figure 2 to Figure 6). The depth of wells was also studied in relation to concentrations of the four solutes.

This study will not only identify high-risk areas, but also relate potential sources of contaminants to land use. The relationship between well depth and solute concentration will also help in determining potential sources from both geological formations in the region and anthropogenic effects. Statistics will be applied throughout the research, including using Spearman's rank correlation coefficient and Kruskal-Wallis tests to determine associations between land use and the concentration of each contaminant, well depth, and the concentration of each contaminant, and each pair of contaminants. By using a Geographic Information System (GIS), the distribution of each solute will be mapped to show the direction and intensity of the contaminants related to their potential sources over the past five decades.

1.2 Objectives

- To identify areas with relatively high solute concentrations in groundwater.
- To study relationships between well depth and four contaminants (chloride, sulfate, fluoride, and nitrate).
- To identify whether land use affects contaminant levels and to identify potential sources of contaminants.
- To map the distribution of contaminants in five decades, 1950 – 1999.
- To identify temporal trends of contaminants, 1950 - 1999.
- To identify differences of contaminants among different primary well uses.

1.3 Research Hypotheses

- There are higher concentrations of nitrate beneath urban and agricultural land uses than other land uses.
- Chloride, sulfate, and fluoride concentrations increase downdip in the aquifer (with well depth).
- Concentrations of nitrate decrease with well depth.
- Concentrations of each solute have increased over time.
- Concentrations of each solute differ with well use.

1.4 Scientific Merits

This study will identify areas of contaminated groundwater. As a result, we can control contaminants sources and limit use. This study can be used by planning departments and environmental health agencies of each county in the study area, and by NCTCOG to reduce consumption of the contaminated groundwater in the Woodbine Aquifer.

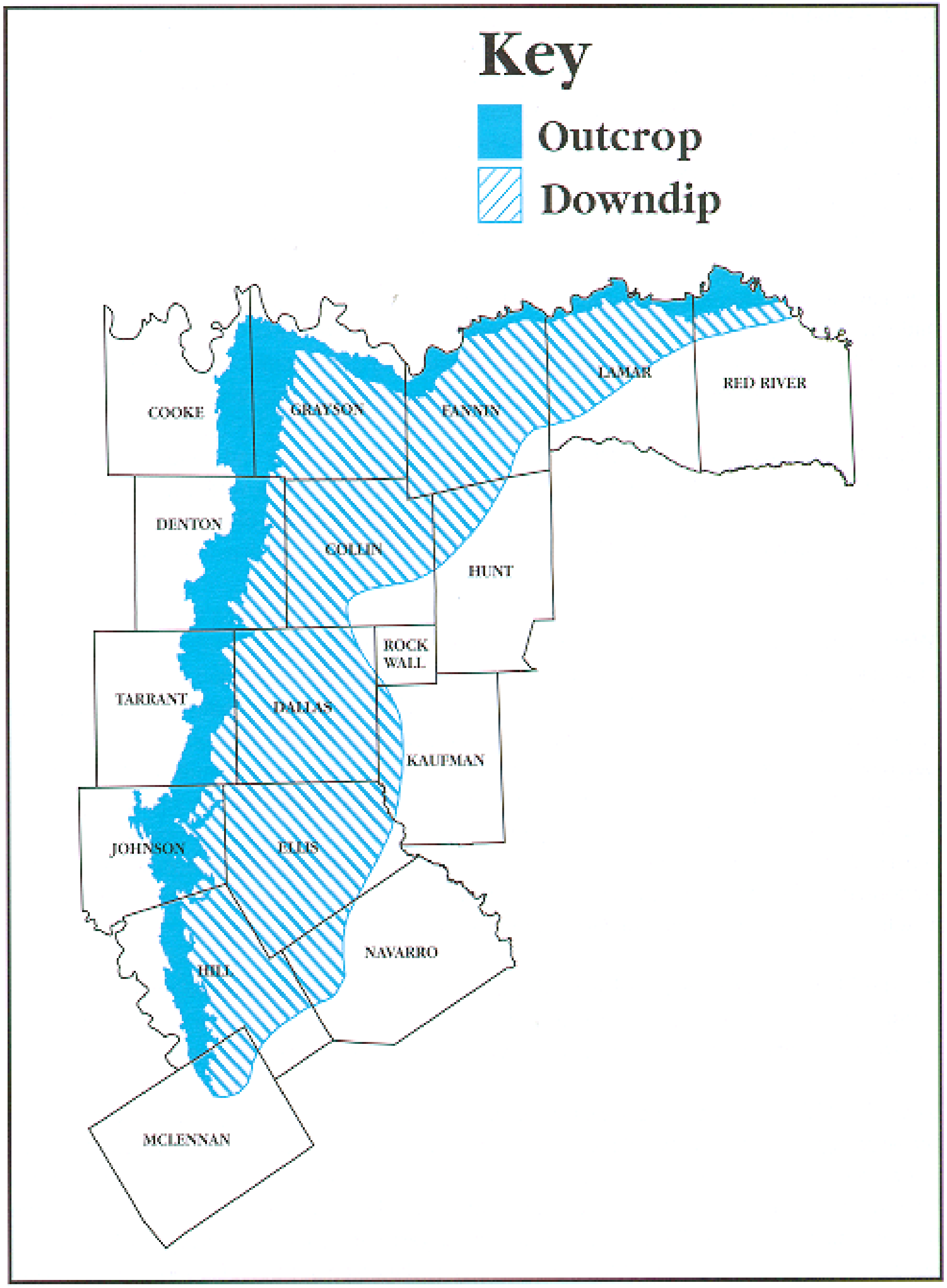


Figure 1 Surface exposure and downdip area of the Woodbine Aquifer (TWDB, 1997)

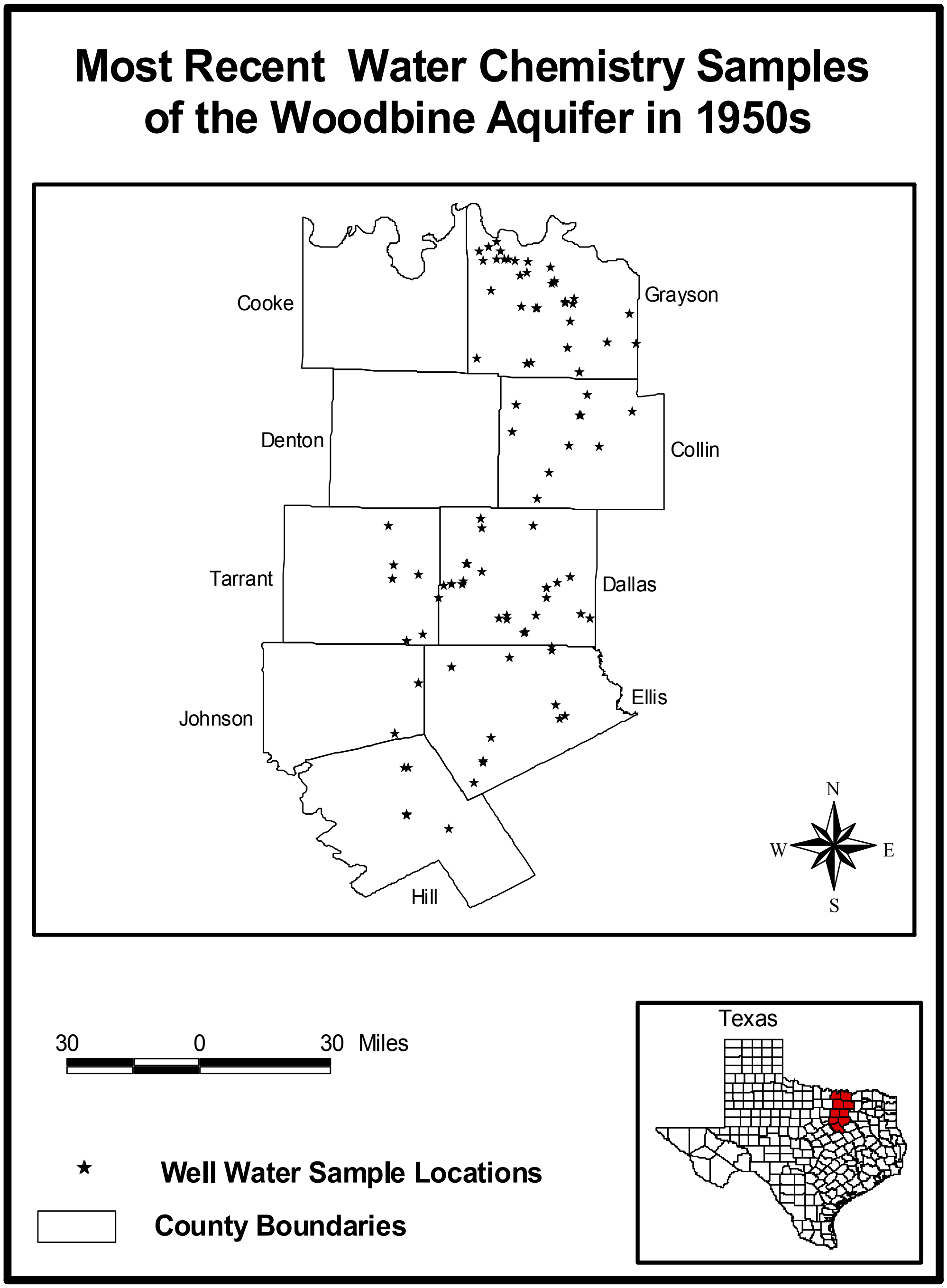


Figure 2. Most Recent Water Chemistry Samples of the Woodbine Aquifer in 1950s

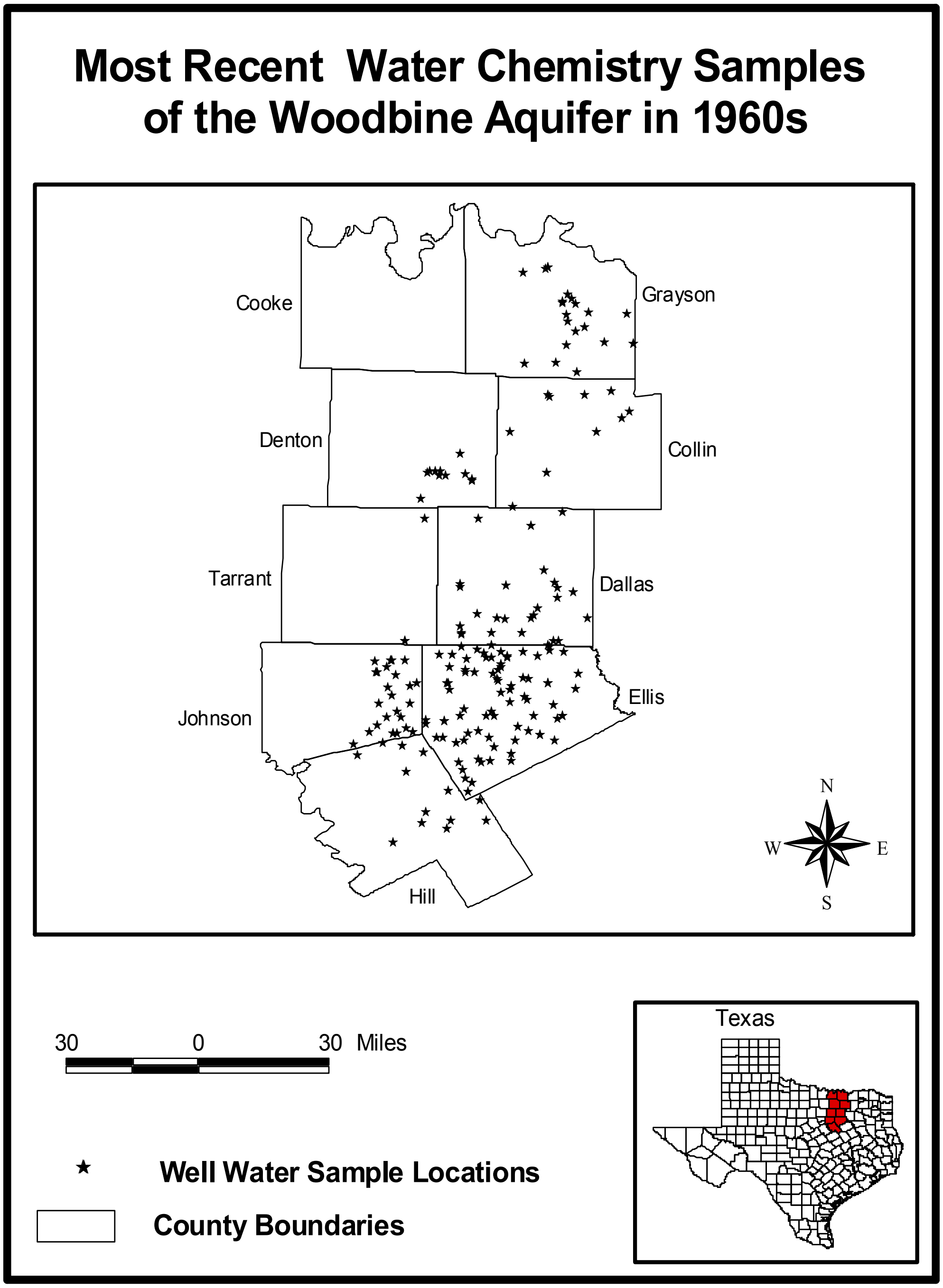


Figure 3. Most Recent Water Chemistry Samples of the Woodbine Aquifer in 1960s

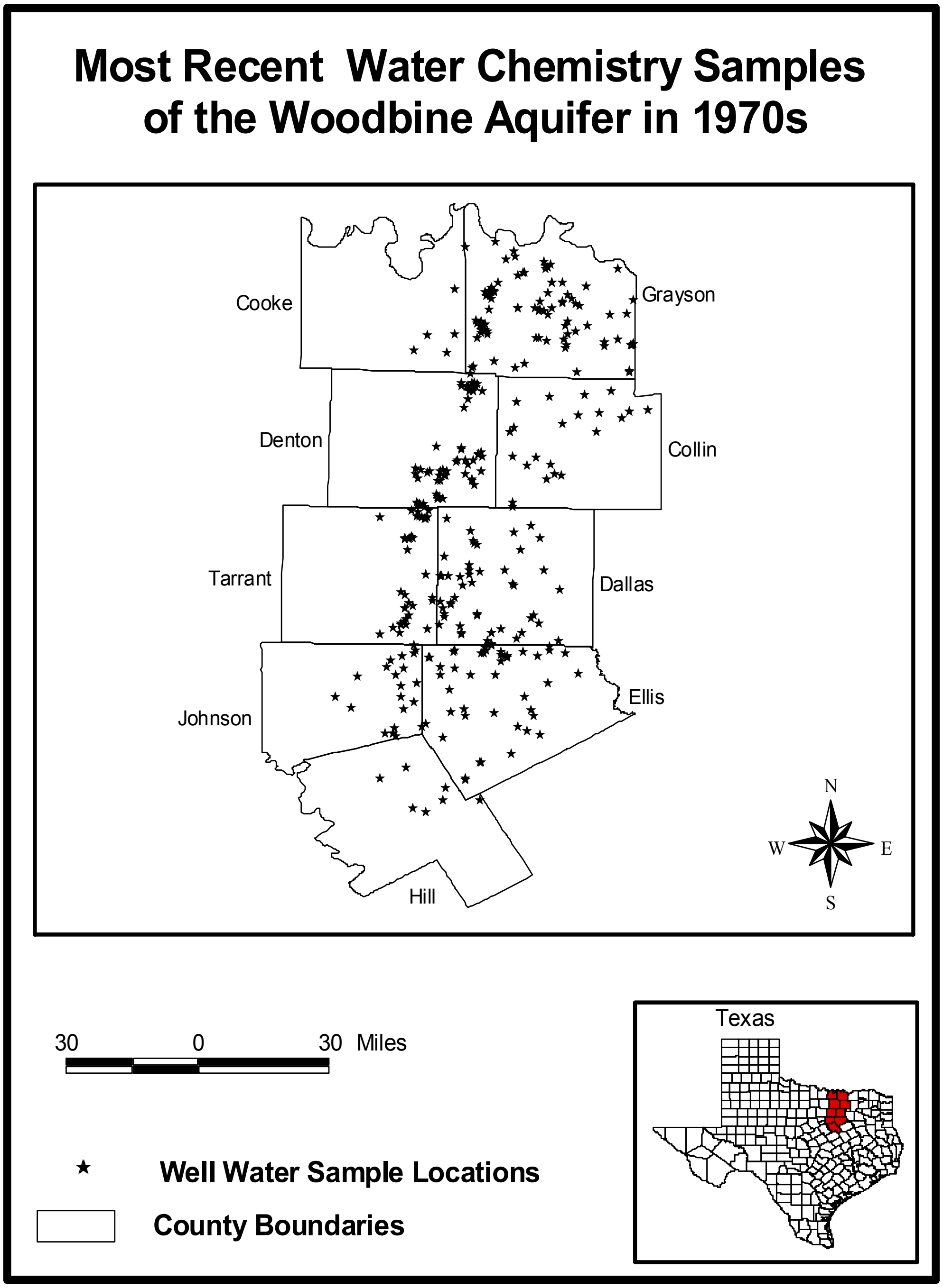


Figure 4. Most Recent Water Chemistry Samples of the Woodbine Aquifer in 1970s

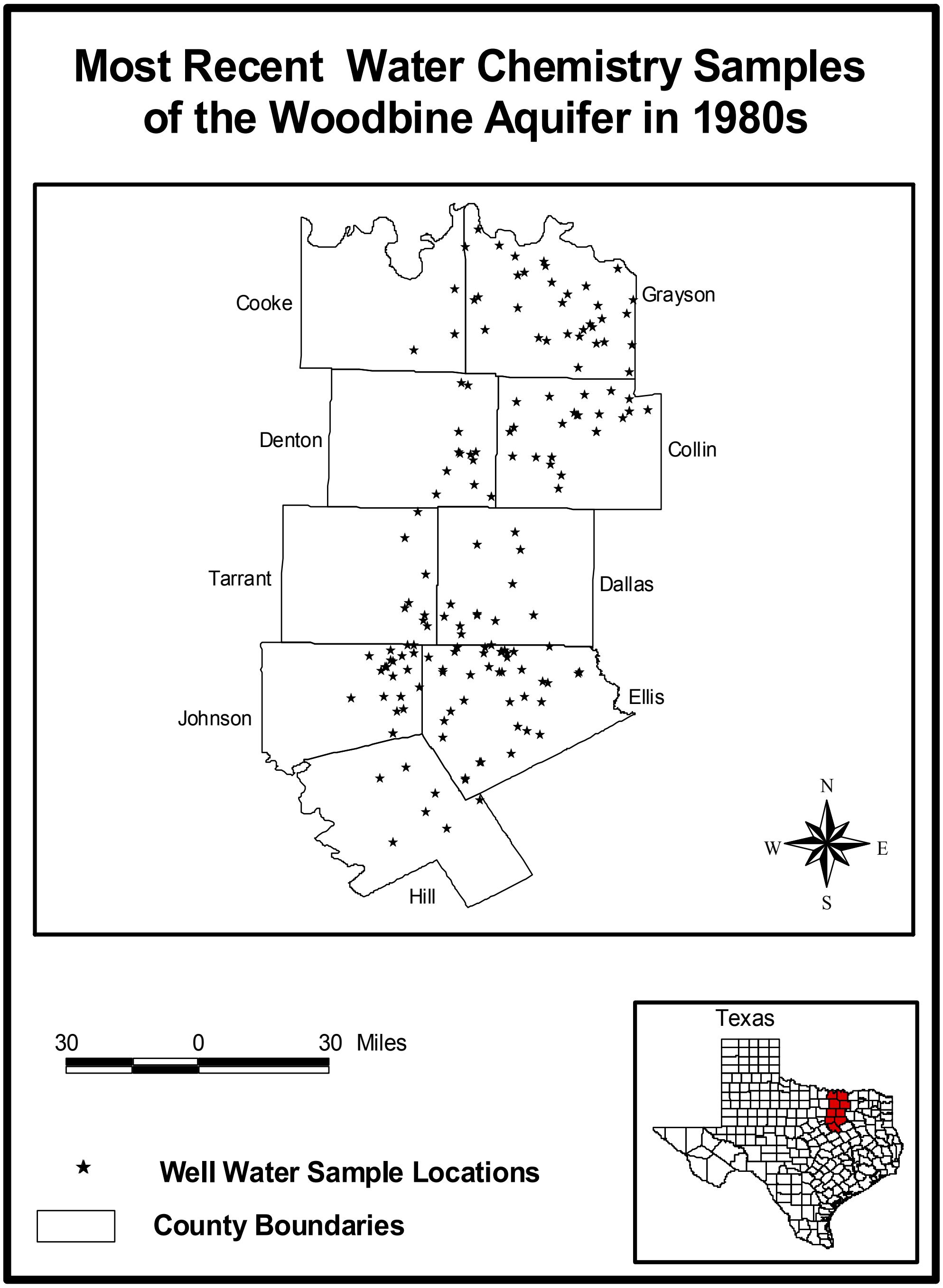


Figure 5. Most Recent Water Chemistry Samples of the Woodbine Aquifer in 1980s

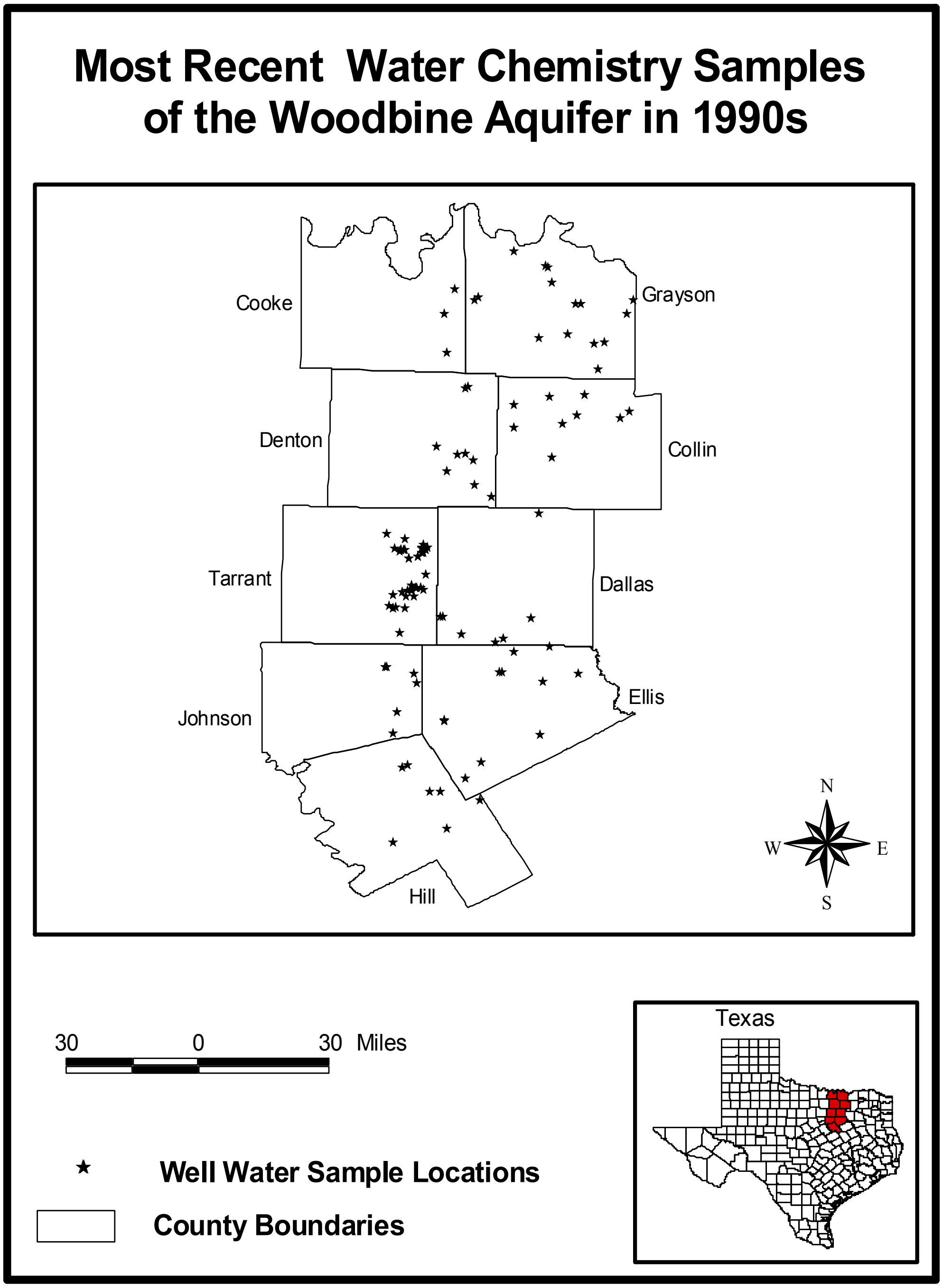


Figure 6. Most Recent Water Chemistry Samples of the Woodbine Aquifer in 1990s

CHAPTER 2

LITERATURE REVIEW

2.1 Groundwater use in the United States and Texas

In the United States, groundwater is used for agriculture, domestic, industrial, and commercial purposes. In 1990, groundwater supplied 51 percent of the nation's overall population with drinking water (US.EPA, 1999b) and supplied 95 percent of the population with drinking water in rural areas (US. EPA, 1999b). Therefore, groundwater is the major drinking water supply in the nation.

Groundwater constituted approximately 60 percent of water consumed in Texas (Hudak, 1999). The remainder was from surface-water reservoirs. Most of groundwater in Texas is contained in unconsolidated sediment and porous, permeable rock formations known as aquifers (Swanson, 1995). Approximately 76 percent of the groundwater consumed in Texas comes from nine primary aquifers, which constitutes nine billion acre-feet of drinking water capacity (Swanson, 1995). The Texas Water Development Board estimated that Texans in 1984 consumed 8,854,470 acre-feet of groundwater, approximately 78 percent of which was used for irrigation (Swanson, 1995).

Texas water laws complicate groundwater depletion problems in the state. The Texas Water Code considers surface water as the property of the state and requires permits for its use, which apply to the Texas Natural Resource Conservation Commission

(TNRCC); on the other hand, groundwater belongs to the owner of the land above it and may be used or sold as private property (TWDB, 1997 and Ruesink, 1982).

Texas courts have consistently ruled that a landowner has the right to pump all the water he or she can from beneath his or her land regardless of the effects on other wells. Groundwater pumped from a renewable aquifer should be balanced against the average annual recharge rates, while quantities pumped from a nonrenewable aquifer determine how long a time the existing groundwater supply will last. Ground-water conservation districts on the High Plains control the distance between wells to reduce competition for water (TWDB, 1997 and Ruesink, 1982).

2.2 General Geology of the Woodbine Aquifer

The name of Woodbine strata containing the Woodbine Aquifer was first named and published by B.F Schmard in 1863 (Sellards et al., 1932). The Woodbine aquifer, a minor aquifer of Cretaceous age, is located in North Central Texas. It furnishes water for municipal, industrial, and small irrigation supplies. The aquifer crops out in a narrow belt, trending south (Figure 1) from southeastern Cooke County, and is exposed in patches in a west-east direction paralleling the Red River in Grayson, Fannin, Lamar, and Red River Counties (Muller et al, 1979). It consists of the Templeton, the Lewisville, the Red Branch, and the Dexter Members of the Upper Cretaceous Woodbine Formation (TWC, 1989). The aquifer consists of fine to coarse ferruginous sand and sandstone, clay, shale, sandy shale, some lignite, and some gypsum (TWC, 1989).

Woodbine sand outcrops from Hill County northward to Grayson County are leaf bearing, and are not typically marine, or at least no marine invertebrates have been recorded from them (Sellards et al, 1932). Eastward from Hyatts Bluff, Fannin County, Woodbine clays contain decomposed volcanic material and may represent outwash on a rather flatly depositional plain, but they may be in part marine because they were closely associated with beds containing invertebrate fossils (Sellards et al, 1932). These beds were suggested to be of upper Woodbine age (Sellards et al, 1932). The Lewisville beds are a near shore sandy deposit and contain marine fossils. The upper black, lustrous clays contain oysters, and near shore, marine, or blackish deposit. The overlying Eagle Ford is a neritic marine deposit (Sellards et al, 1932). Those marine sources may contribute to elevated fluoride, sulfate, and chloride levels in the Woodbine Aquifer.

2.3 Hydrogeology of the Woodbine Aquifer

The Woodbine Aquifer is interesting because it underlies both prime agricultural land and rapid suburban growth (UT, 2000). The Woodbine aquifer extends from McLennan County, south of Hill County, in North Central Texas northward to Cooke County and eastward to Red River County (Figure 1).

Water produced from the aquifer furnishes municipal, industrial, domestic, and agricultural supplies throughout this extensive North Texas region. Total pumpage for all purposes in 1994 was 15,572 acre-feet. The largest user of groundwater for public supply purposes was the city of Sherman, which pumped 6,604 ac-ft (TWDB, 1997). This aquifer is composed of water-bearing sand and sandstone beds interbedded with shale and clay. The aquifer is hydraulically connected to overlying alluvium along the Red River (TWC, 1989). The Woodbine Group is divided into three water-bearing parts that differ considerably in productivity and quality. Generally, the lower part of the aquifer has been developed to supply water for domestic and municipal wells (TWDB, 1997).

Since the aquifer dips eastward into the subsurface where it reaches a maximum depth of 2500 feet below land surface, and a maximum thickness of approximately 700 feet, its water is under water-table conditions in the outcrop and under artesian conditions in the subsurface (TWC, 1989 and TWDB, 1997). In downdip areas, the Woodbine aquifer is confined above by shales of the upper Cretaceous Eagle Ford Group, and below by the Buda Formation or the Grayson Marl and the Mainstreet Limestone (Figure 7), all of which are Cretaceous age (TWC, 1989). Yields of wells drilled in the Woodbine aquifer range from less than 100 gal/min to about 700 gal/min (TWC, 1989; TWDB, 1997).

The average annual groundwater availability for the Woodbine Aquifer, equivalent to the transmission capacity of the aquifer, was estimated to be 26,100 ac-ft (TWDB, 1997), less than one inch of the average annual precipitation of 35 inches. So, one inch of annual precipitation is enough to recharge this aquifer (TWDB, 1997).

Water to the aquifer is recharged by precipitation on aquifer outcrop areas, and by seepage from lakes and streams where there is a downward gradient to the aquifer. Water moves through the aquifer from the outcrop in an east-southeast direction, generally following the dip of the beds. As a result, water from the aquifer in the outcrop area has an average dissolved-solids of around 550 mg/L, and the average dissolved-solids increases downdip to greater than 3,000 mg/L.

Chemical quality of Woodbine water deteriorates rapidly at depths below 1,500 feet (TWDB, 1997). In areas between the outcrop and this depth, water quality is considered good overall as long as groundwater from the upper Woodbine is sealed off.

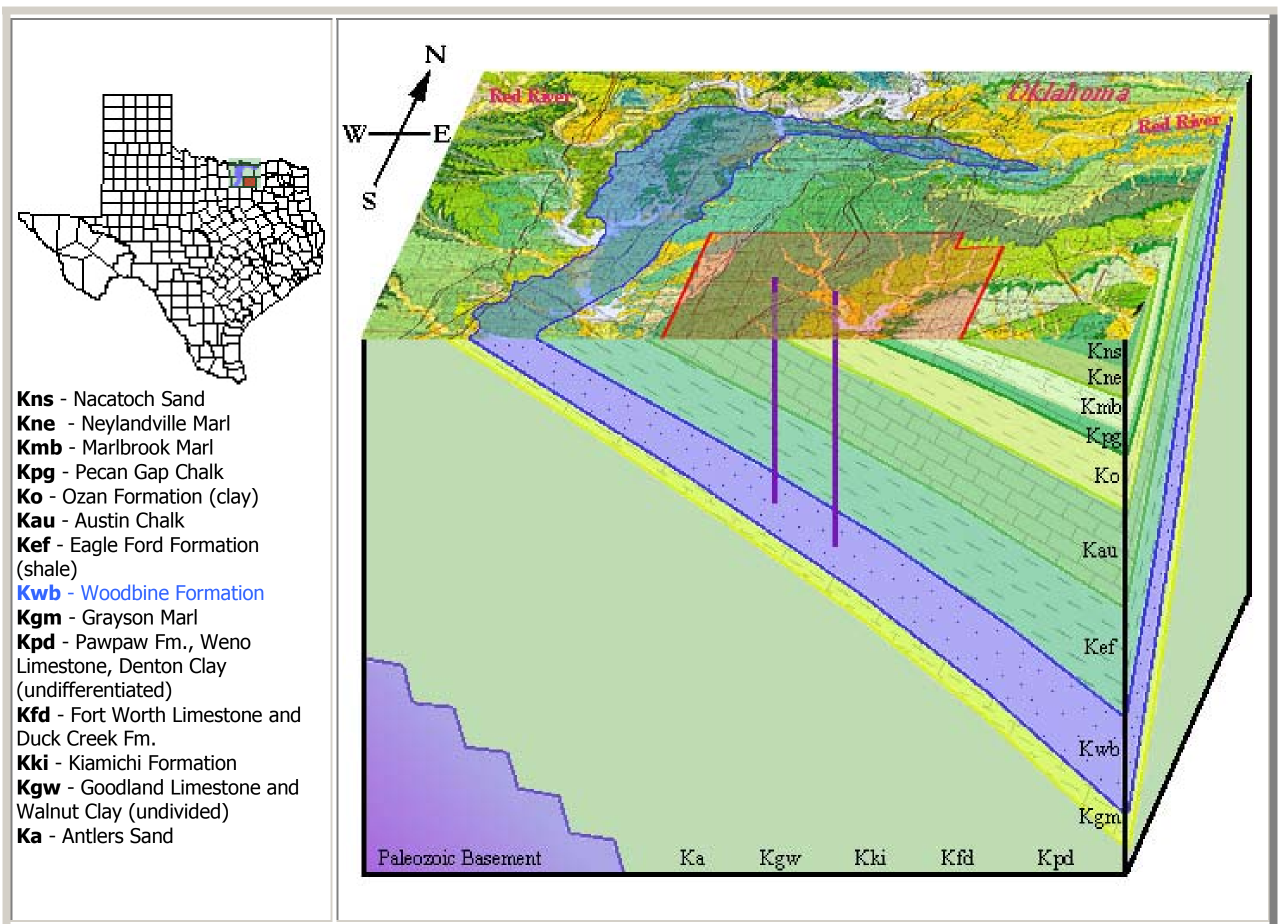


Figure 7 Geological cross-section of the Woodbine Aquifer in Collin County (University of Colorado at Boulder, 2001)

Generally, the upper Woodbine Aquifer contains extremely poor water quality in downdip locales and contains excessive iron concentrations along the outcrop (TWDB, 1997). Locally, the water has objectionable concentrations of iron, sodium, and chloride (TWC, 1989). Water from artesian areas in Dallas, Ellis, and Navarro Counties was characterized by high concentrations of sulfate. In Johnson and Tarrant Counties, lots of water wells contained sulfate concentrations in excess of the drinking-water standard and were apparently associated with extensive non-commercial lignite beds (TWDB, 1997).

2.4 Drinking Water Standards

National Primary Drinking Water Regulations (NPDWRs or primary standards) are legally enforceable standards that apply to public water systems. Primary standards protect drinking water quality by limiting the levels of specific contaminants that can adversely affect public health (US EPA, 2000). They are sometimes referred to as maximum contaminant levels (MCLS).

National Secondary Drinking Water Regulations (NSDWRs or secondary standards) are non-enforceable guidelines regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as deterioration of taste, odor, or color) in drinking water. EPA recommends secondary standards for water supply systems, but cannot enforce them. However, each state may choose to adopt them as enforceable standards (US EPA, 2000).

Fluoride has primary and secondary standards of 4 mg/L and 2 mg/L, respectively. The maximum contaminant level (MCL) of nitrate is 10 mg/L of nitrate as nitrogen (NO_3- N) in drinking water, equivalent to 45 mg/L of nitrate (NO_3), and 1 mg/L for nitrite. Sulfate and chloride have secondary standards of 250 mg/L. The secondary drinking water standard for chloride is based on taste rather than toxicity (Gaggiani, 1984). However, a fixed limit for chloride for agricultural use has not been set because the harmful concentration level varies with crop, climate, soil, and management practices (National Economy of Sciences, National Academy of Engineering, 1974).

2.5 Sources of Fluoride, Sulfate, Chloride, and Nitrate

Fluoride

Several factors contribute to elevated fluoride levels in groundwater, including nearby saline formations and native mineral constituents of the aquifers (Hudak, 1999). Fluorine is the 13th most abundant element in the earth's crust, and fluoride develops in several geologic environments, including igneous, sedimentary, and metamorphic rocks (Hudak, 1999). However, the major minerals that incorporate fluoride are fluorite (CaF_2) and fluorapatites [$Ca_5(PO4)_3F$] (Hudak, 1999 and Gosselin, 1999). Both are present in sedimentary and igneous rocks, but they have rather low solubility (US. EPA, 1999c). Other potentially important F- bearing minerals, that are rare, are cryolite (Na_3AlF_6), ralsonite ($NaMgAl(F,OH)_6.H_2O$), villiaumite (NaF), topaz ($Al_2(F,OH)_2SiO_2$) , and phlogopite (F-mica). F substitutes for hydroxyl ions in the structures of many silicate minerals such as tourmaline, mica, and amphiboles (Gosselin, 1999). Volcanic ash and gases may also be rich in fluoride, and fluoride is present in much larger quantities in marine animals than terrestrial animals (Hudak, 1999).

Fluoride concentrations in natural waters depend on factors such as temperature, pH, presence or absence of complex or precipitating ions and colloids, solubility of fluorine-bearing minerals, anion exchange capacity of aquifer materials (OH^- for F^-), the size and type of geological formations delivered by water, and the amount of time that water is in contact with a particular formation (Apambire et al., 1997). Sodium may exhibit a positive correlation with fluoride in many types of groundwater, especially those having low calcium contents (waters undergoing base exchange). High sodium concentrations will increase the solubility of fluoride in waters. A process that can lead to very high concentrations of fluoride in waters (values up to 30 mg/L) is called anion exchange (OH^- for F^-) (Apambire et al., 1997).

Nitrate

Nitrogen occurs in most natural waters primarily as nitrate. Possible sources of nitrate in groundwater include runoff, seepage of excess chemicals, manure, fertilizer, precipitation, biological fixation, geological deposits, waste dumps, animal feedlots, leaking sewer lines, improper waste disposals, and inadequate design and maintenance of septic systems (Dorshelmer and et al., 1997).

Sometimes nitrogen is present in other forms, such as ammonia, nitrite, and organic nitrogen. Naturally, biologically mediated processes can hydrolyze organic nitrogen, such as amides, amines, amino acids, proteins, and urea, to ammonium, which is oxidized to nitrite and then to nitrate by nitrification (Thodal, 1996). Groundwater contamination with nitrate is a pervasive and serious problem. It is a health threat because of population expansion into rural areas, and an increasing population, which relies heavily on private water systems. The US EPA (1999d) estimated that 52 percent of the community water wells and 57 percent of the domestic water wells in the country contain nitrate. A variety of chemicals can pass through the water table along with nitrate. In agricultural areas, groundwater often has a distinct water-quality signature composed of nitrate, potassium, chloride, calcium, and magnesium (Nolan et al., 1997). The sources of these compounds mostly are agricultural chemicals such as inorganic fertilizers, and animal manure.

Extensive application of nitrate in fertilizer to residential lawns and golf courses can cause in widespread degradation of groundwater resources in urban areas. Nitrogen is part of all plant and animal proteins. Thus, plant, animal, and human survival are dependent on an abundance of nitrogen in nature. Nitrogen, however, not used by plants or returned to the atmosphere, is converted to nitrate in aerated soil. Nitrate is soluble in water and can easily leach to the water table. Nolan et al. (1997) also reported that airborne nitrogen compounds are emitted by point sources such as coal and oil burning, electric utilities, automobiles, and other forms of transportation.

Airborne nitrogen compounds dispersed in the air are non-point sources of nitrogen. Nitrate can persist in groundwater for decades and can accumulate to high levels by adding more nitrogen from the land surface every year.

Other non-agricultural sources of nitrate, such as septic systems and leaking sewers, generally are less significant, but can affect groundwater quality locally. Septic systems are soil-based wastewater treatment systems. The digested liquids from septic tanks seep into the surrounding soil. Cogger (1988) explained that a conventional septic system consisted of three parts: the septic tank, the absorption area, and the surrounding soil. Normally, the septic system tank provides preliminary settling and digestion of the wastewater. Septic systems introduce pathogenic bacteria, viruses, and nitrate into aquifers when the systems are poorly designed, poorly constructed or sealed, and improperly located. The closer a well is to a septic tank, the greater the opportunity for contamination.

Agricultural injection wells also contribute nitrate to groundwater. Injection well technology began in the 1920s. TEC (1999a) documented agricultural injection wells in the Lower Rio Grande Valley, Texas. The agricultural drainage wells help eliminate excess water from agricultural production. These wells collect surface water and drain it into subsurface formations. As a result, groundwater can be contaminated with nitrate and pesticides, when the well casing is eroded.

Other potential sources of nitrate contamination in groundwater come from natural occurrences. Wlotzka (cited by Feth, 1966) studied the ammonia-nitrogen concentrations in various suites of rocks. Concentrations of NH_3-N depend upon the type of rocks. For example, the average NH_3-N content was 20, 580, 135, and 70 gram / ton for magnetic rock, claystone, sandstone, and limestone, respectively. NH_3-N from these natural sources, when they are eroded, gradually accumulated in covered soil over many years. Weathering by products are probably fixed by microorganisms living in root nodes of leguminous plants and by soil organisms (both aerobes and anaerobes). Alison (1955; cited by Feth, 1966) reported that leguminous plants generally fix 40 to 200 pounds of nitrogen/acre/year, approximately equivalent to 50 to 250 tons/squared mile/year of nitrate.

Also, the degradation of plant protein can generate nitrate in soil. For example, when plants die in the fall, the plant protein may be converted to nitrate. However, if this residue nitrate remains in the root zone, it may be utilized in the spring by new plants and recovered to plant protein. In addition, nitrate may be transported below the root zone by winter and spring rains, ultimately contaminating underlying aquifers (US EPA, 1973).

Chloride and Sulfate

Chloride and sulfate, primary anionic components of groundwater, are regularly present at concentrations over 5 mg/L (Freeze and Cherry, 1979). Chloride, naturally dissolved from rocks and soils (Hopkins, 1996), can reach groundwater from human activities, as it is present in sewage, oil-field brines, industrial brines, and seawater at concentrations reported to range from 37 to 101 mg/L (Canter and Knox, 1985). Since chloride generally is not removed from wastewater by either individual sewage-disposal systems or conventional community wastewater-treatment systems, it can be used as an indicator of contamination from sewage-disposal systems (Canter and Knox, 1985). Furthermore, it can also be used as an indicator of groundwater contamination from landfill leachate (Canter and et al., 1987). Sedimentary rocks, particularly evaporites and marine deposits, and precipitation-borne chloride from oceans, contribute chloride to groundwater and natural water (Hem, 1985).

Kyoto University, Japan reported an unusual increase in the discharge rate of groundwater with high levels of sulfate and chloride after the Kobe earthquake in 1995 (Tsunogal et al., 1995). Evidently, crustal movements increased the amount of chloride and sulfate in groundwater. When sodium is formed together with chloride, it will give a salty taste to drinking water and can increase the corrosiveness of water (Hopkins, 1996).

Sulfate comes from dissolution of sulfur from rocks and soils containing sulfur compounds such as gypsum, anhydrite, and iron sulfide (Hopkins, 1996). Gypsum apparently is derived from pyrite sulfur when pyrite is oxidized in the vadose zone (Logan et al., 1999). Most of sulfate in groundwater is derived from gypsum and anhydrite (Hudak, 2000). Sulfur is mostly present in reduced forms as metallic sulfides in igneous, sedimentary and metamorphic rocks (Hem 1985; Hudak, 2000). In general, groundwater in sedimentary rocks contains above 100 mg/L sulfate; however, water in igneous and metamorphic rocks generally contains less than 100 mg/L sulfate (Driscoll 1986). Sulfate concentrations in excess of the drinking-water standard found in Johnson and Tarrant Counties, Texas are apparently associated with extensive non-commercial lignite beds (TWDB, 1997).

2.6 Problems with Contaminated Water

2.6.1 Fluoride, Nitrate, Sulfate, and Chloride levels in the Woodbine Aquifer

High levels of fluoride, sulfate, chloride, and nitrate have been documented at the Woodbine Aquifer. High concentrations of sulfate in several wells from this aquifer were found in Dallas, Ellis, Johnson, Tarrant, and Navarro Counties (TWDB, 1997). High chloride concentrations, exceeding the standard for drinking water, also were found in Collin, Dallas, Kaufman, Ellis, Hill, and Navarro Counties (Hopkins, 1996). Fluoride concentrations higher than the secondary standard for drinking water (2.0 mg/L) were found in 13 out of 17 counties above the aquifer. Finally, nitrate concentrations in water quality samples of the TWDB database, which were higher than the primary drinking water standard (45 mg/L of nitrate), were found in some wells in the aquifer (TWDB, 1997).

2.6.2 Health Effects from Fluoride, Nitrate, Sulfate, and Chloride

Fluoride

Fluoride helps in the normal mineralization of bones and formation of dental enamel (Agrawal, et al., 1997). Fluoride consumed in inadequate quantities, less than 0.5 mg/L, causes health problems like dental carries, lack of formation of dental enamel and deficiency of mineralization of bones, especially among children (Agrawal, et al., 1997). On the other hand, if fluoride is consumed in excess of 1.0 mg/L (Agrawal, et al., 1997), it may cause dental fluorosis (mottled enamel), brittle teeth, non-skeleton manifestation, or a combination of the above (Hudak, 1999; Gosselin et al, 1999; and Agrawal, et al., 1997). The severity and incidence of fluorosis is related to the fluoride content in various components of the environment, such as air, water, groundwater, and soil. Out of these, groundwater is the major contributor to the problem (Agrawal, et al., 1997).

Furthermore, intelligence was measured in 907 children aged 8-13 years living in areas that differed in the amount of fluoride present in the environment. The Intelligence Quotient of children living in areas with a medium or severe prevalence of fluorosis was lower than that of children living in areas with only slight fluorosis or no fluorosis. The development of intelligence appeared to be adversely affected by fluoride (Li and et al., 1995).

Nitrate

The US.EPA estimated that about 4.5 million people were served by groundwater containing nitrate as nitrogen greater than the Maximum Contaminant Level (MCL) of 10 mg/L (Bing-Canar, 1997). 66,000 people from that number are infants less than one-year old (US EPA, 1992).

D'Itri and Wolfson (1987) reported that nitrates have the potential to pose both acute and chronic health threats. Acute toxicity comes about through conversion of nitrate to nitrite by stomach microorganisms and then binding of nitrite to the oxygen-carrying molecules in the blood cells where nitrite oxidizes the ferrous ion (Fe^{++}) in hemoglobin to ferric ion (Fe^{+++}) (US EPA, 1973). This prevents transportation of oxygen by hemoglobin molecule being bound to nitrite over 10 percent, so victims of nitrate poisoning show a general symptom of oxygen deficiency called methemoglobinemia or blue-baby syndrome (Mitchell, 1996, Johnson and Kross, 1990, and US EPA, 1999d). The acidity of small infants' stomachs is considerably less than that of adults (US. EPA, 1973), which results in a more favorable environment for the conversion of nitrate to nitrite by bacteria (Patrick et al, 1987). As a result, nitrate toxicity affects mainly small infants, commonly less than three months old who have digested high levels of nitrate. Hubert and Canter (1980; cited by Patrick et al., 1987) reported that death might occur from the ingestion of water containing 50 to 100 mg/L of nitrate.

Another potential health effect of nitrate ingestion is gastric cancers (Knight et al., 1990, Forman, 1989). Furthermore, Mitchell (1996) explained that nitrate and nitrite might cause such conditions as cancer, mutagenic and teratogenic effects, birth defects, behavioral and developmental abnormalities, and cardiovascular disease. Nitrates reduced to nitrites could lead to "nitrosation of amines, amides and proteins to give rise to carcinogenic N-nitroso compounds" (Forman, 1989).

However, there is inadequate laboratory data for the US EPA to determine whether nitrate could increase the risk of cancer in humans (US EPA, 1990). Furthermore, D'Itri et al. (1987) reported that the possibility of chronic threats from nitrate, such as cancer in animals, did not necessity apply to humans. There were no good epidemiological studies relating nitrate to cancer in humans. As a result, carcinogenicity(cancer) was not taken into account in the establishment of the drinking water standard for nitrate.

Ruminants, particularly cattle, are also susceptible to nitrate toxicity because of the action of rumen microorganisms (US EPA, 2000). For example, the large numbers of cattle in Runnels County, Texas died during 1968 to 1969 due to nitrate poisoning (US EPA, 1973).

Sulfate and Chloride

Health concerns regarding sulfate and chloride in drinking water have also been raised. Diarrhea may be associated with ingestion of water containing high levels of sulfate (US EPA, 1999a). Groups of people may be at greater risk from the laxative effects of sulfate when they experience an abrupt change from drinking water with low sulfate concentrations to drinking water with high sulfate concentrations (US EPA, 1999a). The Dakota Department of Health suggested that water with sulfate levels over 750 mg/L had a laxative effect and less than 600 mg/L had no laxative effect (Peterson, 1951 & 1972).

High sulfate and chloride concentrations also affected the taste of water (Hudak, 2000). Chloride in drinking water might cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color). Chloride also enhanced the corrosion of pipes (TEC, 1999b) and it might cause heart and kidney diseases (TEC, 1999b). Chloride concentrations over 150 mg/L were toxic to crops (Bouwer, 1978), and above 350 mg/L in water are not suitable for most industrial uses (Driscoll, 1986).

CHAPTER 3

METHODOLOGY

There were 9 steps to this study as listed below:

1) Water chemistry data were obtained from the Groundwater Database of the TWDB (Texas Water Development Board). Samples were sampled from each well. The wells were pumped until temperature, conductivity, and pH stabilized. Samples were filtered, preserved, and delivered to an analytical laboratory within prescribed maximum holding time (Hudak, 2000). The total obtained water samples were 4,244 samples (Table 1) covering 1,976 wells in the study area (nine counties). There were 1,211 wells drilled in the Woodbine aquifer, but only 679 wells had available water quality analysis. The latest analysis date given in a decade was used for each well. The samples were divided into 1950s, 1960s, 1970s, 1980s, and 1990s (Table 2).
2) Fluoride, sulfate, chloride, and nitrate concentrations were tabulated in an attribute table including well type, well location, and sampling date (primarily used for public supply and domestic supply).
3) Latitude and longitude were converted to decimal format.
4) Fluoride, sulfate, chloride and nitrate concentrations were evaluated with statistics, such as Kruskal-Wallis analysis, Spearman’s rank correlation coeficient, and descriptive statistics.

5) Fluoride, sulfate, chloride and nitrate concentrations for each decade were overlaid on county boundaries (ESRI, 1999).
6) Individual wells representing each county were selected for time trends.
7) A GIS (ArcView 3.2 and ArcInfo 7.2) were used to map, query and analyze the data (Figure 7).
8) Land use at each well location was determined. Land use files were obtained from the Texas Gap vegetation data in CD-ROM, developed by Cooperative Fish and Wildlife Research Center, Texas Tech University, Lubbock, Texas, using 52 Landsat images in 1993, and hyperclustered data, received from the Earth Resources Observation Systems (EROS) Data Center. Almost all of the images were classified in Khoros Spectrum, with ground-truth GPS points and personal knowledge of the areas, and were then converted to grids and classified using adjoining image values. The data set is in interchanged file (*.e00), in Universal Transverse Mercator, Zone 14, NAD-83, Spheroid GRS1980. The data resolution is 90 meters. Details are prescribed below.
9) Spearman Ranking and Kruskal-Wallis statistics were used to evaluate associations between variables and land uses.

Reclassification Group	**Texas GAP Class**
1. Water	1. Water
2. Forest	2. Temporarily Flood Cold – Decidous Forest, Temperate Board – Leaved Evergreen Woodland, Leaved Evergreen Woodland, Cold – Deciduous Woodland, Temporily Flooded Cold – Deciduous Woodland, Planted/Cultivated Woodland, Mixed Board – Leaved Evergreen – Cold – Deciduous Woodland, Temporated Broad – Leaved Evergreen Shrubland
3. Urban	3. Urban Area
4. Grassland	4. Medium – Tall Bunch Temperate or Subpolar Grassland, Short Sod Temperate or Subpolar Grassland, Semipermanently Flooded Temperate or Subpolar Grassland, Temperate Flooded Grassland with Sparse Cold, Temperate or Subpolar Grassland with a Sparse Shrub Layer, Short Temperate or Subpolar Grassland with a Sparse Xeromorphic Shrub Layer
5. Cropland	5. Cropland (irrigated, row, herbaceous, etc.)

Reclassification Group	Texas GAP Class
6. Wetland	6. Wetland
7. Shrubland	7. Sclerophyllous Temperate Board – Leaved Evergreen Shrubland, Microphyllous Evergreen Shrubland, Temporarily Flooded Microphyllous Shrubland, Lowland Mixed Evergreen –Drought Deciduous Shrubland,
8. Bare Soil	8. Bare Soil

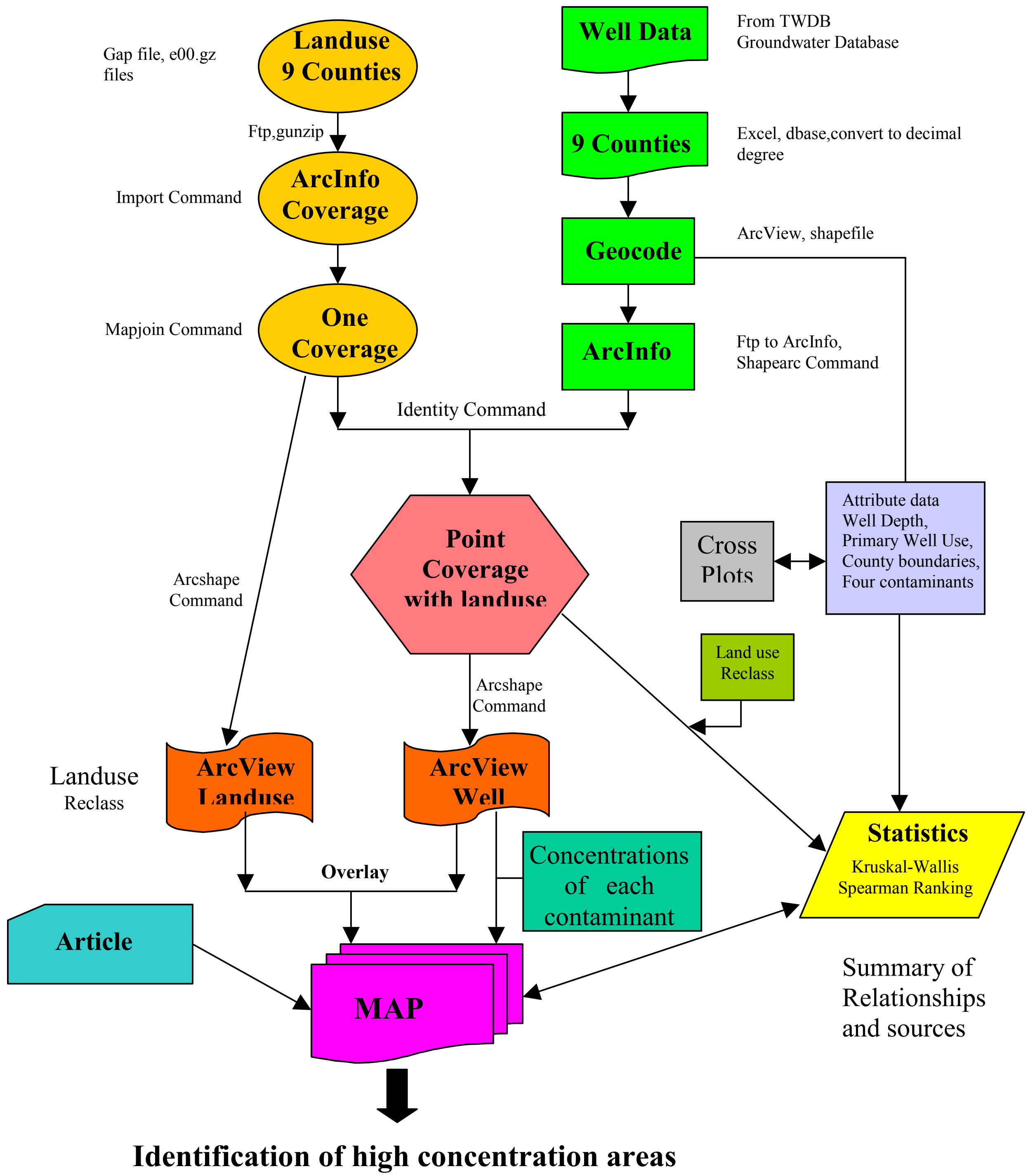


Figure 8 Conceptualization for studying groundwater contamination of the Woodbine Aquifer

Table 1. Woodbine Aquifer Well Chemistry Database

County Name	Water Samples	No. of analyzed wells	No. of analyzed Wells in the Woodbine
Collin	245	126	47
Cooke	171	76	6
Dallas	653	250	113
Denton	412	227	75
Ellis	481	202	120
Grayson	572	226	142
Hill	389	123	28
Johnson	422	242	57
Tarrant	899	504	91
Total	**4244**	**1976**	**679**

Table 2. Most Recent Well Samples of the Woodbine Aquifer in Five Decades

County Name	1950s	1960s	1970s	1980s	1990s
Collin	10	10	24	24	9
Cooke	0	0	5	3	3
Dallas	28	28	53	14	8
Denton	0	11	64	12	9
Ellis	10	78	45	37	10
Grayson	37	22	90	33	15
Hill	7	12	7	7	7
Johnson	4	26	21	19	6
Tarrant	8	3	39	10	43
Total	**104**	**190**	**348**	**159**	**110**

CHAPTER 4

RESULTS AND DISCUSTION

4.1 Well Depth of the collected water samples

Well Depth of the Woodbine Aquifer of the collected water samples from 1950s to 1990s are shown in Figures 9 to13. The well depth contours are elongated in a north-south direction along strike of the Woodbine Formation. The well depth of the western counties from Cooke to Johnson Counties was generally less than 500 feet. The eastern counties from Grayson to Ellis Counties had well depth varying from 500 to over 2000 feet. The eastern part of the study area had the highest well depths. This well depth trend follows the Woodbine Formation beds which dip east. Deeper wells were found in the eastern part of the study area.

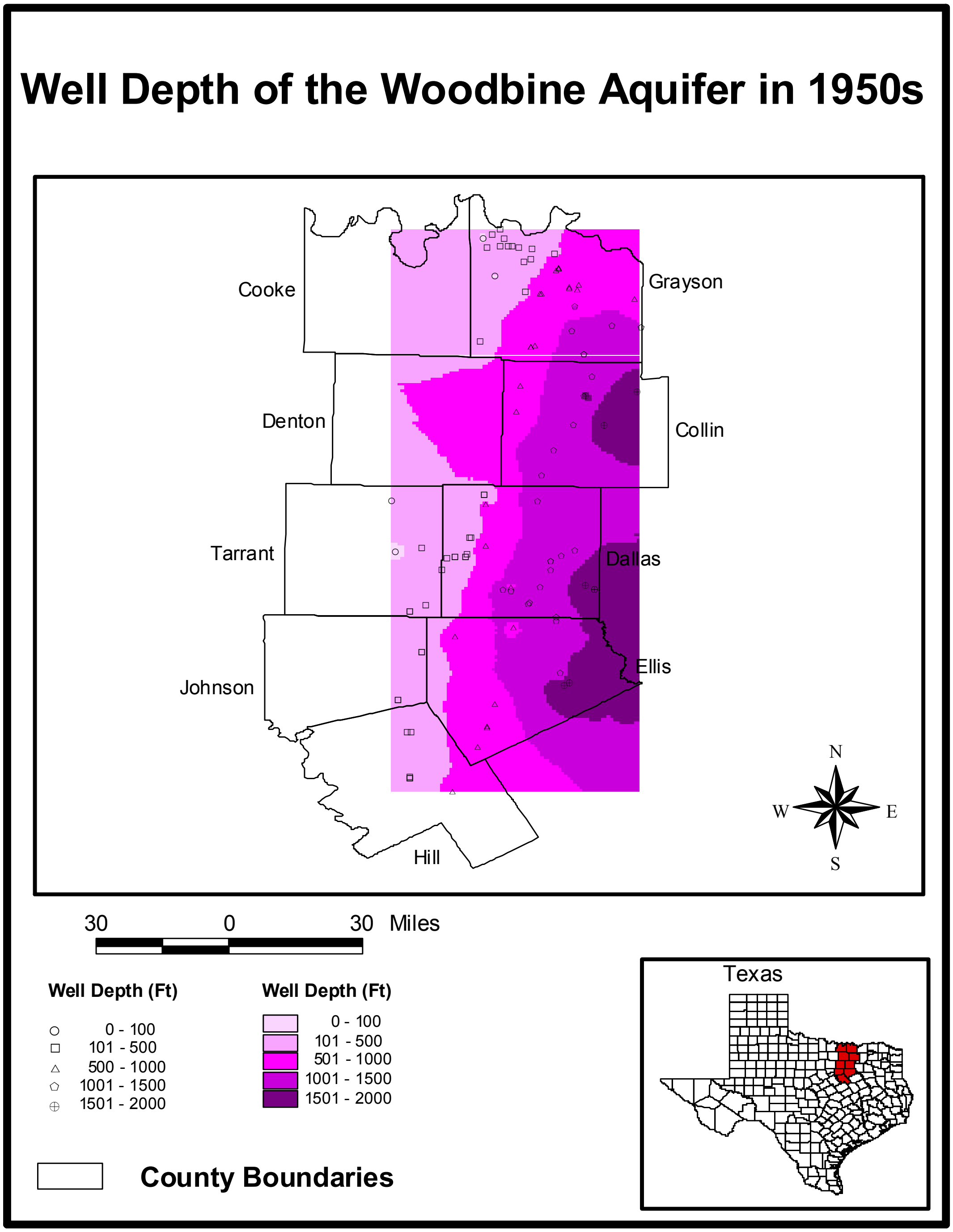


Figure 9 Well Depth of the Woodbine Aquifer in 1950s

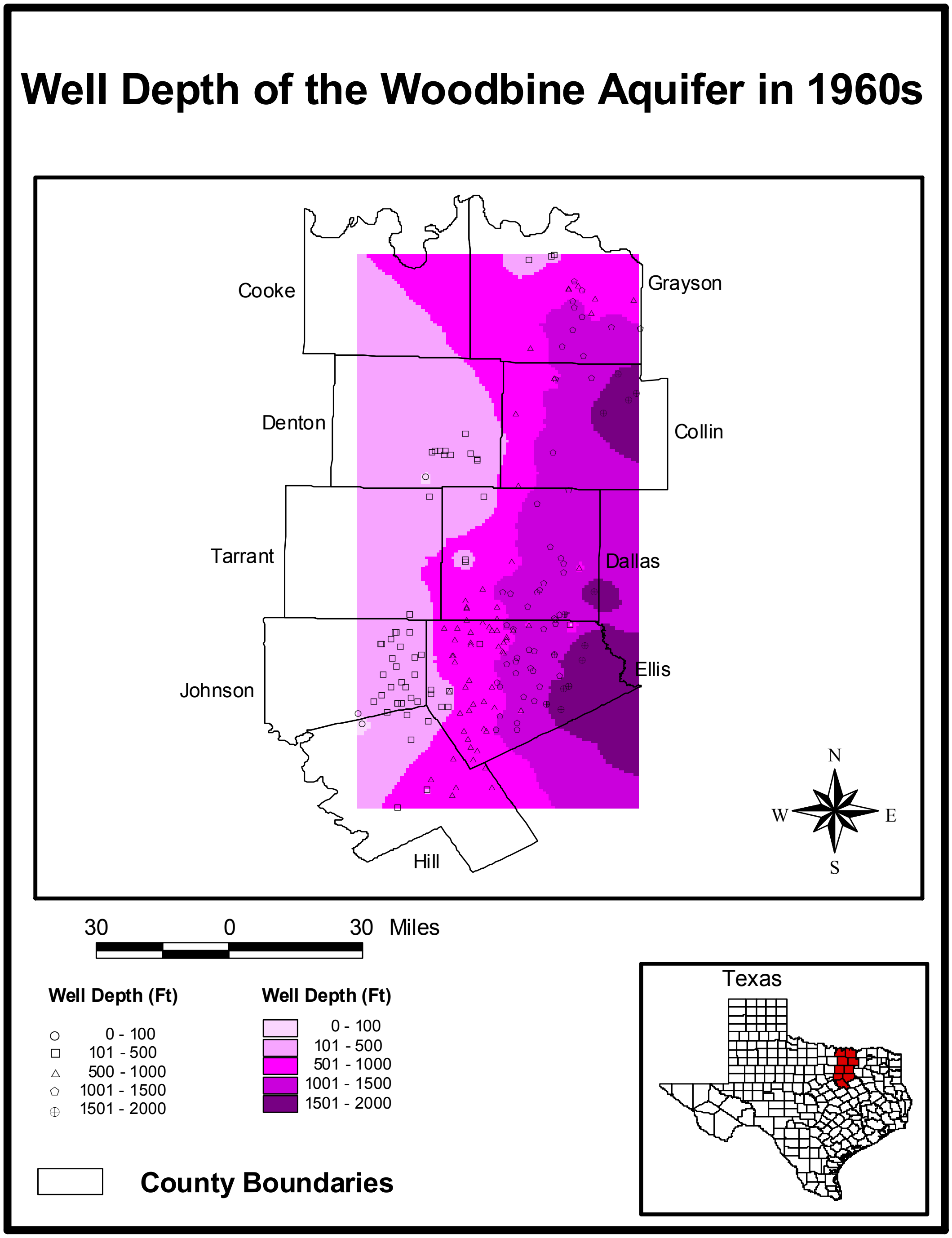


Figure 10 Well Depth of the Woodbine Aquifer in 1960s

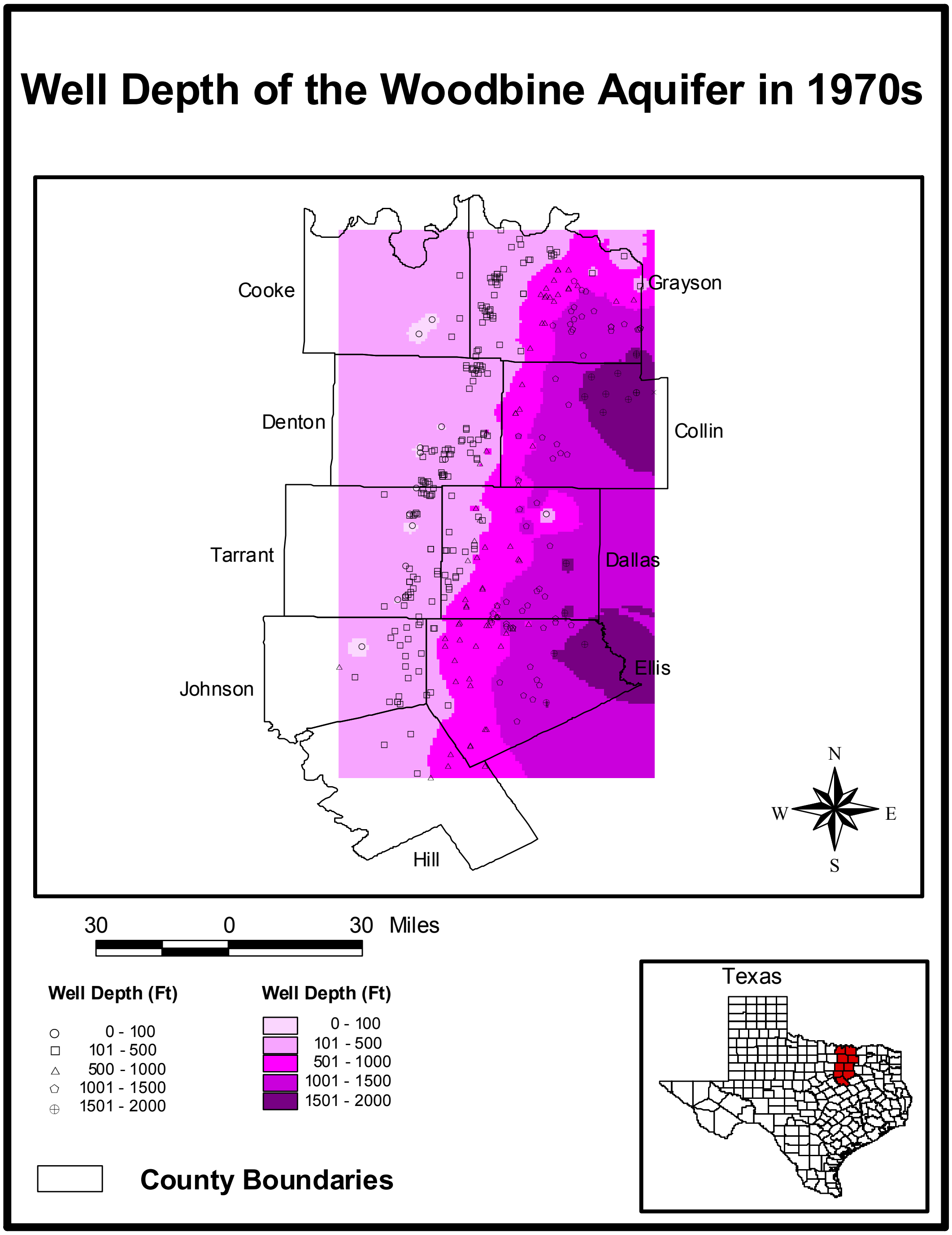


Figure 11 Well Depth of the Woodbine Aquifer in 1970s

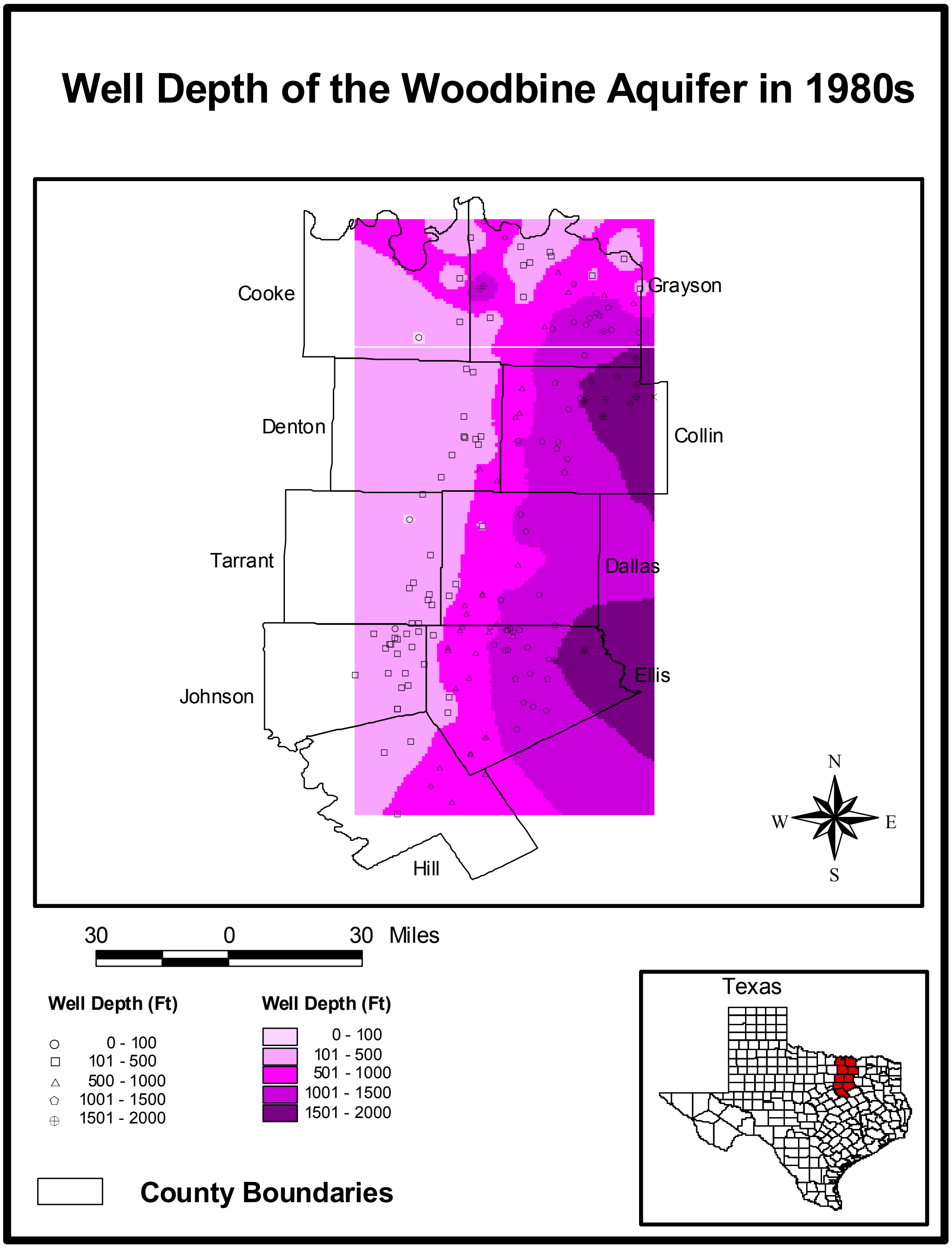


Figure 12 Well Depth of the Woodbine Aquifer in 1980s

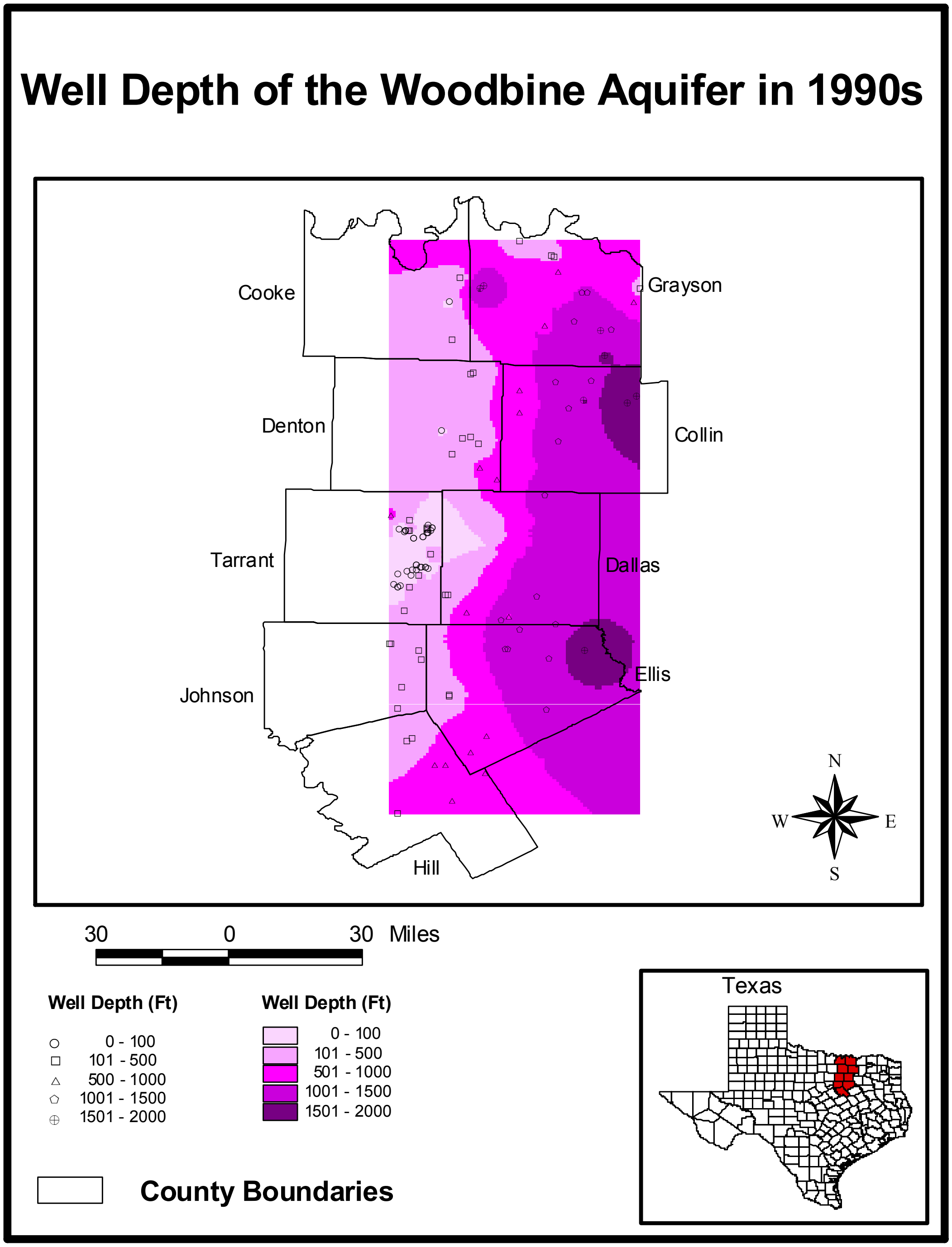


Figure 13 Well Depth of the Woodbine Aquifer in 1990s

4.2 Time Plots of the Woodbine Aquifer

One to three wells in each county having the most complete water analysis from 1950s to 1990s were selected to illustrate time plots of each contaminant shown in Figure 14. The plots are attached in Appendix A. There were two types of plots of each well, one plot was both sulfate and chloride plotted versus well depth, and the other plot was both fluoride and nitrate plotted versus well depth. The state well IDS of these wells represented by letters such as A, B, and D in Figure 14 are listed in Appendix A.

Chloride levels over the secondary drinking water standard (250 mg/L) were found in well # S, located in Hill County, in which chloride concentrations over 250 mg/L were found in almost all of the five decades. Therefore, Hill County might experience a problem from the high chloride levels. Furthermore, chloride levels over 250 mg/L in well # Q located in Ellis County were only found in the 1960s, and then decreased from the 1970s to 1990s.

Sulfate levels over the secondary drinking water standard (250 mg/L) covering the five decades were found in well # I, L, M, N, O, Q, R, S, and T. Those wells were located in Collin, Dallas, Johnson, Ellis, and Hill Counties (Figure 14). Therefore, the southern part of the study area having rapid urban growth contained the sulfate concentrations over the secondary drinking water standard. However, Tarrant County having many new wells drilled in 1990s showed high sulfate levels (> 250 mg/L) in 1990s. Finally, high sulfate level areas in 1990s were also in Collin, Dallas, Johnson, Ellis, Hill, and Tarrant Counties.

Fluoride levels over the secondary drinking water standard (2.0 mg/L) were found in well # D, E, F, G, I, L, N, Q, P, S, and T, which were located in Grayson, Denton, Collin, Dallas, Ellis, and Hill Counties. Its concentrations in Denton County, in 2 out of 3 wells, were decreased in the 1990s. However, fluoride levels over the primary drinking water standard (4 mg/L) were found only in well # Q and S located in Ellis and Hill Counties, respectively, in the southern part of the study area

Nitrate levels did not exceed the drinking water standard (44.3 mg/ L in terms of nitrate concentrations); therefore, nitrate levels should not be the problem for the drinking water from the Woodbine Aquifer. Most of the nitrate concentrations in the plots (Appendix A) were less than 10 mg/L. However, the interpolation surface maps of nitrate concentrations in each decade showed some areas having nitrate levels over the drinking water standard (44.3 mg/ L). Details are discussed next.

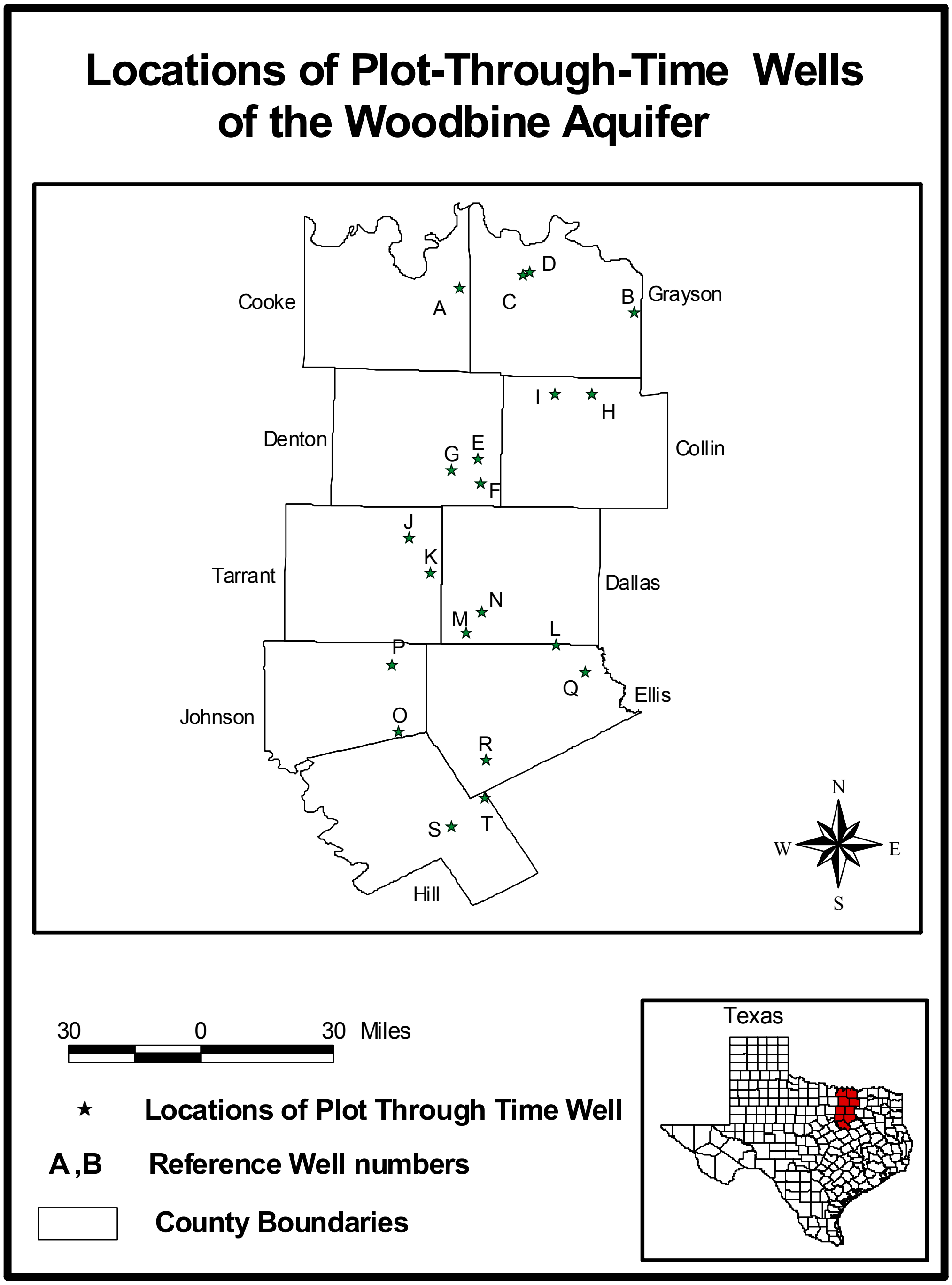


Figure 14 Well Plot-Through-time of the Woodbine Aquifer in the study area

4.3 Concentrations of each Contaminant by Decade and County

4.3.1 Fluoride

4.3.1.1 Interpolated Concentration Contour Maps of Fluoride

Interpolated concentration contour maps (Figures 15 to 19) showed that fluoride concentrations over the primary drinking water standard (4 mg/L) were located in Ellis County for every decade, and in Dallas County in the1960s. High concentrations were most common from the 1960s to 1980s, but for only two wells in the 1950s (located in Hill and Ellis Counties). In the 1990s, high fluoride concentrations were found in Tarrant and Ellis Counties, which had fluoride levels over the primary drinking water standard.

Areas having fluoride concentration levels over the secondary drinking water standard (2 mg/L) covered Dallas, Denton, Collin, and Hill Counties. Generally, fluoride levels have decreased from the 1960s to 1990s. Cross-plots of fluoride concentrations versus well depth, by decade and by county, were studied. Spreadsheets showing fluoride concentrations by decade and county are illustrated in Appendices B and C, respectively. Table 3 illustrates the fluoride levels over the five decades and nine counties summarized from the fluoride concentrations attached in Appendices B and C.

Overall, median fluoride concentrations have decreased since the 1950s (Table 3). Ellis County had the highest median fluoride concentration, 1.94 mg/L, close to the secondary drinking water standard (2.0 mg/L); therefore, residents of this county may have a relatively high health risk from drinking water with high fluoride.

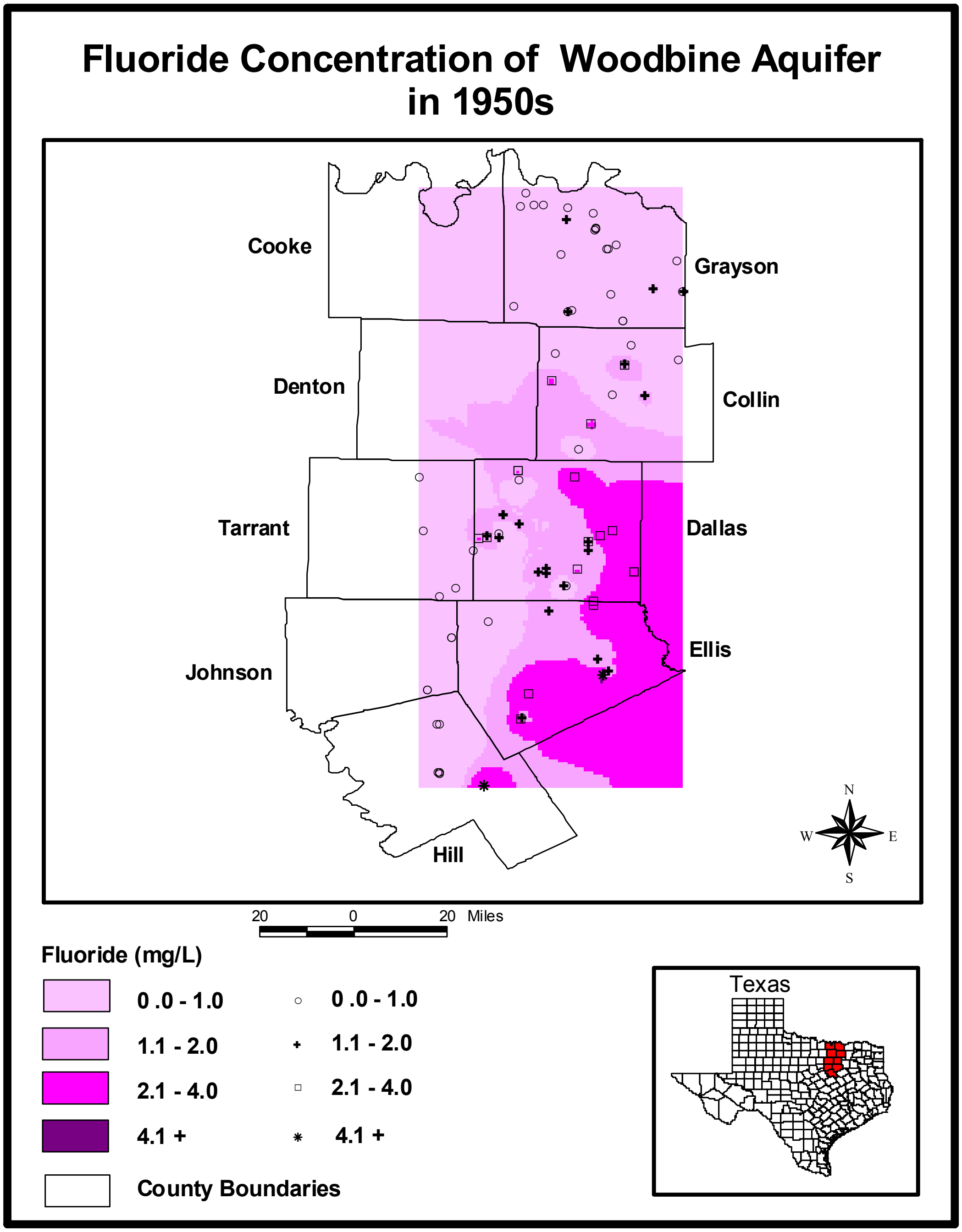


Figure 15 Fluoride Concentration of the Woodbine Aquifer in 1950s

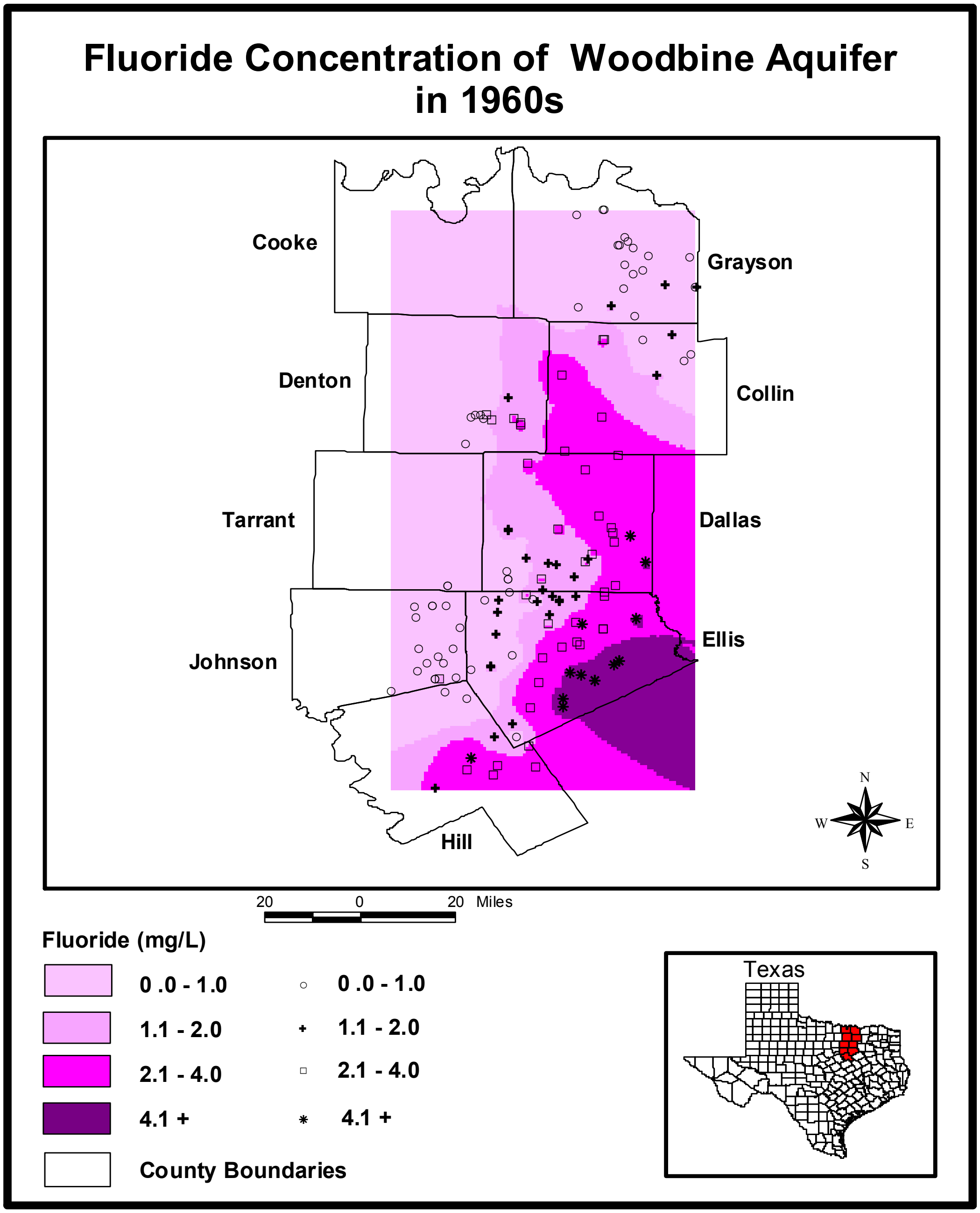


Figure 16 Fluoride Concentration of the Woodbine Aquifer in 1960s

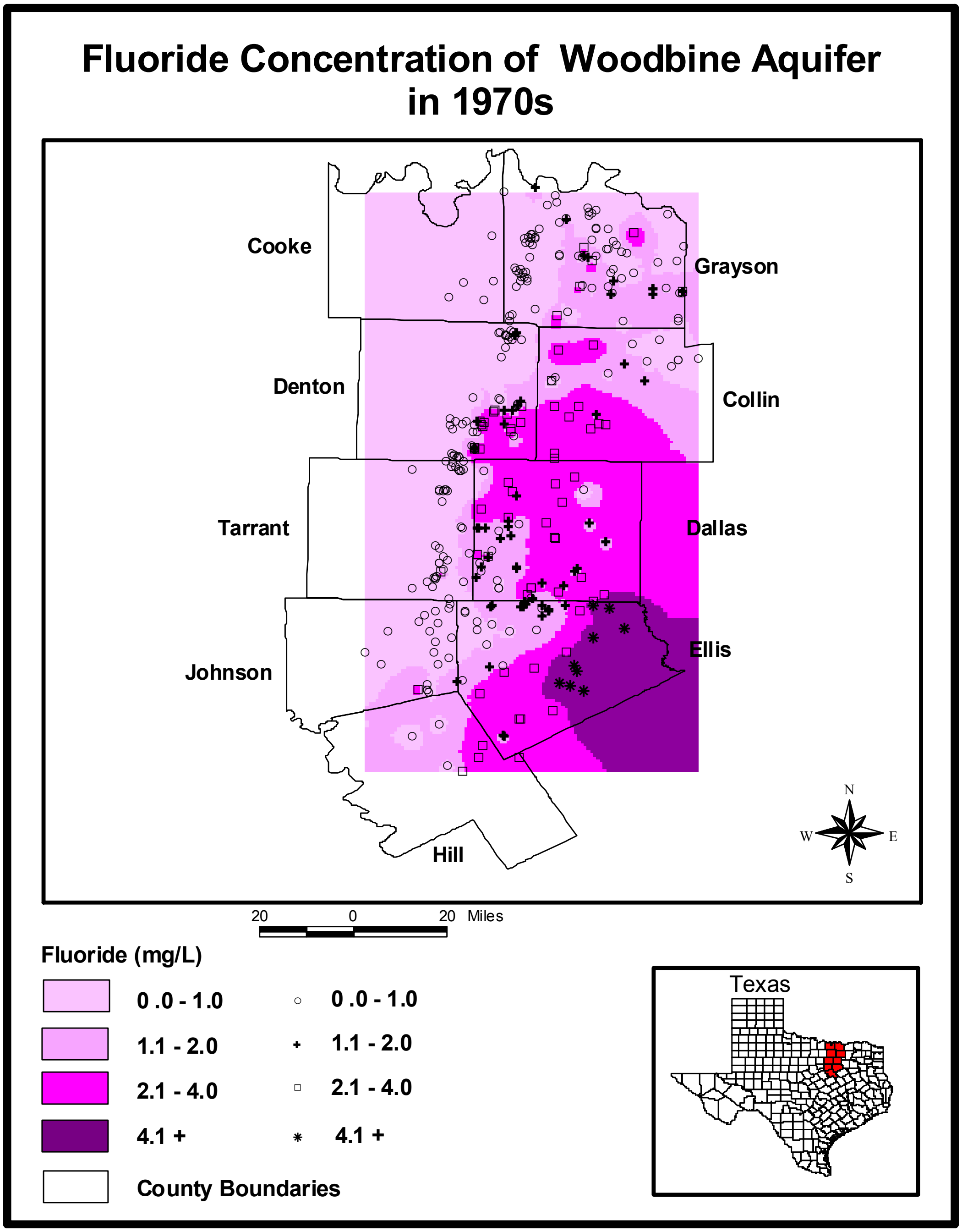


Figure 17 Fluoride Concentration of the Woodbine Aquifer in 1970s

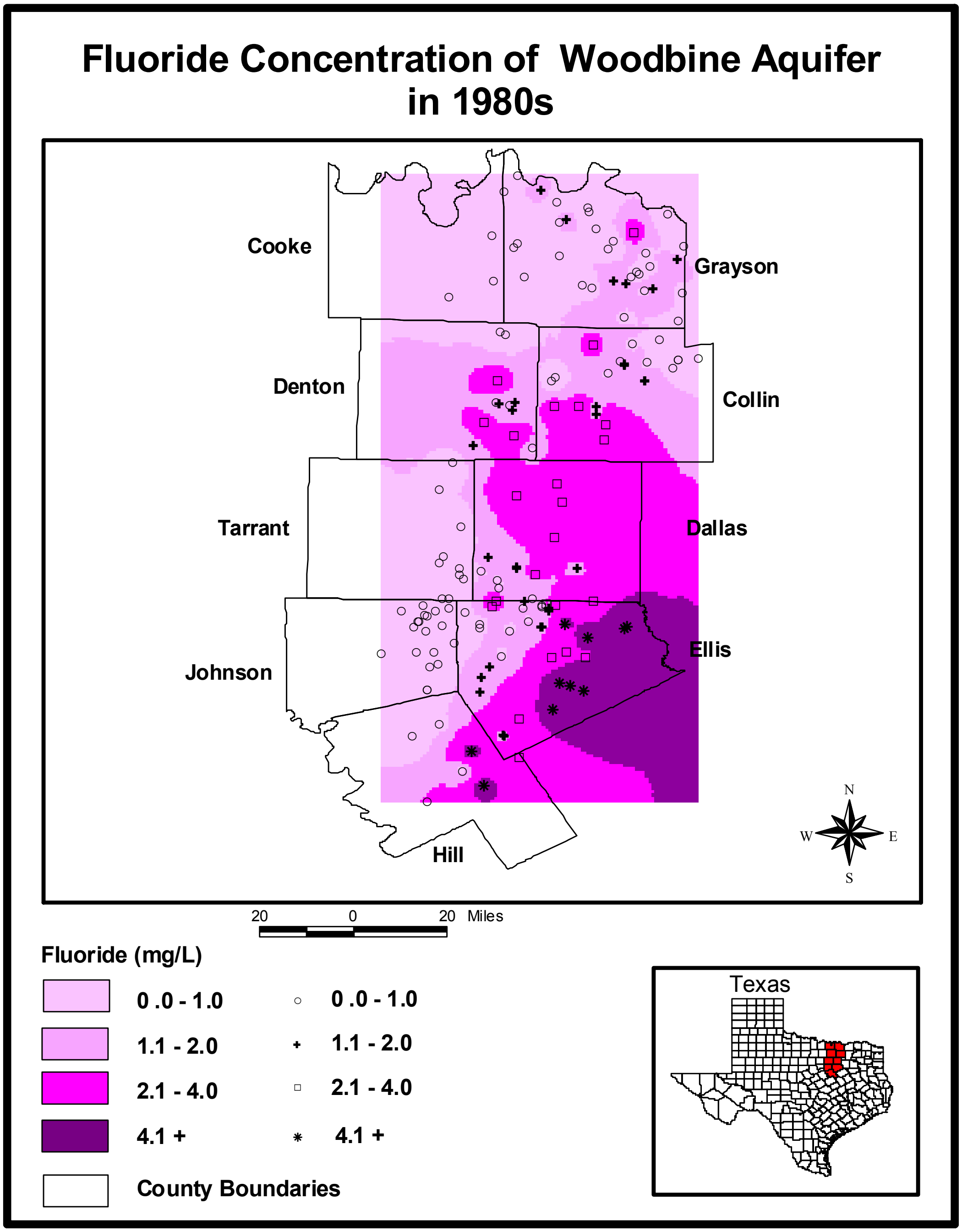


Figure 18 Fluoride Concentration of the Woodbine Aquifer in 1980s

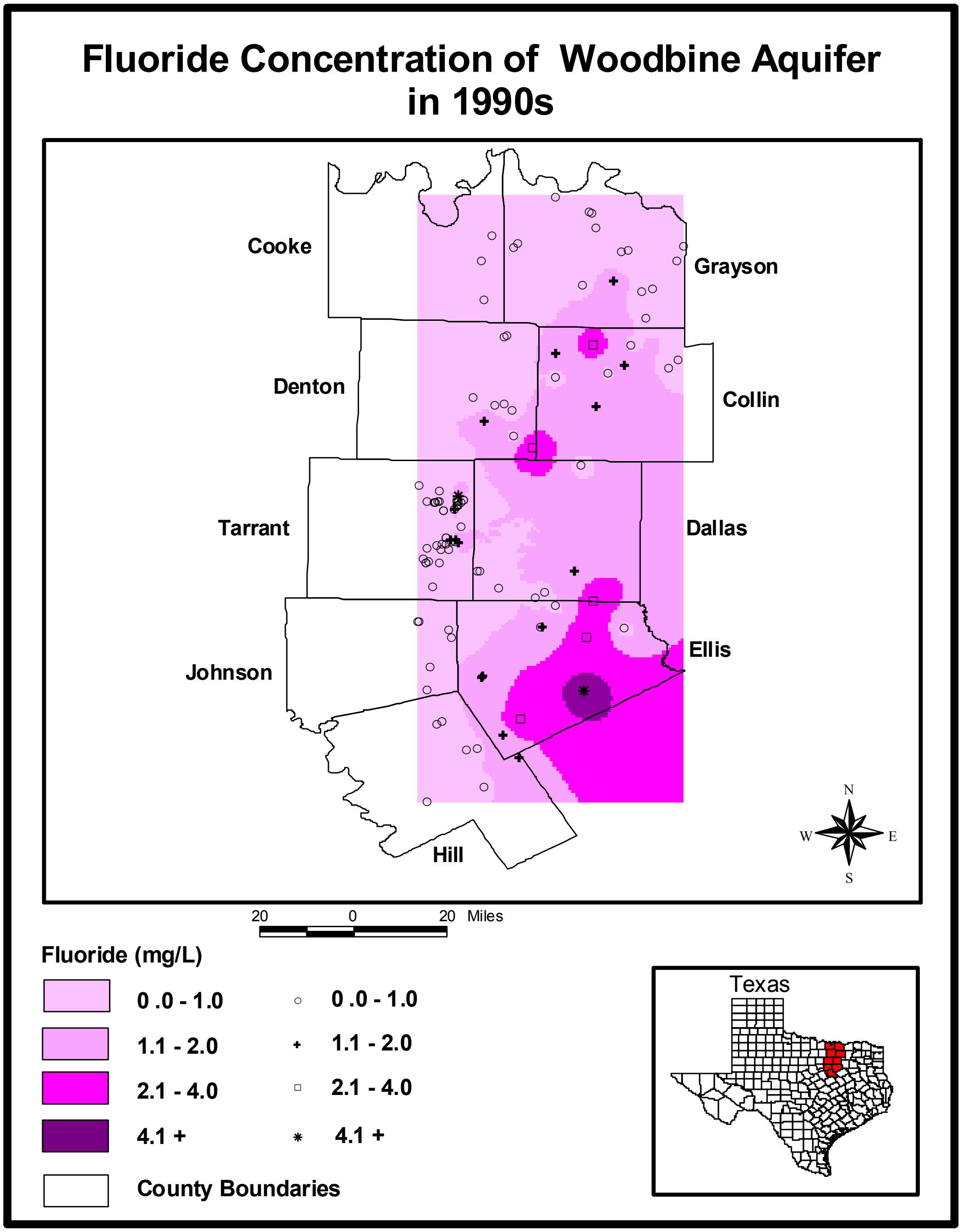


Figure 19 Fluoride Concentration of the Woodbine Aquifer in 1990s

4.3.1.2 Fluoride Levels in each County and Decade

Well depth and fluoride concentrations in Appendixes B and C, and Table 3, show that most of the counties had higher fluoride concentration at deeper depths. Fluoride concentrations increase in the downdip direction, suggesting a geologic origin -- groundwater that has traveled further in the aquifer has dissolved more fluoride from rocks.

However, fluoride concentrations in Collin County, Appendices B and C, and Table 3, had an inverse relationship with well depth. The highest fluoride levels between 1000 and 1500 feet possibly were derived from nearby geological formations such as the Grayson Marl and Eagle Ford Formations (Figure 7), which lie beneath and above the Woodbine Formation, respectively. Also, higher concentrations in shallow wells possibly derived from locally fluoride-enriched parts of the Woodbine Aquifer.

Table 3 Fluoride Levels in each County and Decade

County	The median fluoride concentration (mg/L)					Relationship from Cross-Plots	Overall Median Fluoride (5 decades)
	1950s	1960s	1970s	1980s	1990s		
Collin	1.7	2.15	1.9	1.45	1.3	–	↓
Cooke	N/A	N/A	0.2	0.1	0.38	+	No change
Dallas	2.4	2.85	2.2	2.2	1.12	+	↓
Denton	N/A	1.5	1.0	1.5	1.0	+	↓
Ellis	2.4	3.2	1.9	2.3	1.94	+	↓
Grayson	0.65	0.8	0.7	0.8	0.38	+	↓
Hill	0.9	3.15	2.6	1.4	0.83	+	↓
Johnson	0.45	0.7	0.7	0.5	0.45	+	↓
Tarrant	0.4	0.55	0.4	0.5	0.5	+	No change

Remark: Relationship:

+ = deeper depth, higher concentration

- = deeper depth, lower concentration

Overall Trend:

↑ = the contaminant levels increased from 1950s to 1990s

↓ = the contaminant levels decreased from 1950s to 1990s

4.3.2 Nitrate

4.3.2.1 Interpolated Concentration Contour Maps of Nitrate

Nitrate levels in the study area (Figures 20 to 24) were not excessive the drinking water standard (44.3 mg/L as nitrate). There were only a few wells in the 1970s, which were over the drinking water standard, located in Denton and Johnson Counties. However, Tarrant County in the 1990s showed nitrate levels above 44.3 mg/L; the wells were drilled to shallow depths making them vulnerable to contamination. Low nitrate levels in the study area relate to only small patches of agricultural land and fertilized usage. Nitrate concentrations and well depths are in Appendices B and C.

In the 1970s and 1990s (Figures 22 and 24), high nitrate concentrations (> 44.3 mg/L) were found at shallow depth, Denton, Tarrant, and Johnson Counties, whereas nitrate levels in the eastern part of the study area were less than 44.3 mg/L. However, interpolated contour maps of nitrate (Figures 20-24) showed that most of the nitrate concentrations were lower than 10 mg/L for every decade.

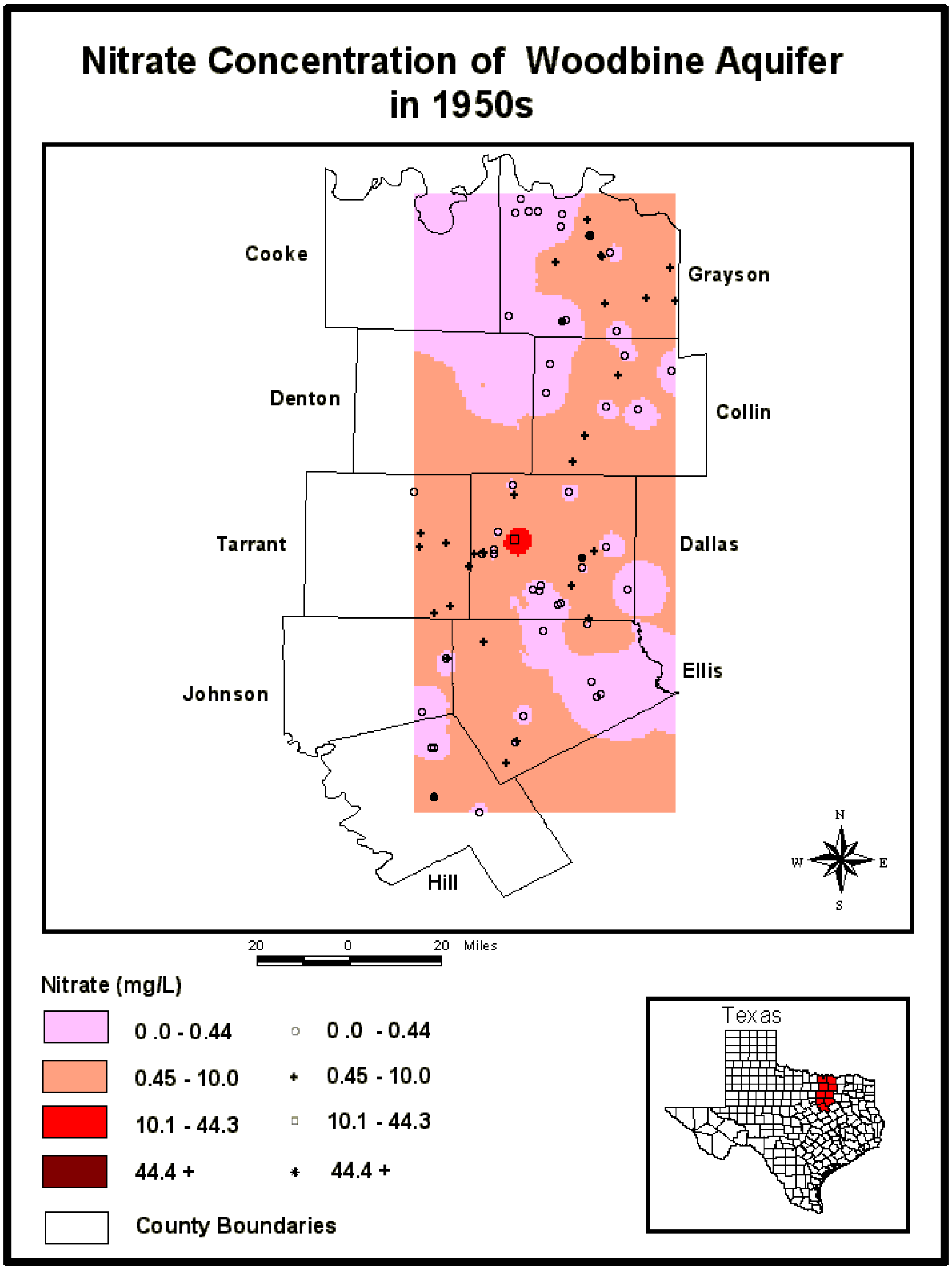


Figure 20 Nitrate Concentration of the Woodbine Aquifer in 1950s

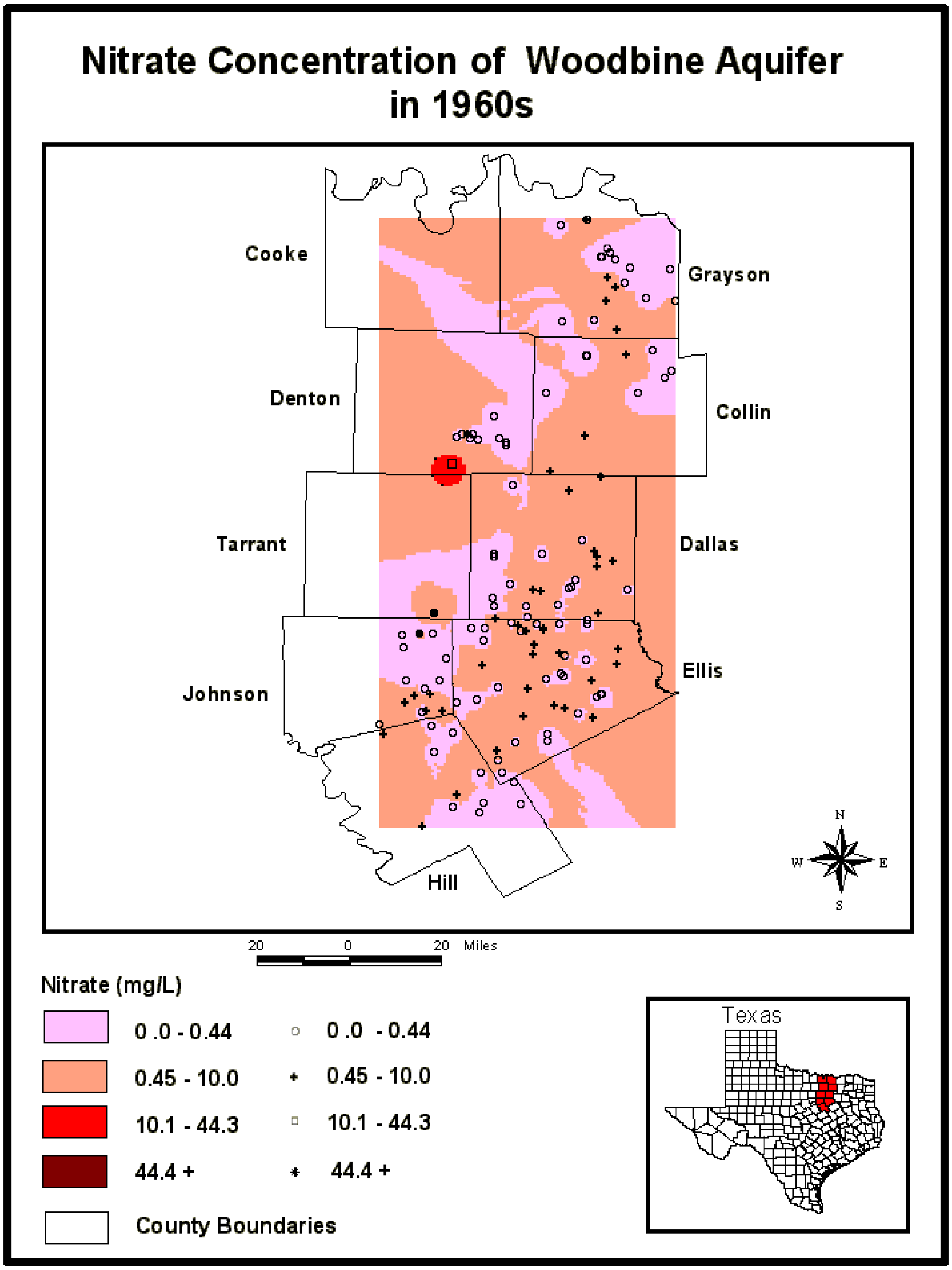


Figure 21 Nitrate Concentration of the Woodbine Aquifer in 1960s

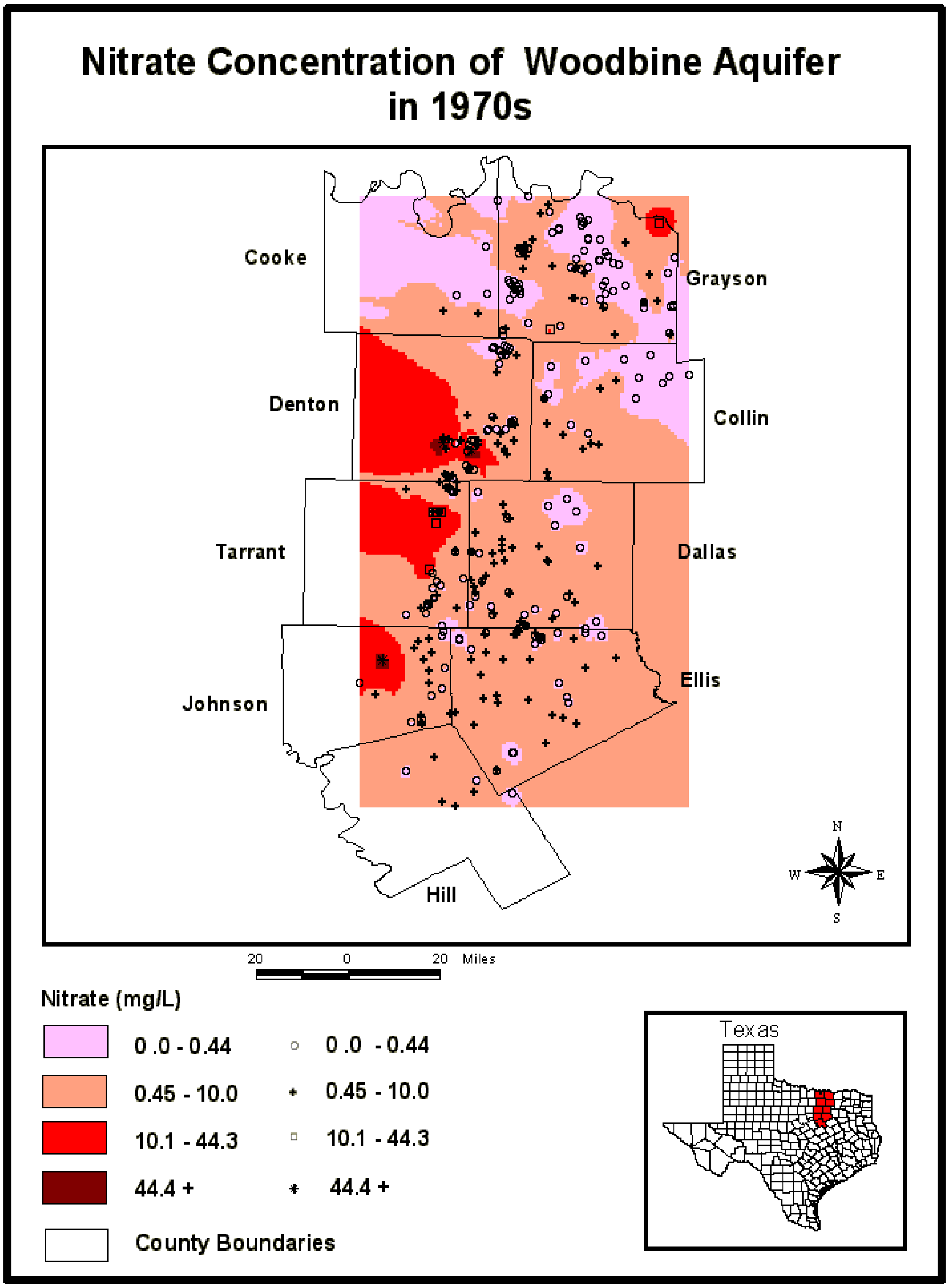


Figure 22 Nitrate Concentration of the Woodbine Aquifer in 1970s

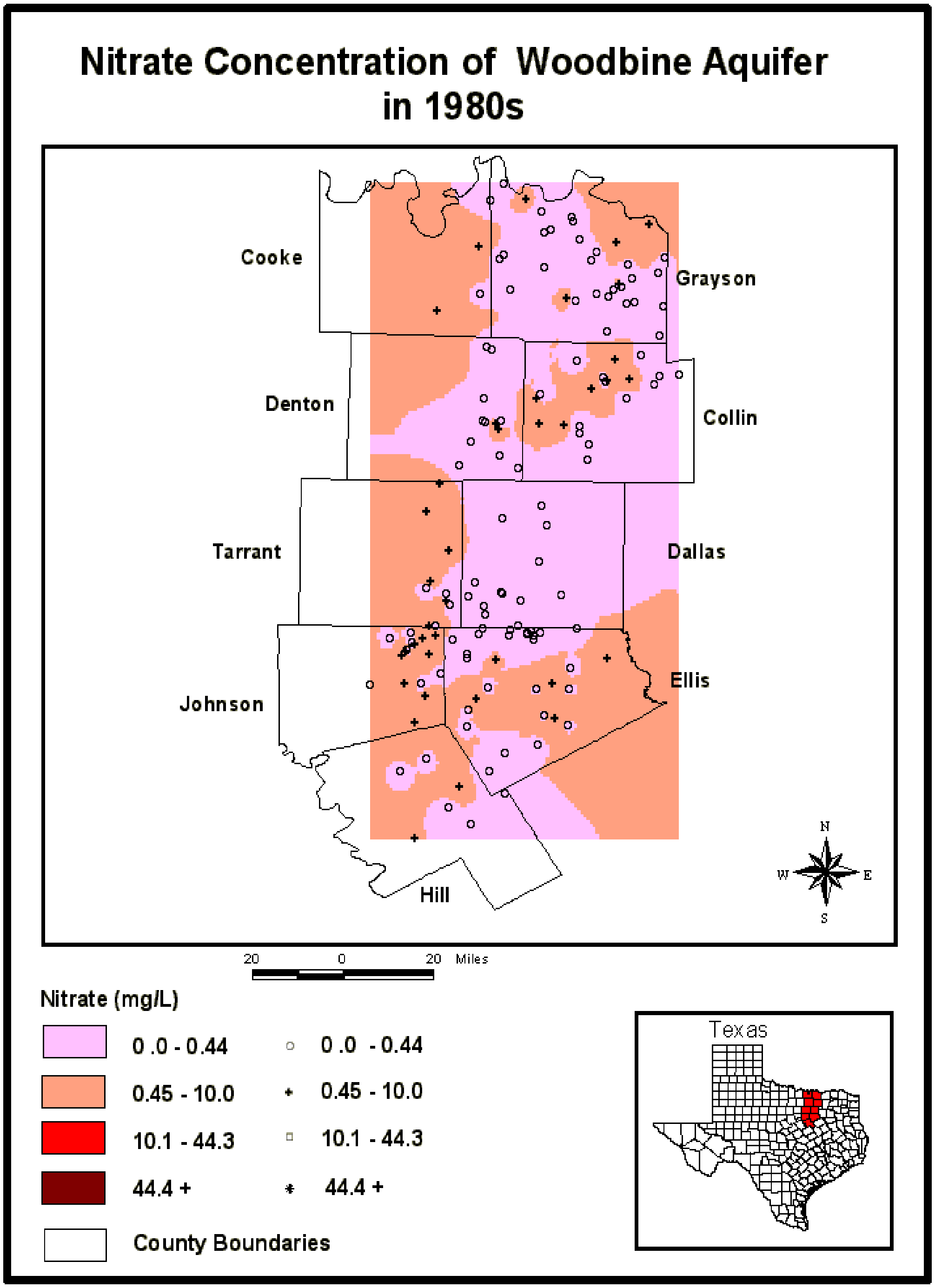


Figure 23 Nitrate Concentration of the Woodbine Aquifer in 1980s

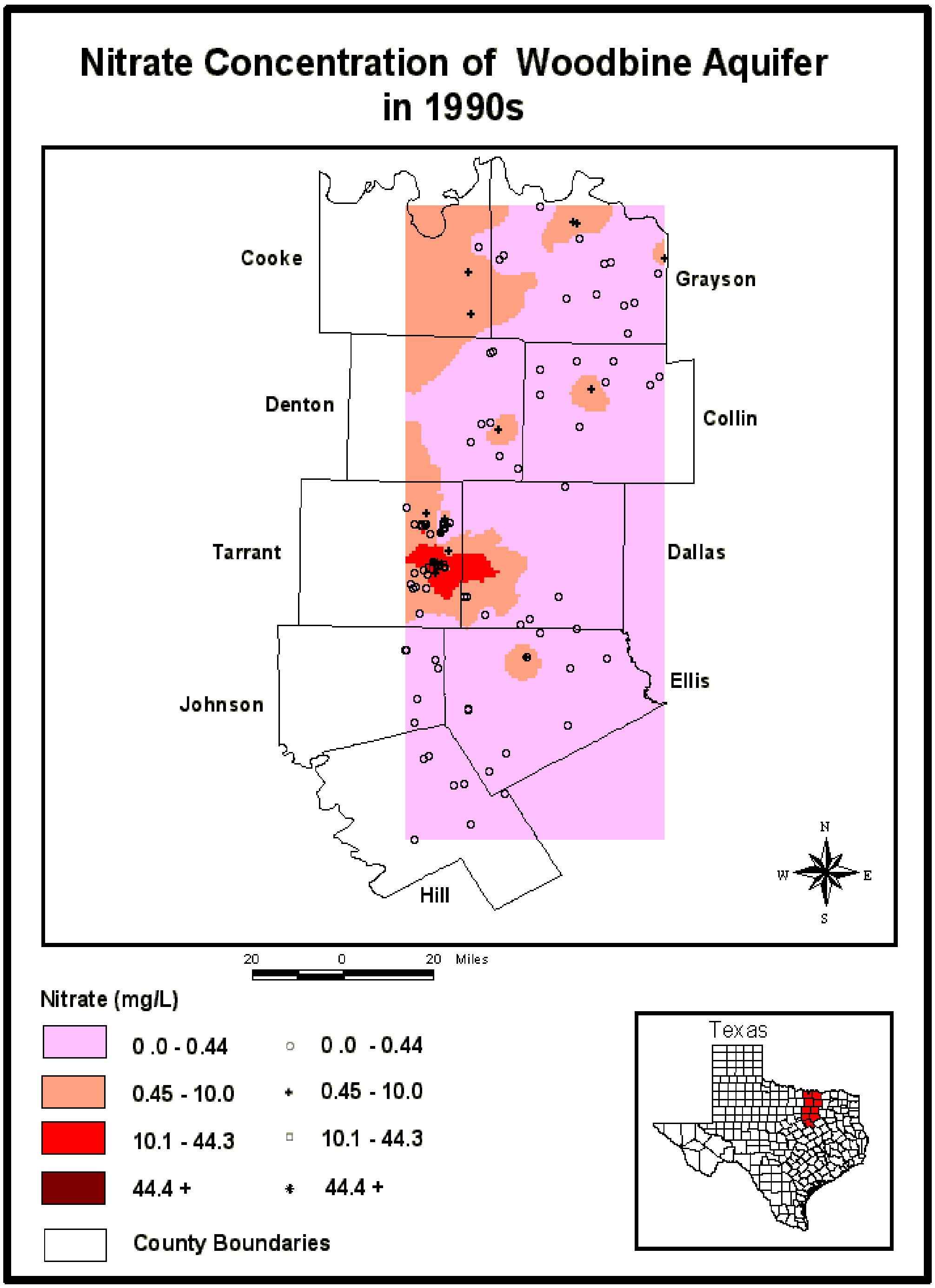


Figure 24 Nitrate Concentration of the Woodbine Aquifer in 1990s

4.3.2.2 Nitrate Levels in each County and Decade

Well depth and nitrate concentrations listed in Appendices B and C, and Table 4, showed that most of counties had higher nitrate concentrations at shallow depths, which suggests that nitrate concentrations were related to human activities. Sources of nitrate in rural areas include agricultural runoff, seepage of excess chemicals, fertilizer, precipitation, biological fixation, and animal feedlots (Dorshelmer and et al., 1997). Nitrate levels in urban areas might come from waste dumps, leaking sewer lines, improper waste disposal, and inadequate design and maintenance of septic systems (Dorshelmer et al., 1997). Nitrate concentrations were controlled primarily by land use practice rather than geologic sources.

However, the nitrate concentrations in Dallas and Ellis Counties, Appendices B and C, and Table 4, had both direct and inverse relationships with well depth, the highest nitrate levels between 500 and 1000 feet. High nitrate concentrations at deeper levels could result from long term use of fertilizer or movement along well annuli. Overall, from the 1950s to 1990s (Appendices B and C, and Figures 20-24, and Table 4), nitrate levels decreased. The median concentrations of nitrate were mainly zero over the five decades.

Table 4 Nitrate Levels in each County and Decade

County	The median concentration over time (mg/L)					Relationship from Cross-plots	Overall Median Nitrate (5 decades)
	1950s	1960s	1970s	1980s	1990s		
Collin	0	0	0	0	0	No trend	↓
Cooke	N/A	N/A	0.4	2.88	1.06	–	↓
Dallas	0	0	1.3	0	0	+ –	↓
Denton	N/A	0	0.5	0	0	–	No change
Ellis	0	0	1.09	0	0	+ –	↓
Grayson	2	0	0	0	0	–	↓
Hill	0	0	0.8	0	0	Scattering	↓
Johnson	0.4	0	3.6	0.66	0	–	↓
Tarrant	2.5	0.75	0	0.68	0	–	↓

Remark: Relationship:

+ = deeper depth, higher concentration
- = deeper depth, lower concentration

Over all Trend:

↑ = the contaminant levels increased from 1950s to 1990s
↓ = the contaminant levels decreased from 1950s to 1990s

4.3.3 Sulfate

4.3.3.1 Interpolated Concentration Contour Maps of Sulfate

Sulfate levels over the drinking water standard (250 mg/L of sulfate) were mainly found in the southern part of the study area. Details of the sulfate levels in each well are posted in Appendixes B and C. In the 1950s (Figure 25), Collin, Dallas, Tarrant, Johnson, Ellis, and Hill Counties principally had high levels. Higher sulfate levels were observed for the 1960s (Figure 26). Sulfate levels over 250 mg/L were found in Collin, Dallas, Tarrant, Ellis, and Hill Counties, and also one well in Denton County.

However, there were high sulfate levels locally in northern counties such as Cooke, Grayson, and Denton Counties in the 1970s (Figure 26). In the 1980s (Figure 27), potentially high sulfate areas in Cooke and Grayson Counties lacked sample data. The southern part of the study area still had relatively high sulfate levels in the 1980s. High sulfate concentrations were found mainly in Tarrant, Dallas, and Ellis Counties, and locally in Grayson, Johnson, and Hill Counties. High sulfate concentration trends projected, observed from the 1950s to the 1990s (Figures 25 to 29), are still a problem in the study area. Geologic sources such as gypsum deposits and lignite beds likely account for high sulfate concentrations in the southeast part of the study area.

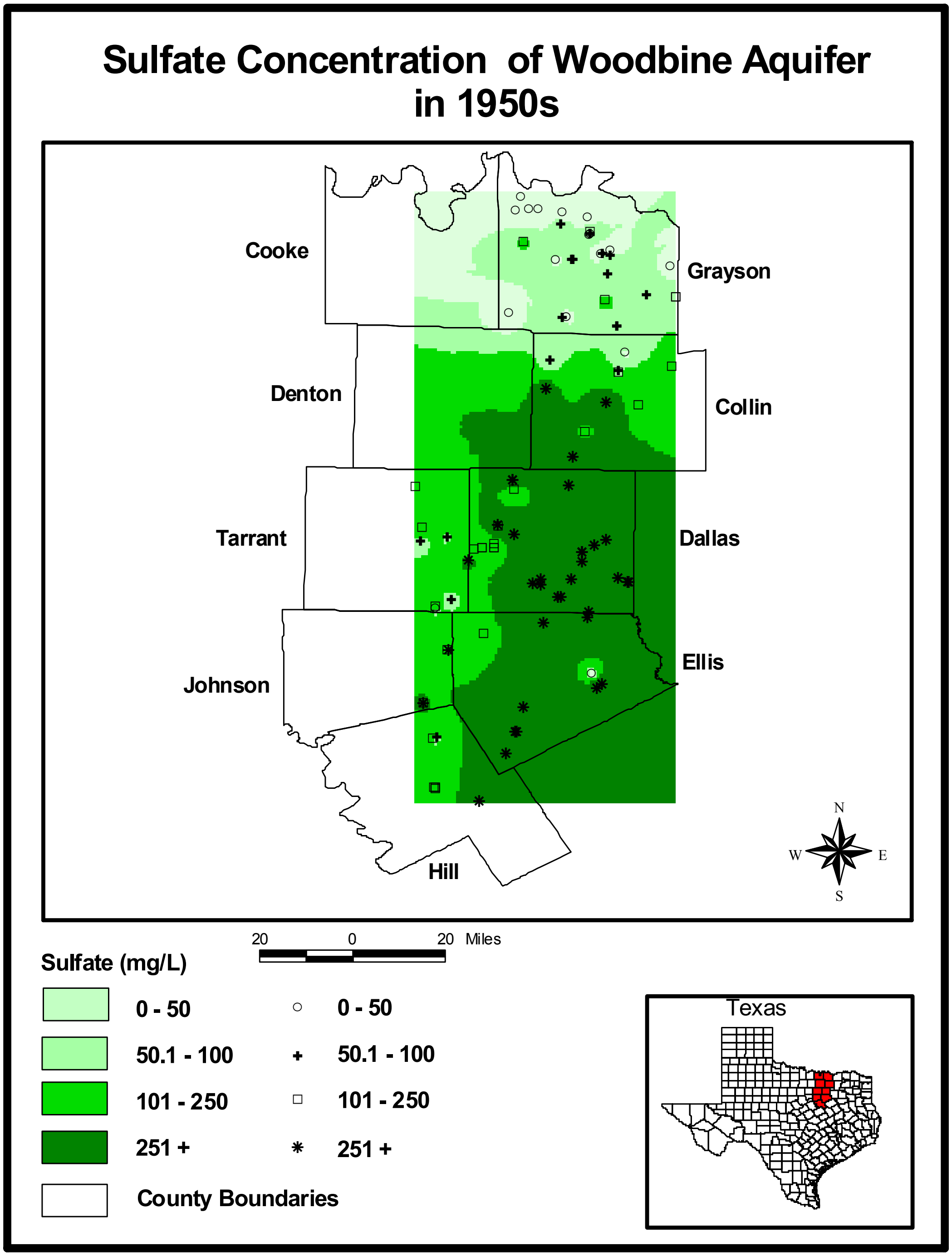


Figure 25 Sulfate Concentration of the Woodbine Aquifer in 1950s

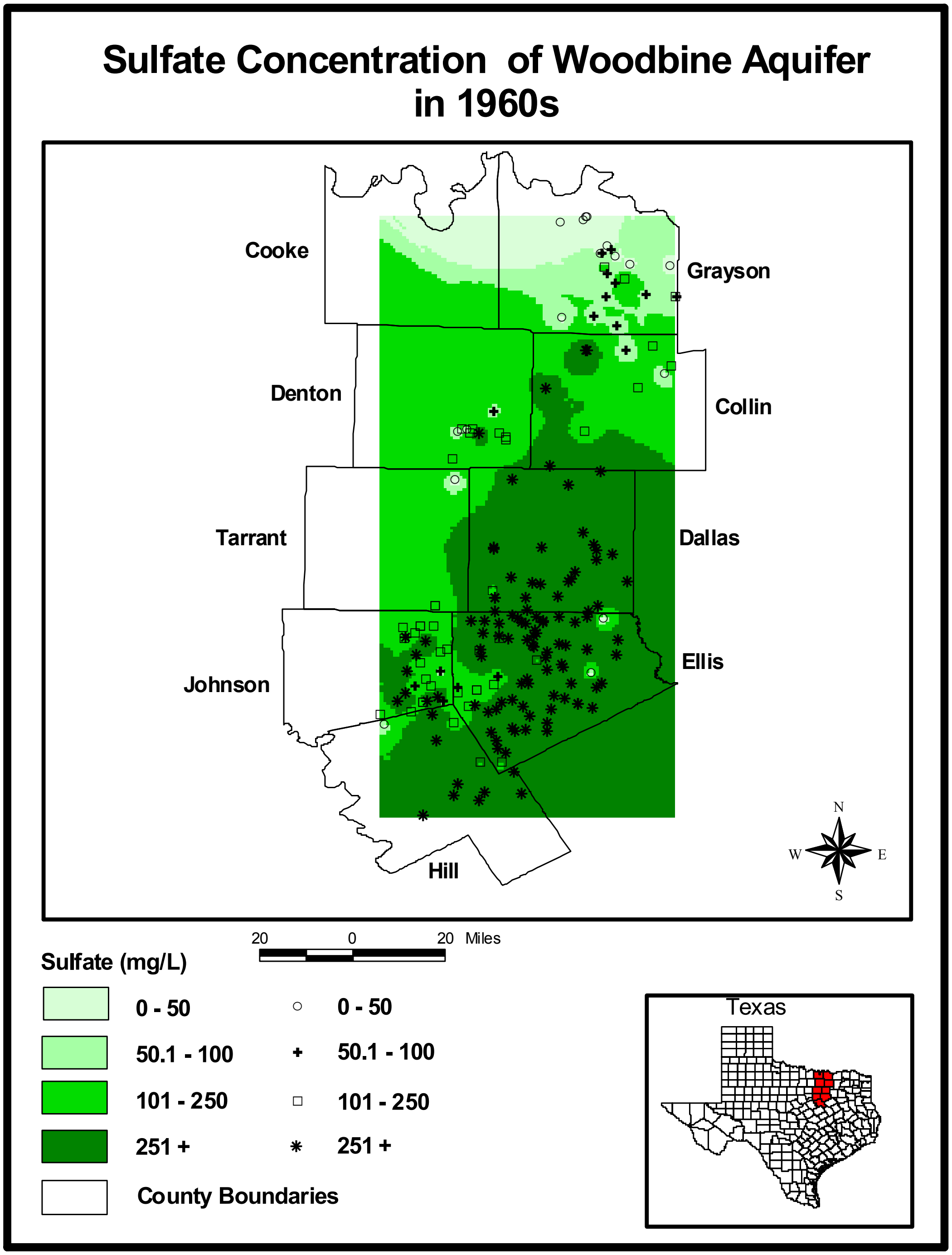


Figure 26 Sulfate Concentration of the Woodbine Aquifer in 1960s

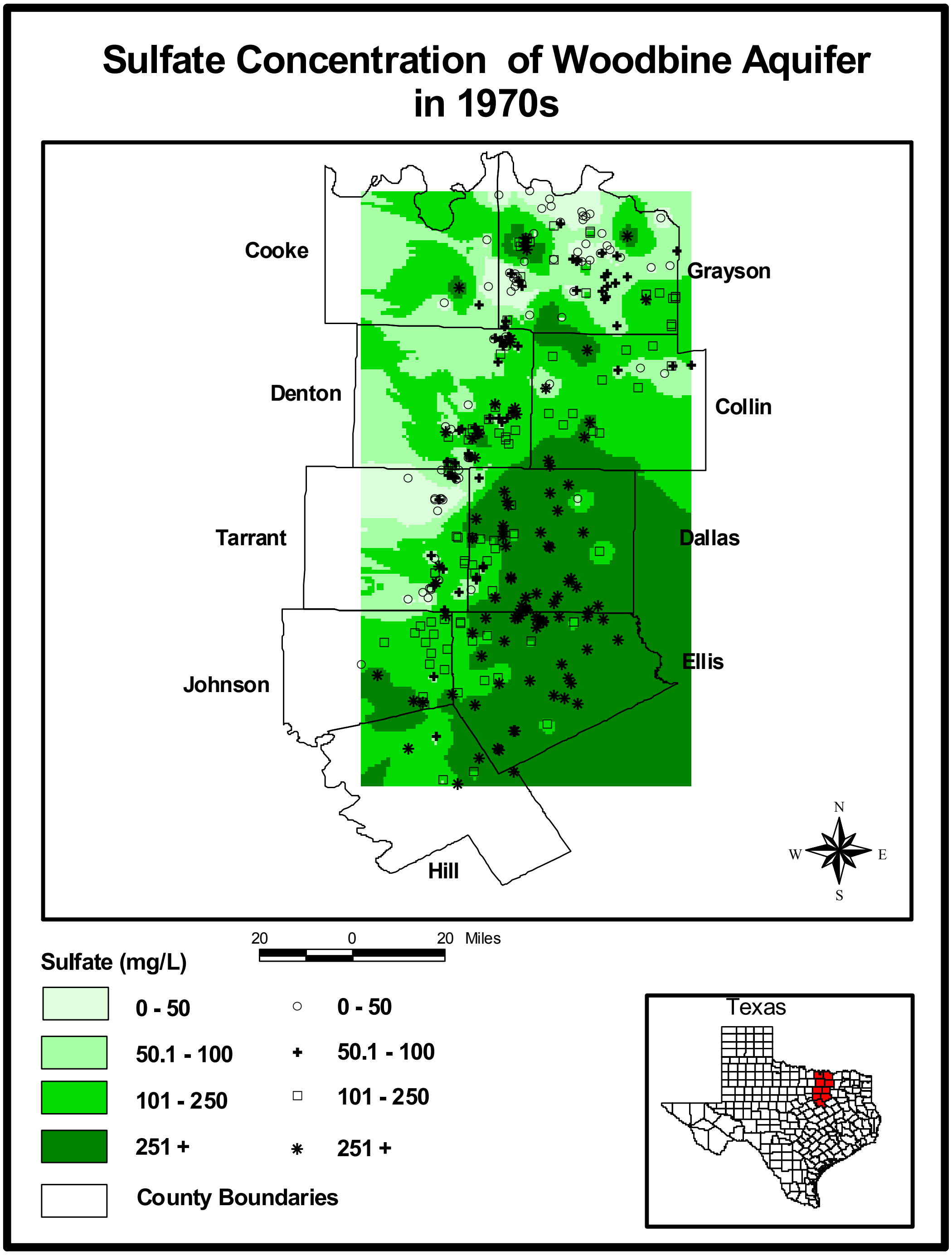


Figure 27 Sulfate Concentration of the Woodbine Aquifer in 1970s

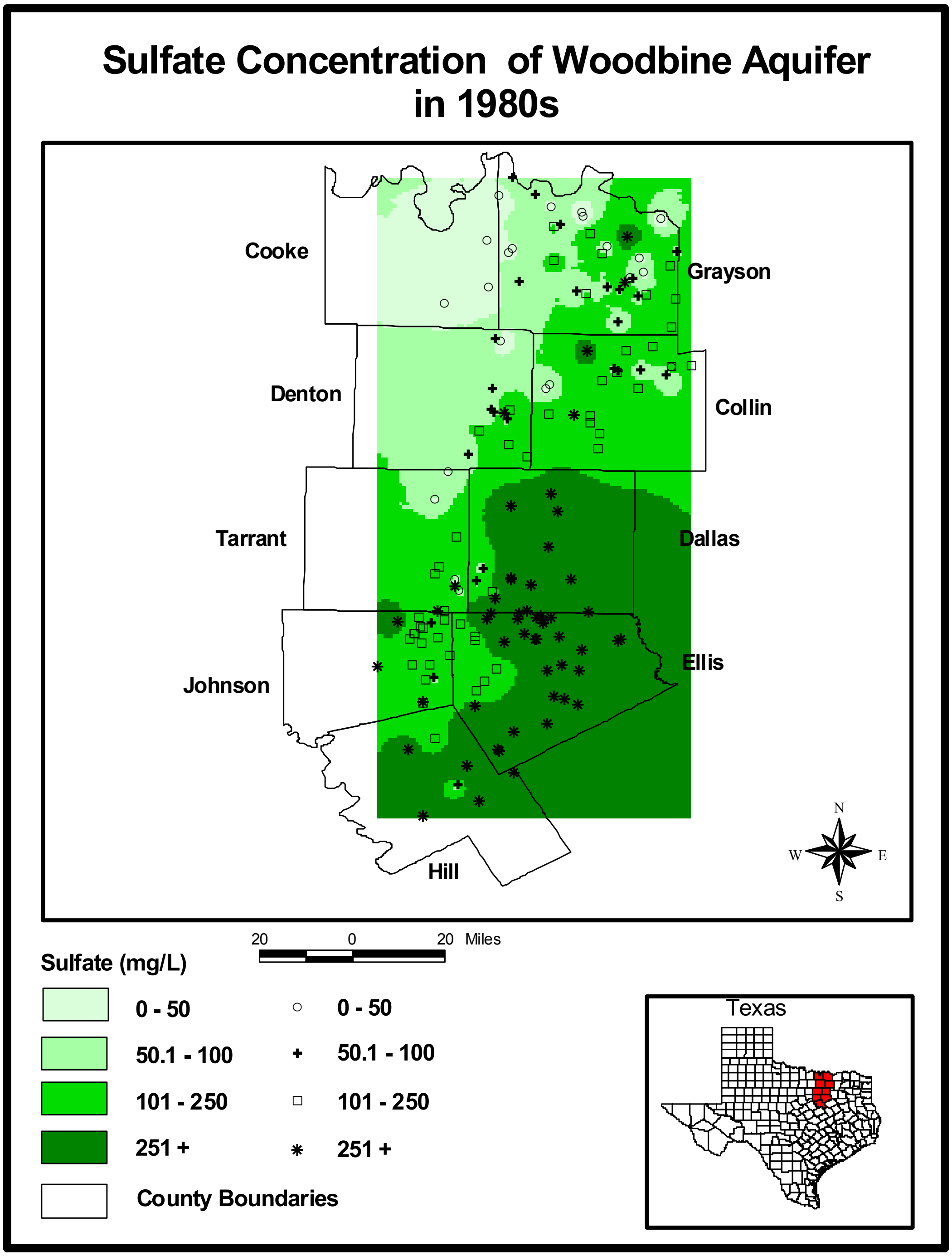


Figure 28 Sulfate Concentration of the Woodbine Aquifer in 1980s

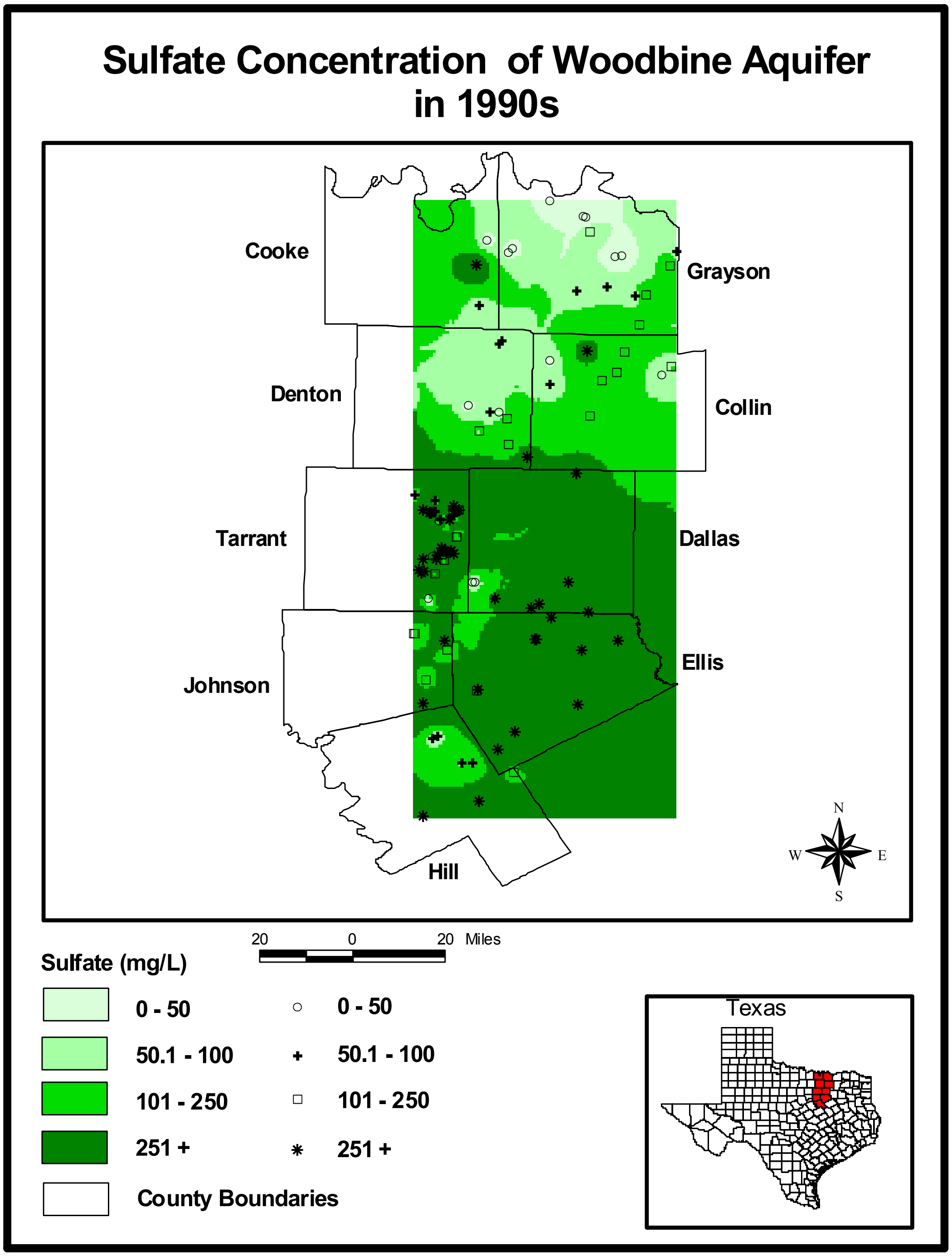


Figure 29 Sulfate Concentration of the Woodbine Aquifer in 1990s

4.3.3.2 Sulfate Levels in each County and Decade

Well depth and sulfate concentrations are listed in Appendices B, C and Table 5. Results showed that Dallas, Ellis, Hill, and Tarrant Counties had median sulfate concentrations over the secondary drinking water standard (250 mg/L); however, only Dallas, Ellis, and Tarrant Counties had such high sulfate levels in the 1990s.

There were both positive and negative associations between sulfate and well depth (Appendices B and C, summarized in Table 5). Negative relationships were found in Collin, Johnson, and Tarrant Counties, with depths of the highest sulfate levels at approximately 800-1200 feet, 200-300 feet, and 50-200 feet, respectively. Positive trends of well depth and sulfate concentration were found in Dallas, Denton, Ellis, Grayson, and Hill Counties, with depths of the highest sulfate levels at approximately 1000-1500 feet, 800-900 feet, 500-1000 feet, 1000-1500 feet, and 600-800 feet, respectively.

The above listed ranges of depths might imply that the sources of sulfate were located near those aquifer depth ranges. The sources of sulfate concentrations might be mineral deposits such as gypsum, anhydrite, and iron sulfide deposited in those depths that high sulfate were found. However, Tarrant County having sulfate levels over 3000 mg/L at depths less than 100 feet, might have sulfate sources in non-commercial lignite beds (TWDB, 1997). Overall, sulfate levels decreased, except for Tarrant County from the 1950s to 1990s (Appendices B and C, Figures 25-29, and Table 5).

Table 5 Sulfate Levels in each County and Decade

County	The median concentration over time (mg/L)					Relationship from Cross-Plots	Overall Median Sulfate (5 decades)
	1950s	1960s	1970s	1980s	1990s		
Collin	164	204	153	138	113	–	↓
Cooke	N/A	N/A	29	30	61	No	No trend
Dallas	375	361	405	419	340	+	↓
Denton	N/A	164	88	86	59	+	↓
Ellis	479	403	344	362	357	+	↓
Grayson	62	64	66	90	73	+	↓
Hill	158	471	251	411	96	+	↓
Johnson	229	193	180	164	173	–	↓
Tarrant	135	150	52	146	340	–	↑

Remark: Relationship:

+ = deeper depth, higher concentration
- = deeper depth, lower concentration

Over all Trend:

↑ = the contaminant levels increased from 1950s to 1990s
↓ = the contaminant levels decreased from 1950s to 1990s

4.3.4 Chloride

4.3.4.1 Interpolated Concentration Contour Maps of Chloride

From the 1950s to 1960s (Figures 30-31), chloride concentrations in the Woodbine Aquifer above the drinking water standard (250 mg/L) were found in the eastern part of Dallas and Ellis Counties, southern part of Collin County, and southeastern part of Hill County. However, in the 1970s (Figure 32), areas over 250 mg/L of chloride decreased, with high clusters in small areas of Cooke, Grayson, Denton, Collin, Dallas, and Ellis Counties. Some of these clusters coincide with areas of heavy pumpage. Groundwater tends to deteriorate as water levels decline. In the 1980s (Figure 33), high concentration areas were found in Collin, Ellis, and Hill Counties, and in the 1990s, mainly found only in Tarrant County (Figure 34).

High chloride levels in Tarrant County were observed at shallow depths suggesting a possible human origin (Figures 35-37). However, the 1990s data set includes several shallow monitoring wells in the upper Woodbine, which were not present in other decades. These wells evidently produce water from the poor quality upper interval of the aquifer. Increases in chloride with downdip flow through rock deposits, as well as heavy pumpage in certain areas, explain most of the chloride trends.

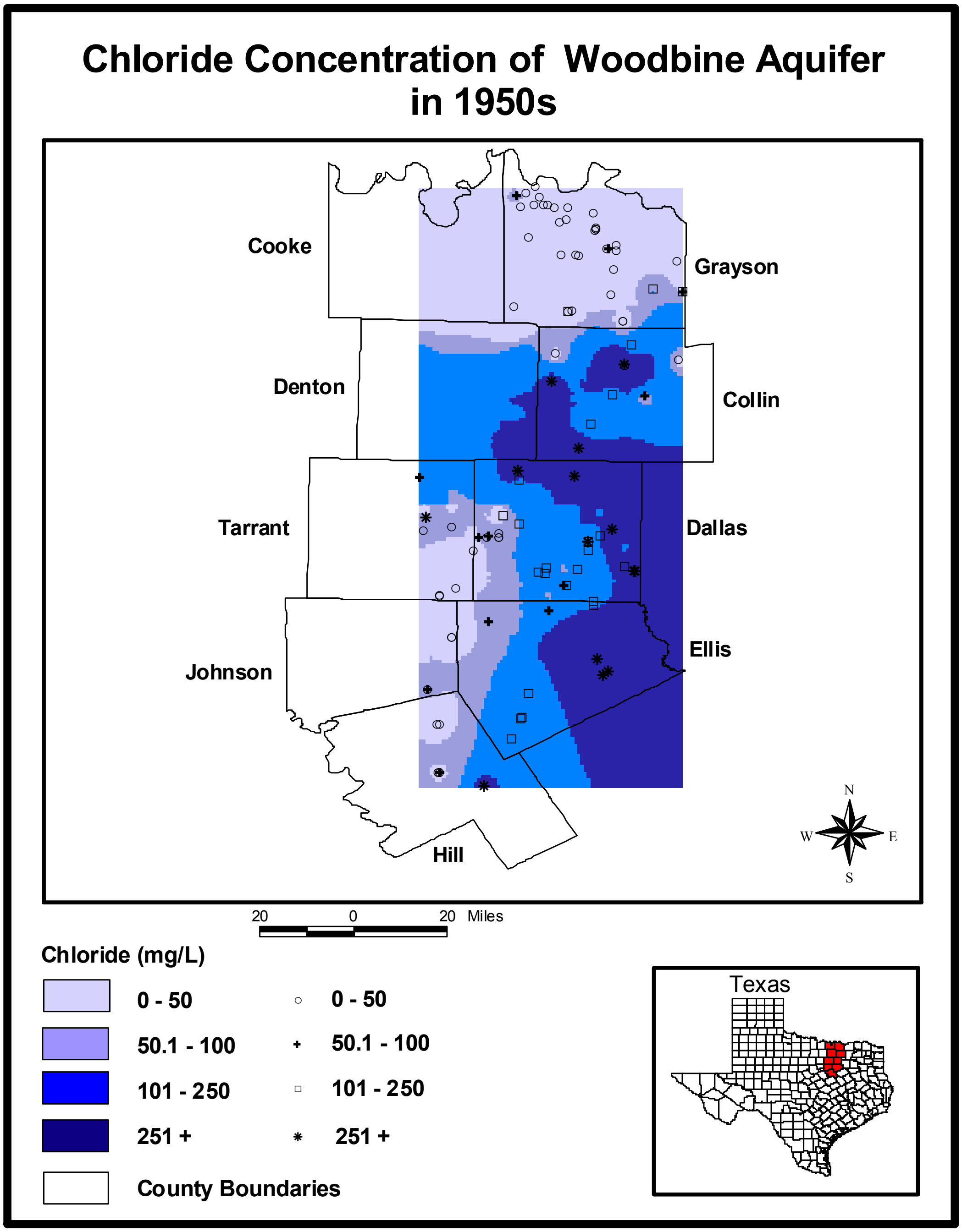


Figure 30 Chloride Concentration of the Woodbine Aquifer in 1950s

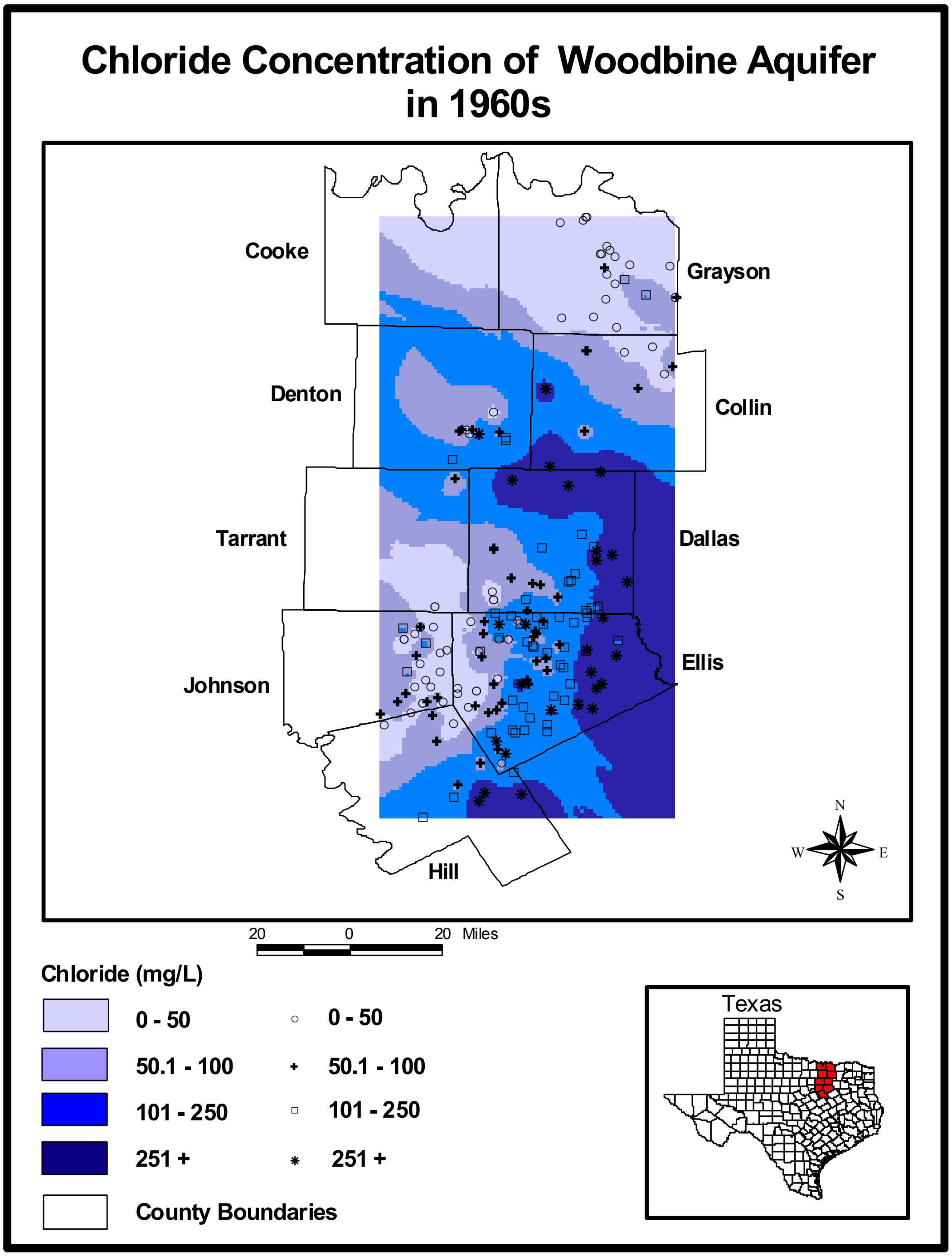


Figure 31 Chloride Concentration of the Woodbine Aquifer in 1960s

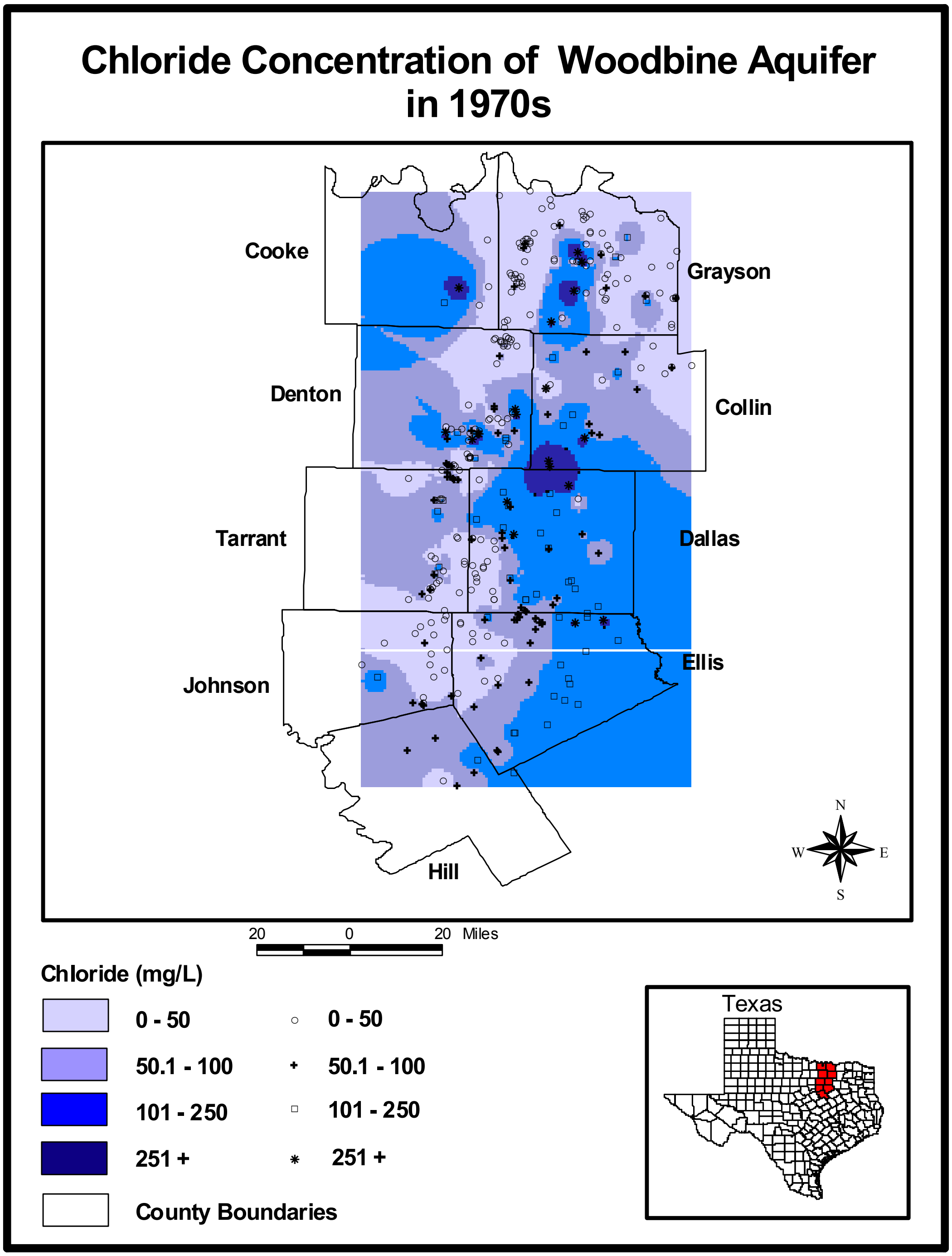


Figure 32 Chloride Concentration of the Woodbine Aquifer in 1970s

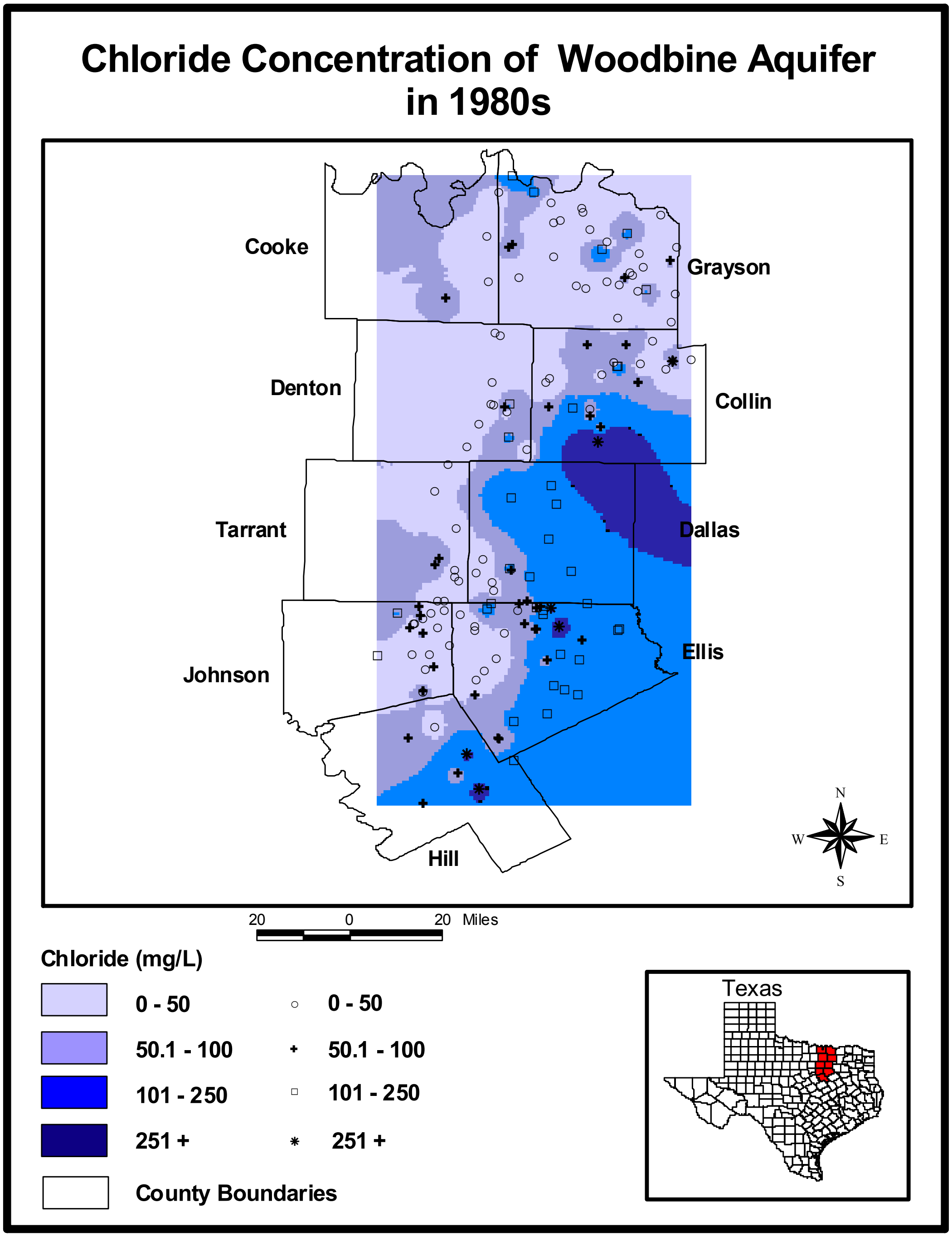


Figure 33 Chloride Concentration of the Woodbine Aquifer in 1980s

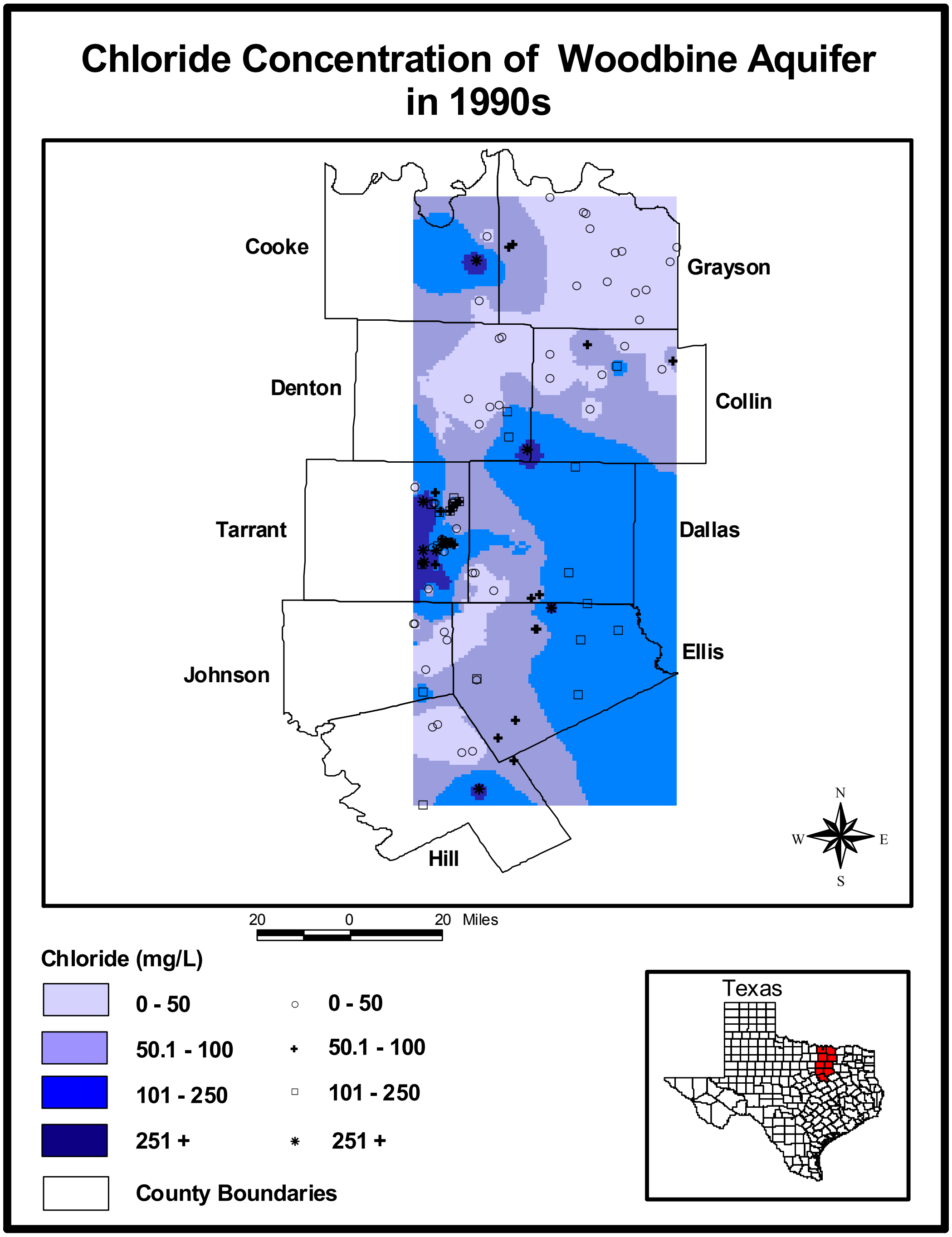


Figure 34 Chloride Concentration of the Woodbine Aquifer in 1990s

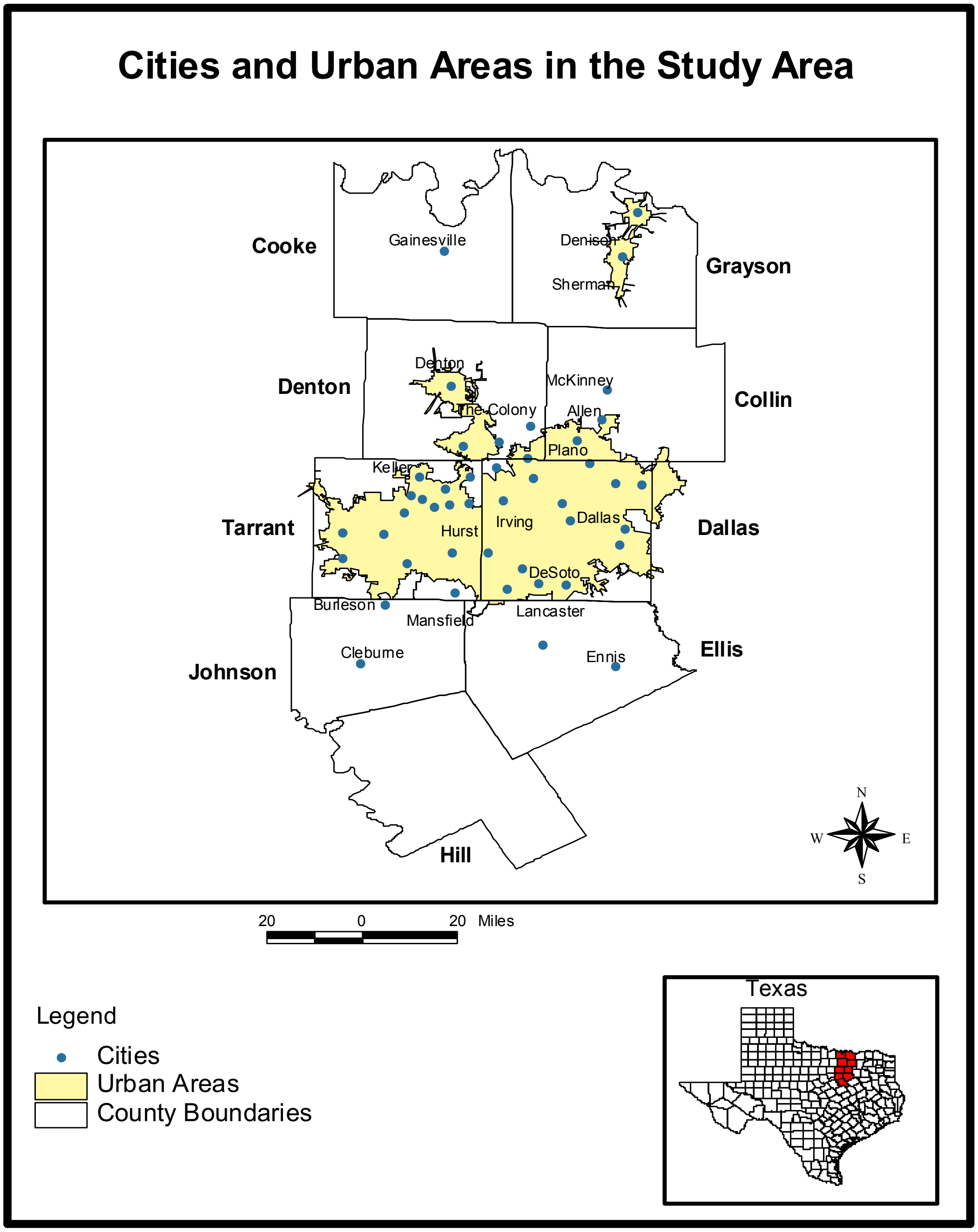


Figure 35 Urban areas in the study area

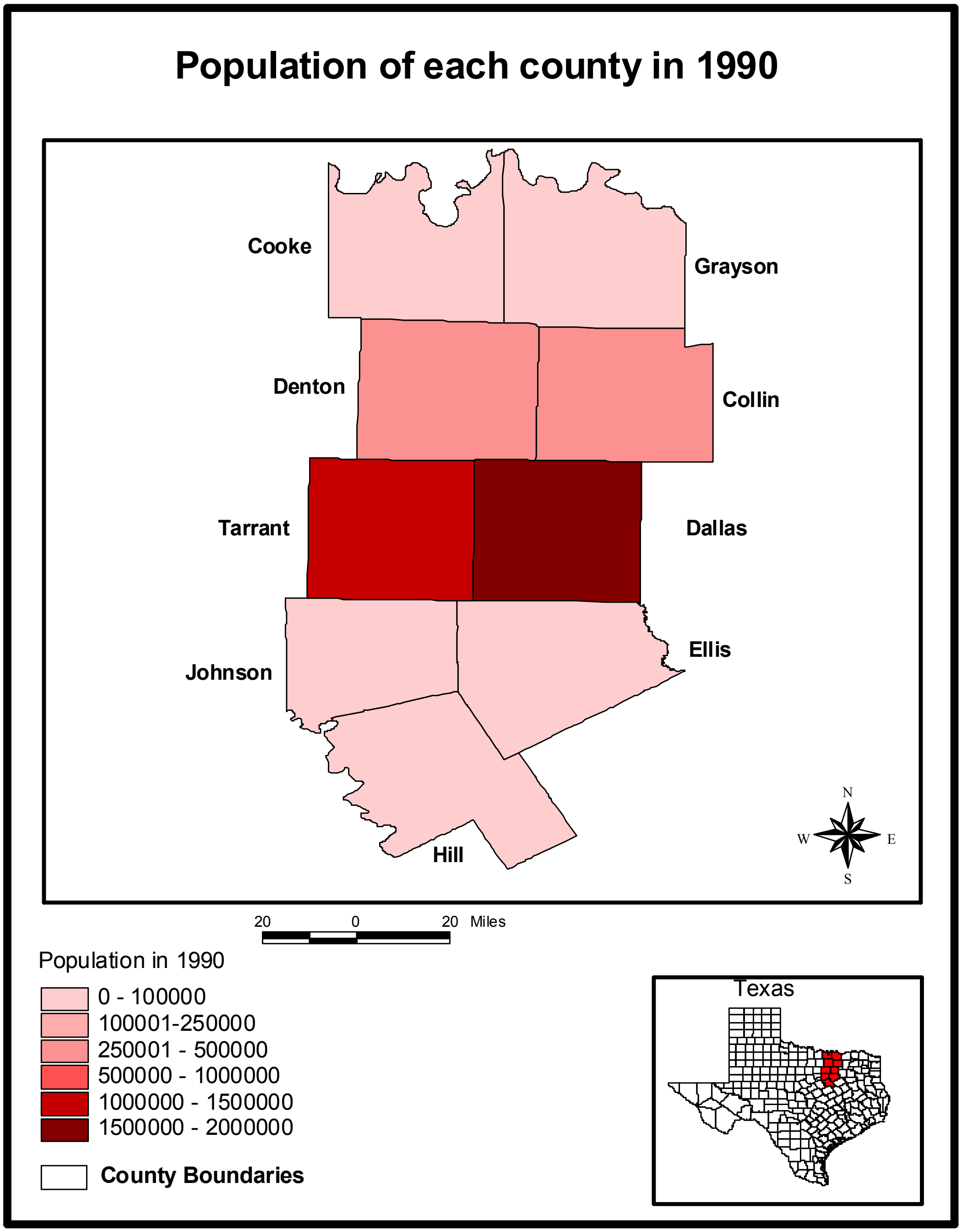


Figure 36 1990 Population in the study area by county

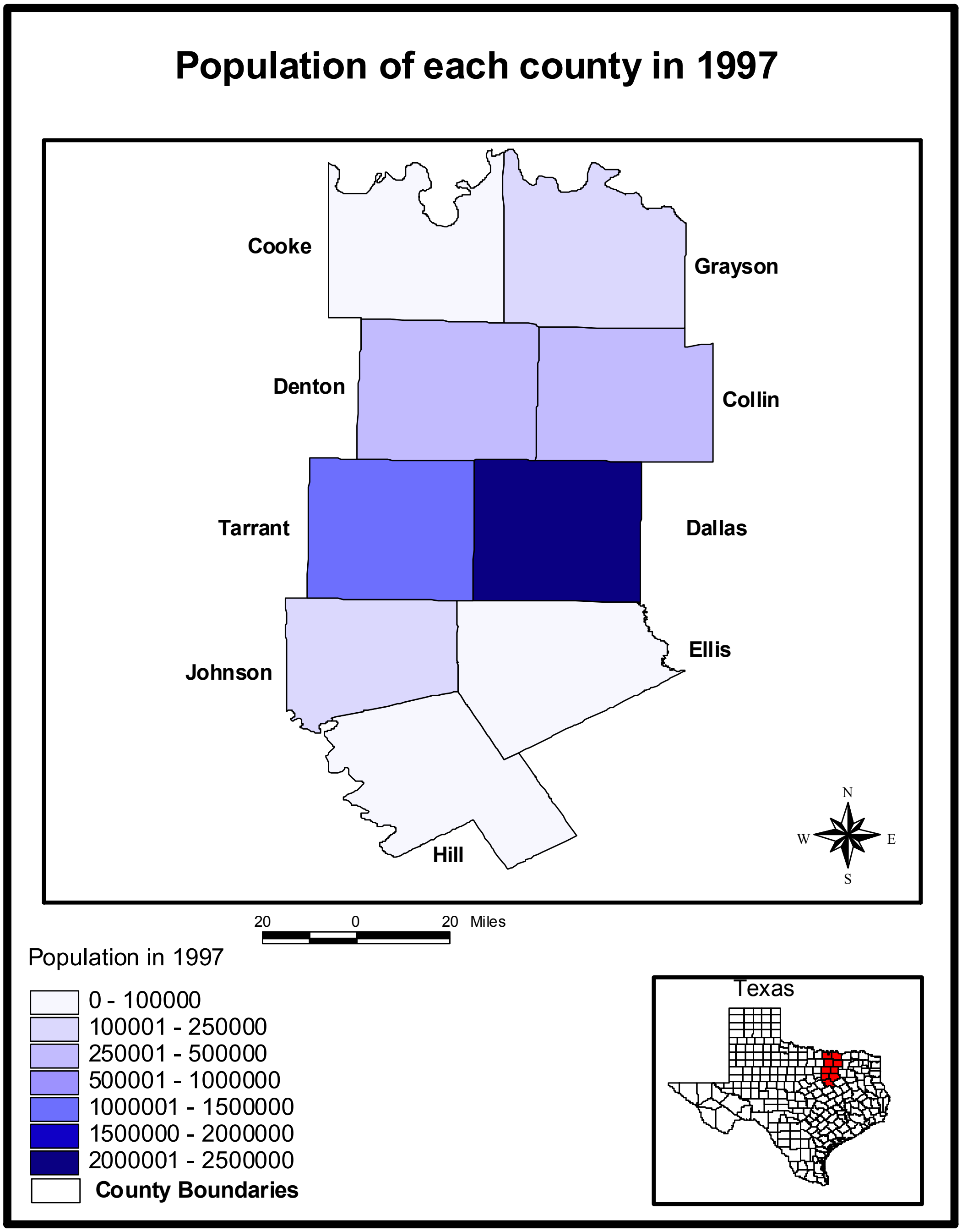


Figure 37 1997 Population in the study area by county

4.3.4.2 Chloride Levels in each County and Decade

Well depth and chloride concentration data are listed in Appendices B and C, and Table 6. Results showed that every county had median chloride concentrations lower than the secondary drinking water standard (250 mg/L); however, Ellis County had the highest median chloride levels in the 1990s (105.35 mg/L).

There were both positive and negative relationships between well depth and chloride concentrations (Appendices B and C, summarized in Table 6). Negative relationships were found in Collin, Johnson, and Tarrant Counties, with trends similar to sulfate levels illustrated in Table 5. Depths of the highest chloride levels were approximately 1000-1500 feet, 200-300 feet, and 100-200 feet, respectively. Tarrant County had over 3000 mg/L of chloride at depths less than 100 feet in the1990s, suggesting human rather than geologic sources. A positive association between well depth and chloride concentrations was found in Dallas, Denton, Ellis, Grayson, and Hill Counties, similar to sulfate levels in Table 5. Depths of the highest chloride levels in the 1990s were approximately 1000-1500 feet, 800-900 feet, 500-1000 feet, 1000-1500 feet, and 1000-1500 feet, respectively.

Table 6 Chloride Levels in each County and Decade

County	The median concentration over time (mg/L)					Relationship from Cross-Plots	Overall Median Chloride (5 decades)
	1950s	1960s	1970s	1980s	1990s		
Collin	143	73.5	65	60	37.4	–	↓
Cooke	N/A	N/A	39	29	37.4	Insufficient data	No change
Dallas	163	132	92	114	74.6	+	↓
Denton	N/A	75	37	33.5	28	+	↓
Ellis	176.5	115.5	77	92	105.35	+	↑
Grayson	19	21.5	21	18	18	+	↓
Hill	43	105	64	93	29.4	+	↓
Johnson	35.5	33.5	29	46	36.65	–	↓
Tarrant	38.5	32	43	34	92	–	↑

Remark: Relationship:

+ = deeper depth, higher concentration
- = deeper depth, lower concentration

Over all Trend:

↑ = the contaminant levels increased from 1950s to 1990s
↓ = the contaminant levels decreased from 1950s to 1990s

When both sulfate and chloride concentrations are plotted as cross-plots by county over the five decades (spreadsheets in Appendices B and C). Strongly positive relationships were noticed. The ratio of their concentrations in each county and decade varied, which may reflect varying contributions from geological and human sources in each county and decade. Although concentrations varied over time in each county, the positive relationship was still recognized in cross-plots. Both sulfate and chloride increase in the downdip direction as groundwater dissolves mineral deposits.

4.4 Different Concentrations between Consecutive Decades

4.4.1 Different Fluoride Concentrations between Consecutive Decades

Most of the fluoride concentrations increased from the 1950s to 1960s in the study area (Layer 2 in Figure 38). Fluoride levels increased from 0.1 to 3.0 mg/L in Denton, Collin, Dallas, Ellis, and Hill Counties. From the 1960s to 1970s (Layer 3 in Figure 38), almost half of the fluoride levels increased, ranging from 0.1 to 3.0 mg/L.

From the 1970s to 1980s (Layer 4 in Figure 38), fluoride concentrations in Denton County located in shallow depth had higher concentrations in the 1980s than 1970s, ranging from approximately 2 to 3 mg/L. Higher fluoride levels in shallow wells possibly derive from fluoride-enriched parts of the aquifer. There were some small areas having increasing fluoride concentrations, approximately 1.1 to 2 mg/L, located in Dallas, Ellis, and Hill Counties. Counties increasing from 0-1 mg/L were Cooke, Grayson, Dallas, Tarrant, Johnson, and Hill Counties. However, in the 1990s compared to 1980s (Layer 5 in Figure 38), higher fluoride concentrations, 0.0 – 1.0 mg/L, were found in the northern counties, such as Cooke and Collin Counties. Decreasing fluoride concentrations in the other counties were approximately 0.1 to 3.0 mg/L.

4.4.2 Different Nitrate Concentrations between Consecutive Decades

Nitrate concentrations between the 1950s and 1960s (Layer 2 in Figure 39) both increased and decreased ranging from –50 to 25 mg/L. Most of the increasing nitrate concentrations were located in the eastern part of the study area. From the 1960s to 1970s (Layer 3 in Figure 39), most of the increasing nitrate levels were located in the western part of the study area, where the aquifer is shallow.

However, the concentrations decreased from 0.1 to 50 mg/L in layer 4 of Figure 39, except for Cooke and north of Denton Counties, located in a shallow part of the aquifer, where the increases ranged from 0 to 25 mg/L. High increases were recognized in Tarrant County, where there were shallow USGS monitoring wells drilled to observe high nitrate levels in an urban area. However, over most of the study area, nitrate levels decreased from 0.1 to 50 mg/L (Layer 5 in Figure 39).

4.4.3 Different Sulfate Concentrations between Consecutive Decades

Sulfate concentration differences in Figure 40 are irregular, which is similar to fluoride differences in Figure 38. From 1950s to 1960s (Layer 2 in Figure 40), increasing sulfate concentrations ranged from 0.1 to 300 mg/L, which the higher sulfate concentration difference located in the southwestern part of the study area, where three to four spikes were observed. Decreasing areas had sulfate concentration differences ranging from 0.1 to 250 mg/L. However, those areas having high sulfate concentration differences from the 1950s to 1960s decreased in the 1970s (Layer 3 in Figure 40), which the decreasing concentrations ranging from 0.1 to 250 mg/L. On the contrary, those areas having low sulfate concentration differences from the 1950s to 1960s increased in the1970s, which increases ranging from 0.1 to 300 mg/L.

Sulfate concentration differences from the 1970s to 1980s (Layer 4 in Figure 40) had the same pattern as the 1960s to 1970s -- but areas with increasing differences decreased and areas with decreasing differences increased. The reasons of these patterns might be come from higher pumping rate causing higher sulfate levels in water wells. However, from the 1980s to 1990s (Layer 5 in Figure 40), the higher sulfate concentration differences found in Tarrant County, where the USGS's shallow monitoring wells were drilled in the 1990s, ranged from 0.1 to 1800 mg/L. The source of those high sulfate levels might be non-commercial lignite beds (TWDB, 1997). Furthermore, increasing sulfate differences found in the western part of the study area, where the aquifer is shallow, ranged from 0.1 to 900 mg/L. Therefore, the source of the high sulfate concentration might be shallow sources, such as non-commercial lignite beds (TWDB, 1997) and shallow gypsum and anhydrite deposits (Hudak, 2000).

4.4.4 Different Chloride Concentrations between Consecutive Decades

From the 1950s to 1960s (Layer 2 in Figure 41), chloride concentration differences over 500 mg/L were located in Dallas County, and concentrations from 0.1-500 mg/L located in Collin, Denton, Tarrant, Ellis, Johnson, and Hill Counties. Decreasing chloride concentration differences ranging from 0.1 to 1000 mg/L were found in some parts of every county. From the 1960s to 1970s (Layer 3 in Figure 41), chloride concentration differences over 500 mg/L were found in Grayson County, in the northern part of the study area. The chloride concentration differences in most of the other areas in the 1970s decreased, ranging from 0.1 to 1000 mg/L. Other local increasing differences were found, ranging from 0 to 1000 mg/L.

From the 1980s to 1990s (Layer 4 in Figure 41), concentration differences over 500 mg/L were found in Collin and Dallas Counties. In this layer, chloride level differences from 0.1 mg/L to 500 mg/L, were mainly found in the eastern part of the study area. The source of those high sulfate concentrations might come from geology because of deeper aquifer intervals. From the 1980s to 1990s (Layer 5 in Figure 41), increasing chloride concentration differences were found in the western part of the study area, where the aquifer is shallow. The possible source of high chloride in the 1990s was human activities. Furthermore, Tarrant County, where the USGS's shallow monitoring wells were drilled in the 1990s, had increasing chloride concentration differences over 2700 mg/L. These high chloride concentrations were produced from the poor quality, upper interval of the aquifer.

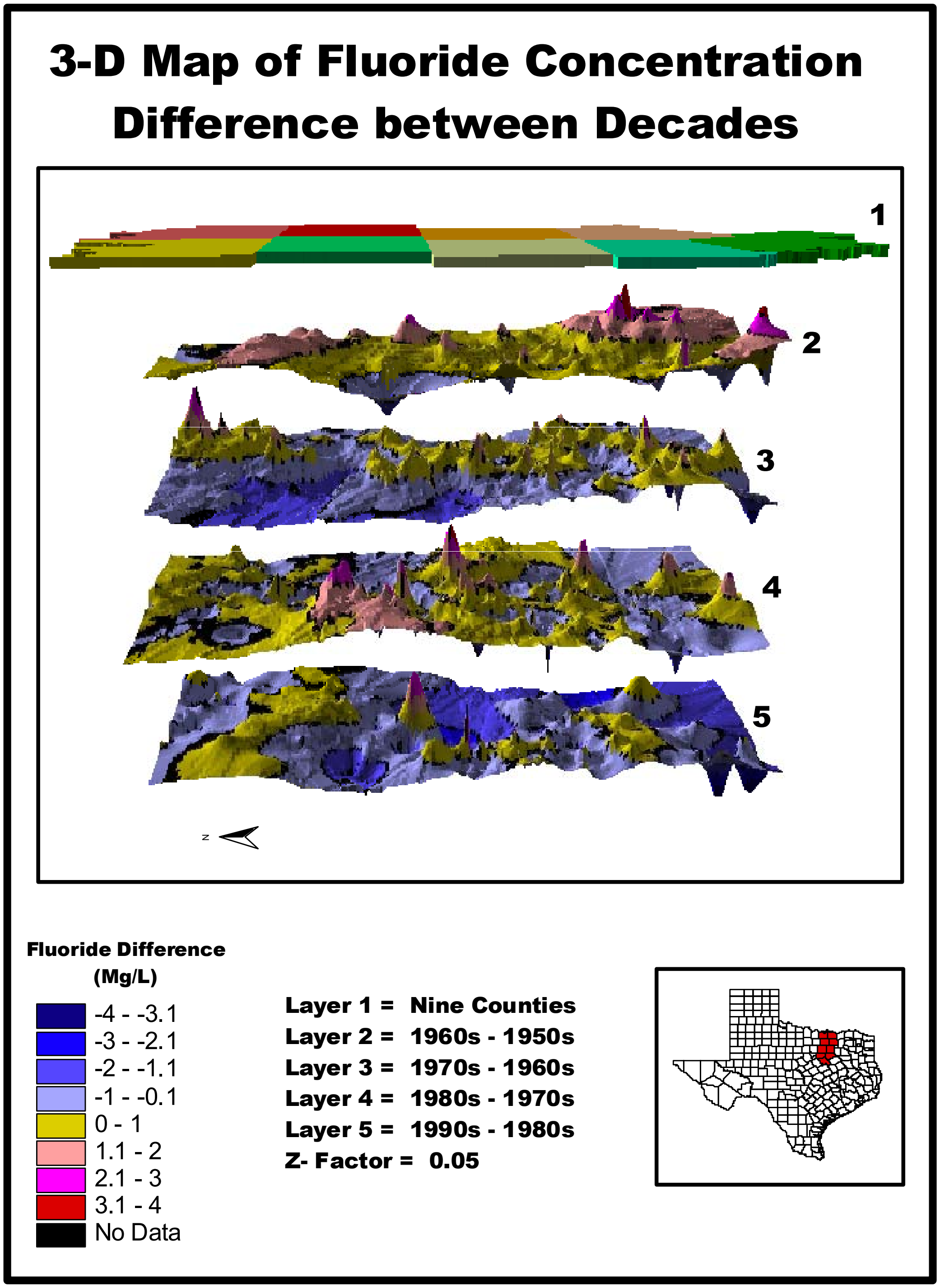


Figure 38 Different Fluoride Concentrations between Consecutive Decades

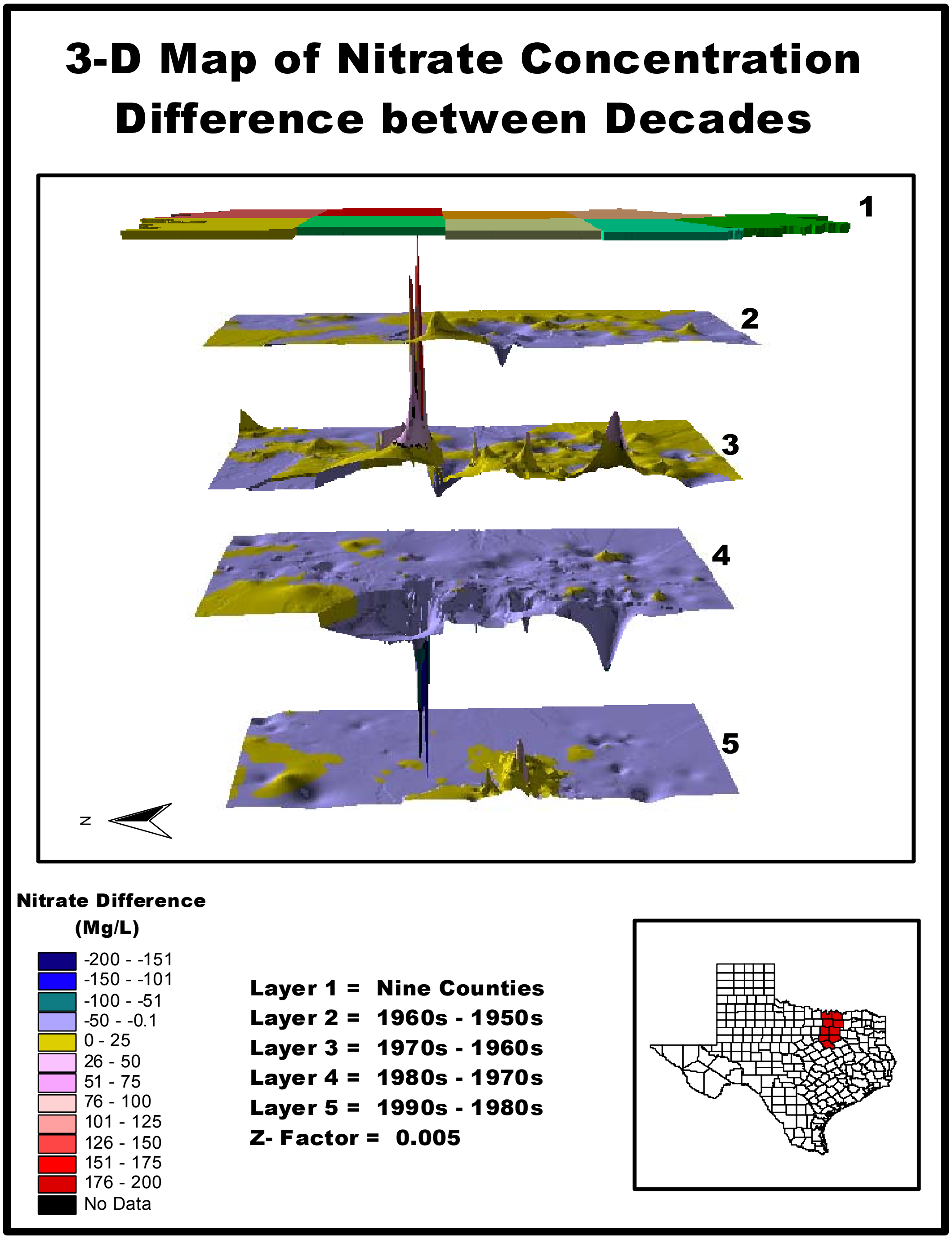


Figure 39 Different Nitrate Concentrations between Consecutive Decades

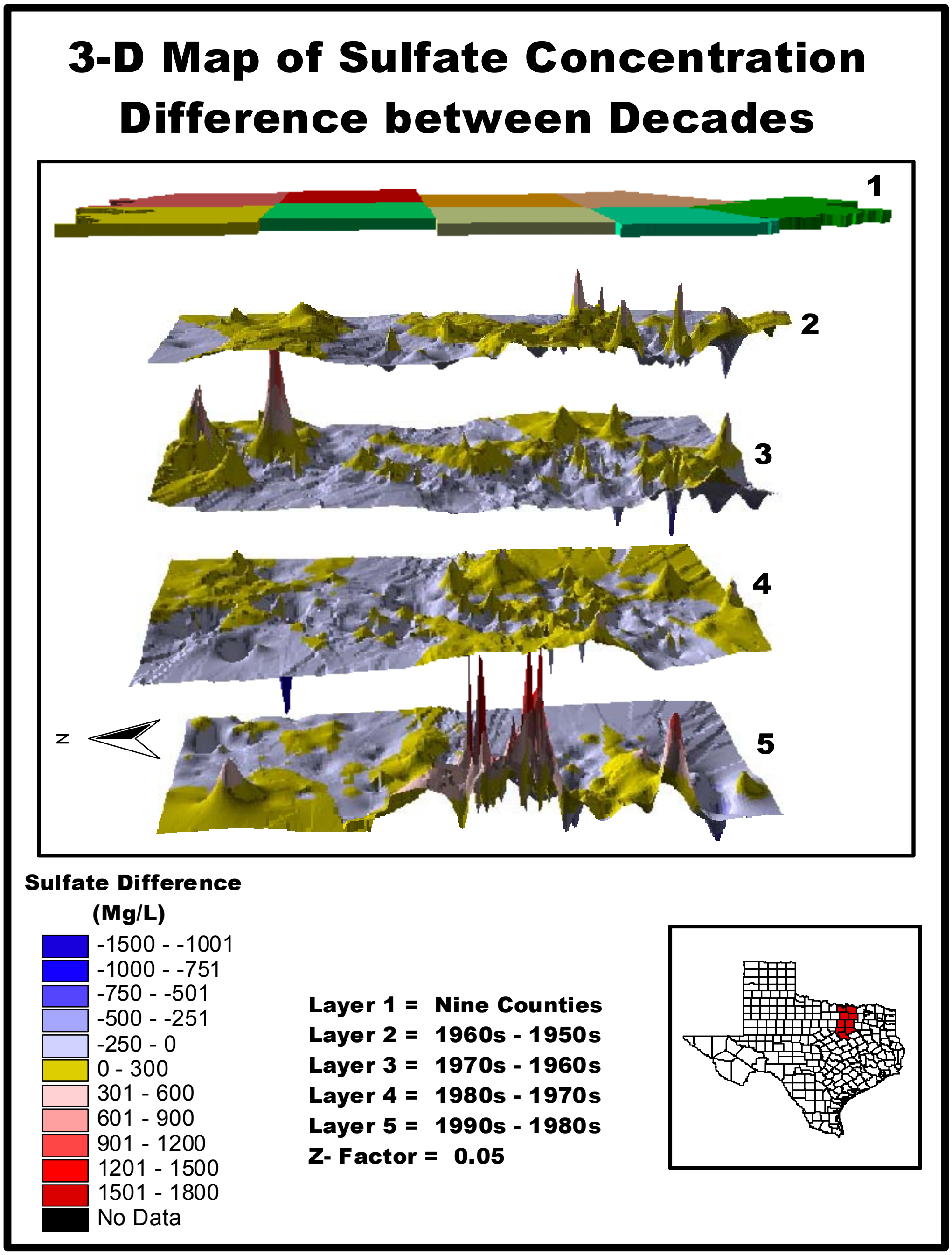


Figure 40 Different Sulfate Concentrations between Consecutive Decades

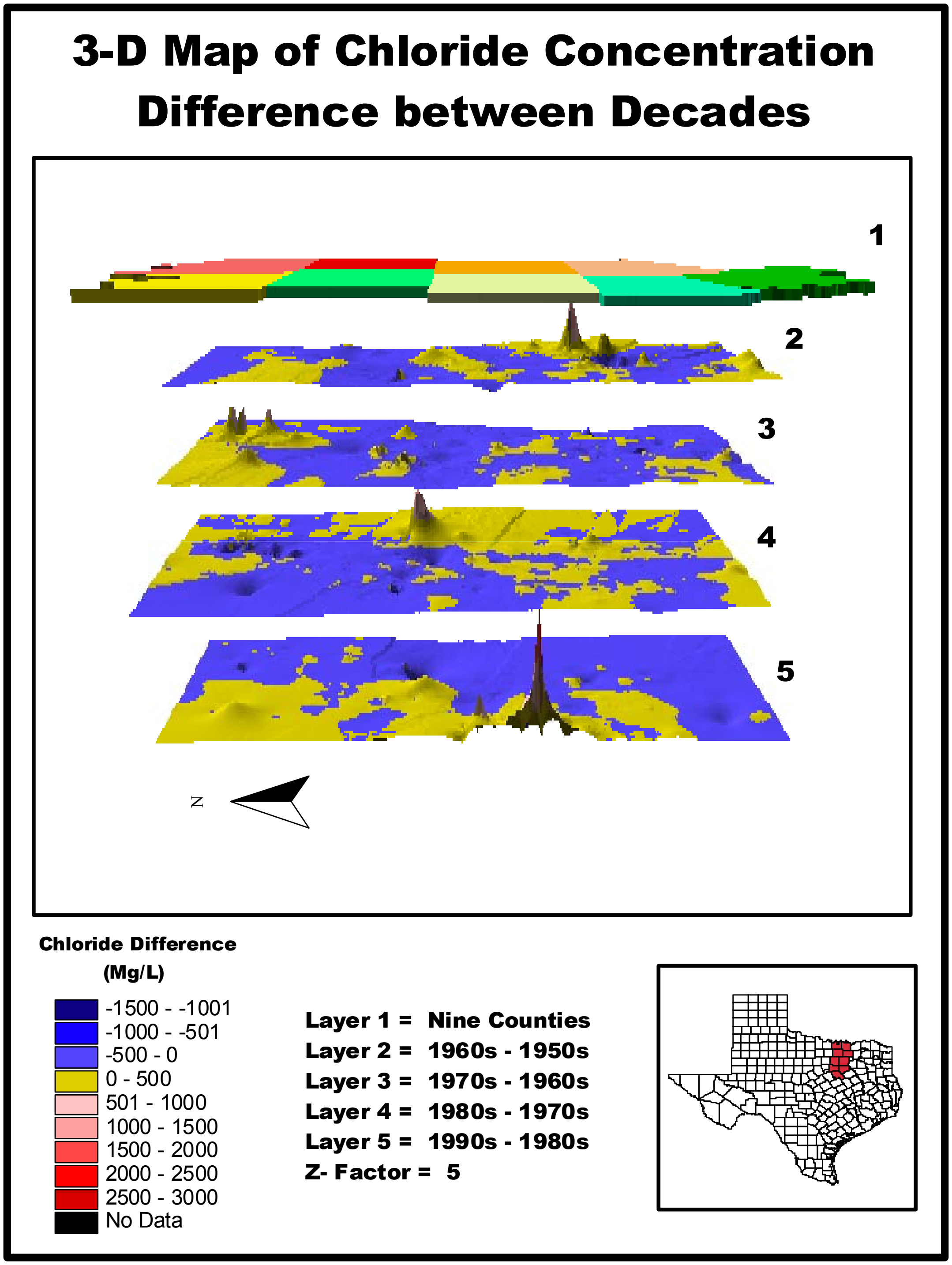


Figure 41 Different Chloride Concentrations between Consecutive Decades

4.5 Statistics test

4.5.1 Kruskal-Wallis Test

4.5.1.1 Kruskal-Wallis Test between Contaminants and Counties

The Kruskal-Wallis test was applied to find relationships between contaminants and counties over the five decades. The statistical details are shown in Appendix D. The null hypothesis (Ho) is no difference between sulfate, chloride, fluoride, or nitrate concentrations among different counties, and the alternative hypothesis (Ha) is that sulfate, chloride, fluoride, or nitrate differs among different counties. The significance level (α) is 0.05. Summarized statistics listed in Table 7 showed that nitrate in the 1950s, 1960s, and 1990s supported the null hypothesis (accept Ho), which means no difference between nitrate concentrations among counties. The rest of the tests rejected the null hypothesis, which means that sulfate, chloride, fluoride, or nitrate differed among different counties in each decade.

Furthermore, Table 7 showed the highest median of each contaminant over five decades. Only five counties, Dallas, Johnson, Ellis, Hill, and Tarrant Counties, located in the southern part of the study area, had the highest median values. Tarrant and Johnson Counties, located in the shallow part of the aquifer, had the highest median nitrate levels. In contrast, the highest median values of sulfate, chloride, and fluoride over the five decades were found in the eastern counties (Dallas, Ellis, and Hill Counties). These results point strongly to principally human sources for nitrate and geologic sources for the other three solutes.

Table 7 Kruskal-Wallis Test between Contaminants and County over Five Decades

Ho = no difference between sulfate, chloride, fluoride, or nitrate concentrations among different counties

Ha = sulfate, chloride, fluoride, or nitrate differs among different counties

$\alpha = 0.05$

Contaminants	**Years**	**Accept Ho**	**Reject Ho**	**The highest median**	
				Mg/L	In county Name
Sulfate	1950s		√	479.5	Ellis
	1960s		√	471	Hill
	1970s		√	405	Dallas
	1980s		√	419.5	Dallas
	1990s		√	357	Ellis
Chloride	1950s		√	176.5	Ellis
	1960s		√	132	Dallas
	1970s		√	92	Dallas
	1980s		√	114.5	Dallas
	1990s		√	105.35	Ellis
Fluoride	1950s		√	2.4	Dallas, Ellis
	1960s		√	3.2	Ellis
	1970s		√	2.6	Hill
	1980s		√	2.3	Ellis
	1990s		√	1.94	Ellis
Nitrate	1950s	√		2.5	Tarrant
	1960s	√		0	-
	1970s		√	3.6	Johnson
	1980s		√	0.68	Tarrant
	1990s	√		0	-

Note: See statistics calculation in Appendix D

4.5.1.2 Kruskal-Wallis Test between Contaminants and Land Use Types

As detailed land use data was obtained in 1993, the study between land use and contaminants focused on the 1990s. Other land use data obtained from 1970 to 1985 from USGS with 1-kilometer resolution could not be used because of coarse spatial and temporal resolution. Land use classes were reclassified into 8 classes, such as water, forest, urban, grassland, cropland, wetland, shrub land, and bare soil, as explained in Chapter 3.

From Figures 42 to 45, the northwest and southwest parts of the study area were predominantly forest land cover (Cooke, Denton, Johnson, and Hill Counties). Cropland areas were located mainly in the eastern part of Grayson and Collin Counties. Urban areas were mainly located in Tarrant and Dallas Counties. Wetland areas were found near the major lakes such as Lewisville Lake and Lake Ray Roberts. Grassland, and shrubland areas were located in every county. Finally, bare soil was found mainly in Dallas County.

As the study area covers nine counties, the land cover types in Figures 38-41 can not easily be differentiated among well locations. However, a spreadsheet having contaminants, land use types, and county names of each well is attached in Appendix H. Statistics in Table 8 summarize the Kruskal-Wallis tests with details in Appendix E. Every test supported the null hypothesis, which means no difference between each contaminant among different land uses. Therefore, land use was not an important factor controlling the distribution of contaminants in the aquifer.

Table 8 Kruskal-Wallis Test between Contaminants and Land Use Types

Ho = no difference between sulfate, chloride, fluoride, or nitrate concentrations among different land uses

Ha = sulfate, chloride, fluoride, or nitrate differs among different land uses

σ = 0.05

Contaminants	**Years**	**Accept Ho**	**Reject Ho**	**The highest median**	
				mg/L	In land use type
Sulfate	1990s	√		290	cropland
Chloride	1990s	√		76	urban
Fluoride	1990s	√		0.7	urban
Nitrate	1990s	√		0	-

Note: See statistics calculation in Appendix E

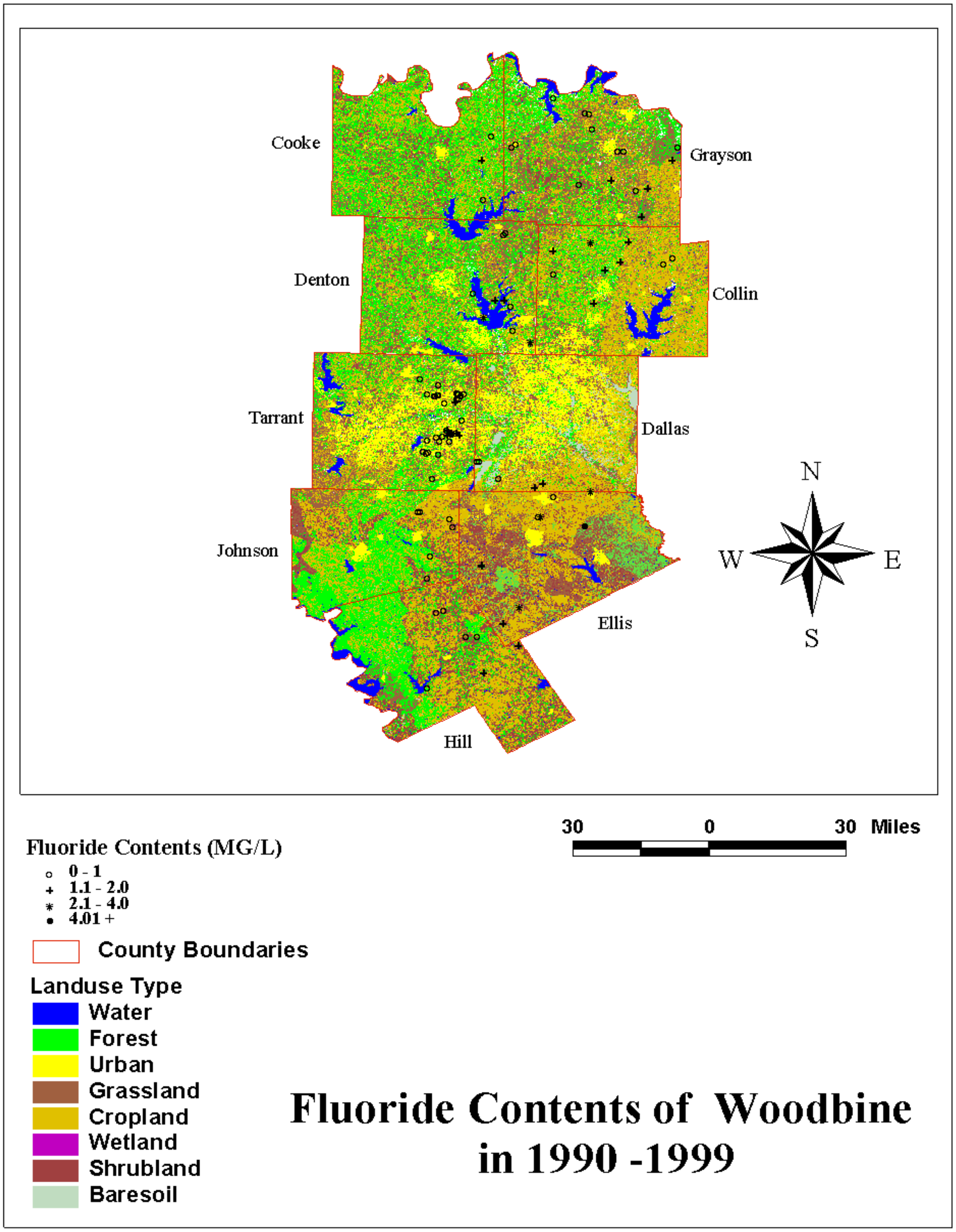


Figure 42 Fluoride Concentration of land use types in the Woodbine Aquifer

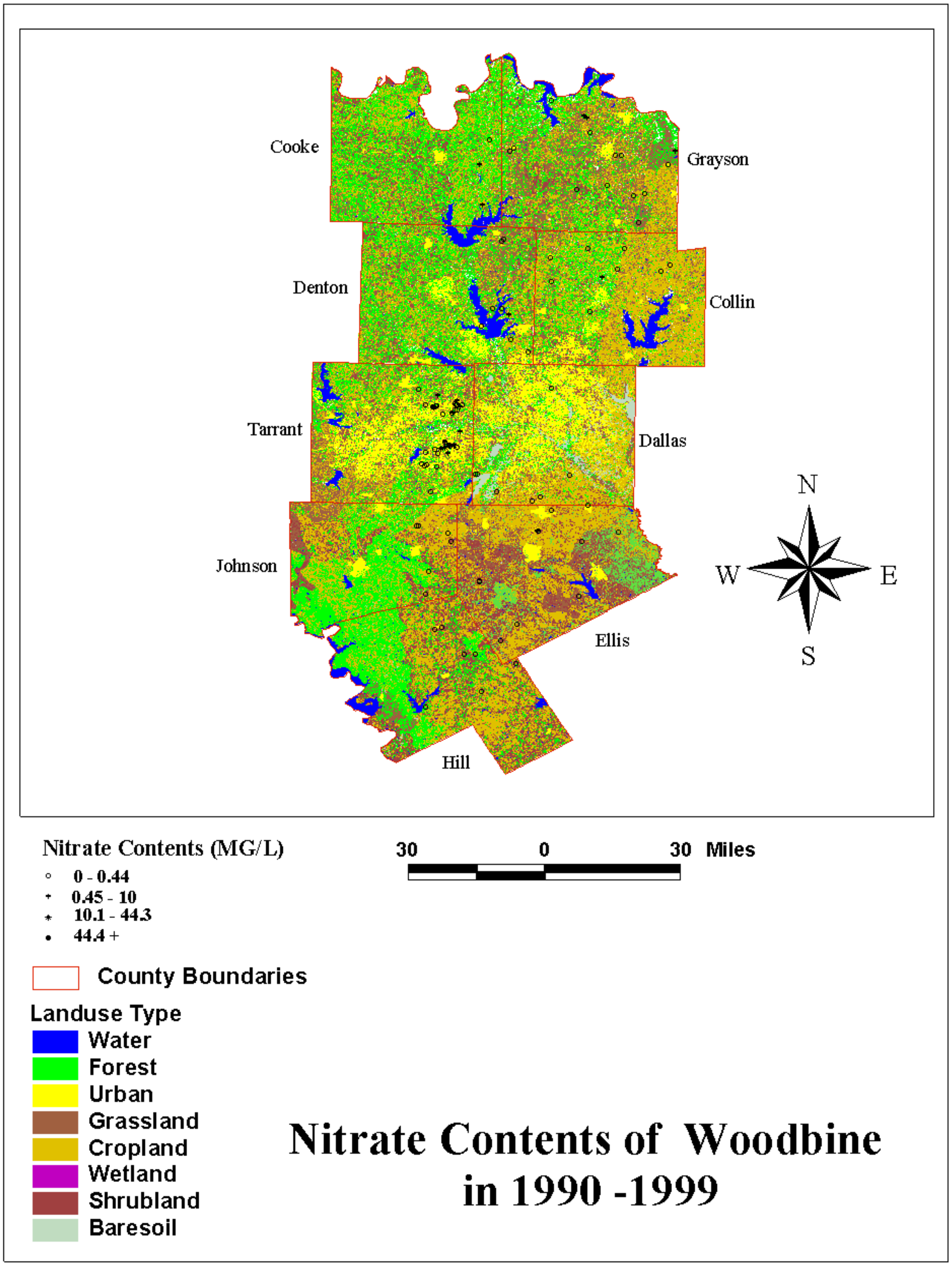


Figure 43 Nitrate Concentration of land use types in the Woodbine Aquifer

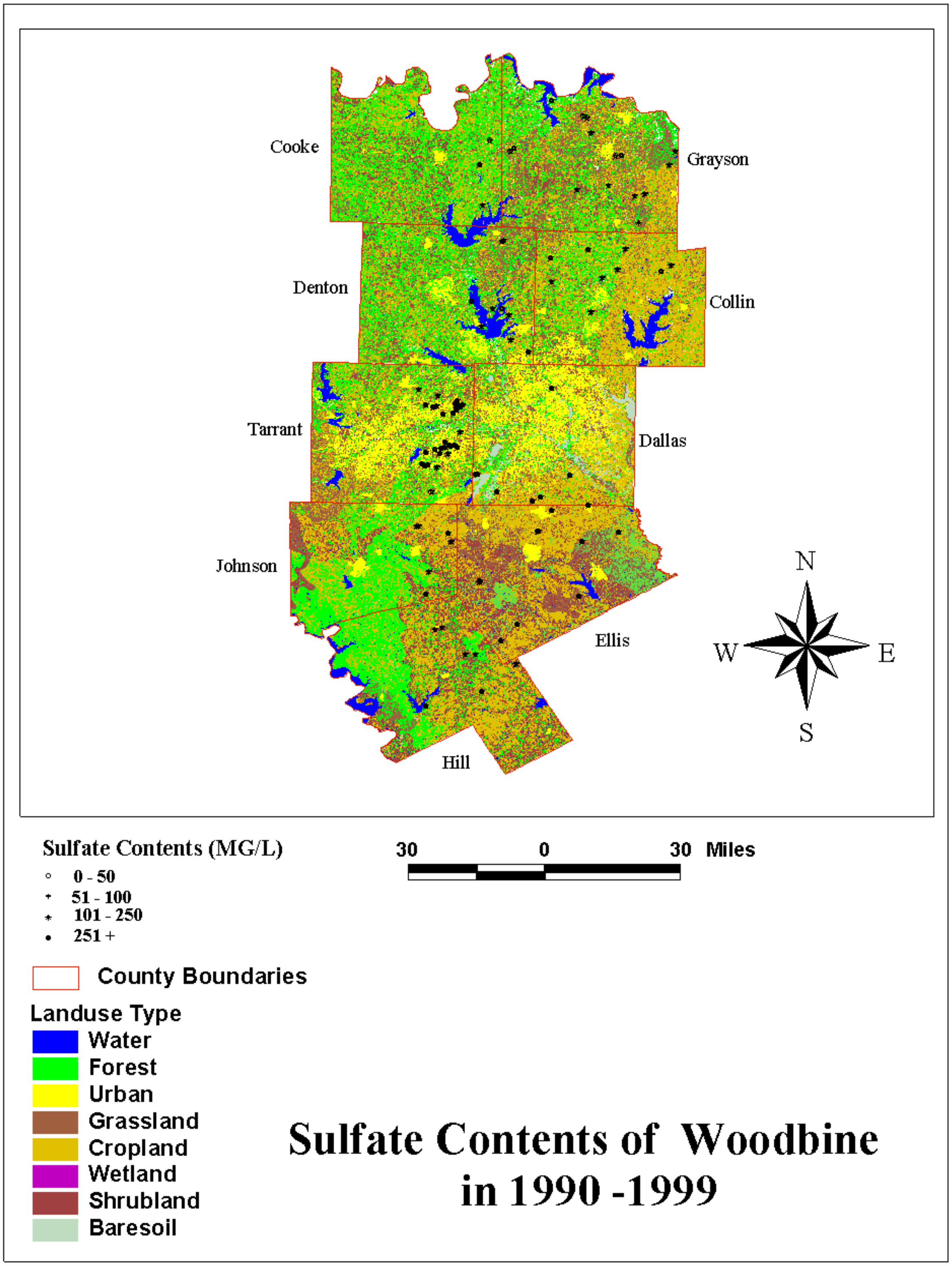


Figure 44 Sulfate Concentration of land use types in the Woodbine Aquifer

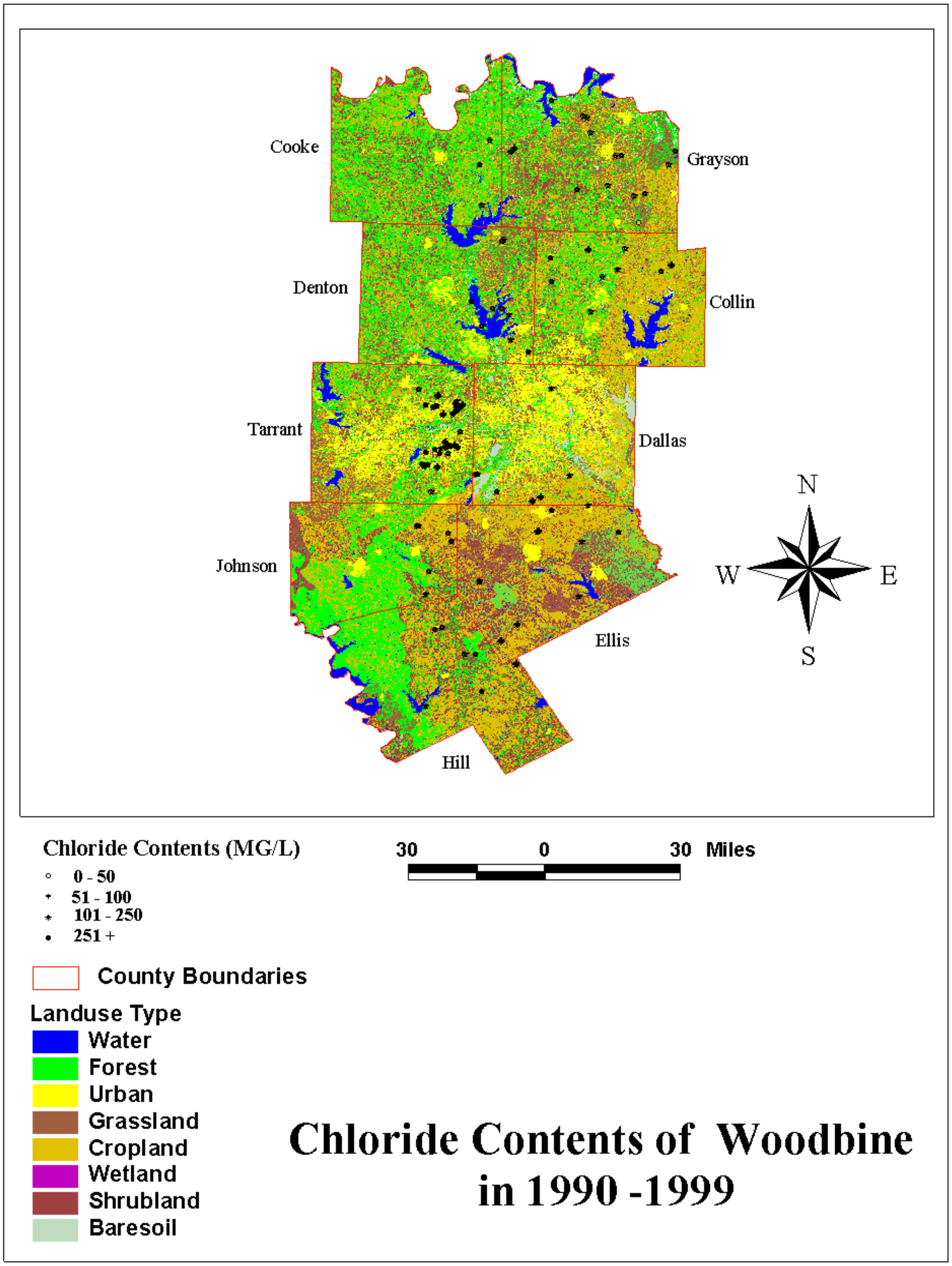


Figure 45 Chloride Concentration of land use types in the Woodbine Aquifer

4.5.1.3 Kruskal-Wallis Test between Contaminants and Primary Well Uses

There are 7 primary well use types in the TWDB database used in this study, which were domestic, irrigation, industrial, public supply, stock, unused, other (miscellaneous uses not included in the TWDB listed categories). Details of the Kruskal-Wallis statistics test are attached in Appendix F.

The null hypothesis (Ho) is that there is no difference between sulfate, chloride, fluoride, or nitrate concentrations among different primary well uses, and the alternative hypothesis (Ha) is that sulfate, chloride, fluoride, or nitrate differs among different primary well uses. The significance level (α) is 0.05. There were both acceptances and rejections of the null hypothesis before the 1990s among different contaminants; however, there was only rejection of the null hypothesis in the 1990s (every contaminant) which means that sulfate, chloride, fluoride, and nitrate concentrations differed among different primary well uses (Table 9).

In the 1950s, all of the tests accepted the null hypothesis, which means that there were no differences between each contaminant among different primary well uses. Almost all of the highest median values fell into the public well use, except for nitrate classified into the unused well use type (Table 9).

In the1960s, chloride, fluoride, and nitrate tests accepted the null hypothesis; thus, there were no differences between each of these contaminants among different primary well use in the 1960s. However, the sulfate test rejected the null hypothesis, with the highest median value of sulfate were located in the stock well type. The stock wells often contain lower quality water than wells supplying drinking water to humans.

In the 1970s, sulfate, chloride, and fluoride tests rejected the null hypothesis. Therefore, their concentrations differed among different well use types. Again, the highest medians were found in wells not supplying drinking water. Nitrate tests accepted the null hypothesis; their concentrations did not differ among different well uses.

In the 1980s, sulfate and nitrate concentrations accepted the null hypothesis. On the other hand, chloride and fluoride concentrations rejected the null hypothesis. The highest median of three contaminants (sulfate, chloride, and fluoride) fell into the unused well type.

Table 9 Kruskal-Wallis Test between Contaminants and Primary Well Uses

Ho = no difference between sulfate, chloride, fluoride, or nitrate concentrations among different primary well uses

Ha = sulfate, chloride, fluoride, or nitrate concentrations differ among different primary well uses

$\alpha = 0.05$

Contaminants	**Years**	**Accept Ho**	**Reject Ho**	**The highest median**	
				Mg/L	Primary well use type
Sulfate	1950s	√		183	Public
	1960s		√	374	Stock
	1970s		√	337.5	Stock
	1980s	√		333.5	Unused
	1990s		√	410	Other
Chloride	1950s	√		75	Public
	1960s	√		118	Unused
	1970s		√	113.5	Unused
	1980s		√	125	Unused
	1990s		√	120	Other
Fluoride	1950s	√		1.8	Public
	1960s	√		2.85	Unused
	1970s		√	1.4	Industrial
	1980s		√	2.2	Unused
	1990s		√	1.08	Public
Nitrate	1950s	√		2.4	Unused
	1960s	√		2.0	Stock
	1970s	√		2.2	Industrial
	1980s	√		0	-
	1990s		√	0	-

Note: See statistics calculation in Appendix F

4.5.2 Spearman' s Rank Correlation Coefficient between Well Depth and each Contaminant

Spearman' s rank correlation coefficient was used to find the associations between well depth, sulfate, chloride, fluoride, and nitrate. The statistics calculation was appears in Appendix G, and summary results are shown in Table 10. The variables were abbreviations, such as WD = well depth, S = sulfate concentrations, C= chloride concentrations, and so on. For concise presentation of results, relationships of statistics were represented by symbols; for example, ↔ represented a positive association between pair of variables. The null hypothesis, Ho, was that there was no association between a pair of comparative variables. The alternative hypothesis, Ha, was that paired variables were associated. Finally, the significance level (α) was 0.05.

Appendix G; C1, C2, C3, C4, C5 show well depth, sulfate concentrations, chloride concentrations, fluoride concentrations, and nitrate concentrations, respectively. Also, C6, C7, C8, C9, and C10 represent new ranked columns of well depth, sulfate concentrations, chloride concentrations, fluoride concentrations, and nitrate concentrations, respectively. The critical values (W_p) in each decade were calculated by the formula:

$$W_p = \frac{1.96}{\sqrt{N-1}}$$

where

N = total number of records
N-1 = degree of freedom

The 1950s, 1960s, 1970s, 1980s, and 1990s, the critical values were 0.193, 0.143, 0.105, 0.156, and 0.188, respectively.

Table 10 Spearman's Rank Correlation Coefficient between Well Depth, Sulfate, Chloride, Fluoride, and Nitrate

Variables: WD = Well depth, S = Sulfate concentrations
C = Chloride concentrations, F= Fluoride concentrations
N = Nitrate concentrations

↔ shows that each variable pair is positively associated
↑↓ shows that each variable pair is negatively associated
≠ shows that each variable pair is not associated

Ho = no association between variables
Ha = variables are associated
α = 0.05

Years	**Accept Ho**	**Reject Ho**
1950s	N ≠ WD, S, C, and F	WD↔S, C, and F S↔C, and F C↔F
1960s	N ≠ WD, S, C, and F	WD↔S, C, and F S↔C, and F C↔F
1970s	N ≠ F	WD↔S, C, and F WD ↑↓ N S↔C, F, and N C↔F, and N N↔ WD, S, and C
1980s	N ≠ S, C, and F	WD↔S, C, and F WD ↑↓ N S↔C, and F C↔F

Years	**Accept Ho**	**Reject Ho**
1990s	N ≠ S, C, and F	WD↔ F WD ↑↓ S, C, and N S↔C, and F C↔F

Note: See statistics calculation in Appendix G

In the 1950s, W_p = 0.193; acceptance of the null hypothesis was between –0.193 and 0.193. Nitrate concentrations were not associated with well depth, sulfate, chloride or fluoride concentrations. However, higher concentrations of sulfate, chloride, and fluoride were found in deeper wells. Sulfate concentrations had positive relationships with chloride and fluoride levels. Finally, chloride concentrations had a positive association with fluoride concentrations.

In the 1960s, W_p = 0.143, acceptance of the null hypothesis was between –0.143 and 0.143. Acceptance and rejection of the null hypothesis for this decade was similar to the 1950s.

In the 1970s, W_p = 0.105, acceptance of the null hypothesis was between –0.105 and 0.105. Nitrate concentrations were not associated with fluoride concentrations (Table 10). However, well depth was associated with concentrations of sulfate, chloride, and fluoride. Sulfate concentrations were also positively associated with chloride, fluoride, and nitrate concentrations. Well depth was slightly negatively correlated with nitrate concentration. Finally, chloride concentrations were positively associated with fluoride concentrations.

In the 1980s, Wp = 0.156, acceptance of the null hypothesis was between – 0.156 and 0.156. Nitrate concentrations were not associated with concentrations of sulfate, chloride, and fluoride (Table 10). Well depth was positively associated with concentrations of sulfate, chloride, and fluoride, and was negatively associated with nitrate concentrations. Sulfate concentrations also were positively associated with concentrations of chloride and fluoride. Finally, chloride concentrations were positively associated with concentrations of fluoride.

In the 1990s, Wp = 0.188, acceptance of the null hypothesis was between – 0.188 and 0.188. Acceptance of the null hypothesis for this decade was similar to the 1980s. However, rejection of the null hypothesis in this decade was different from the 1980s. Specifically, well depth was negatively associated with concentrations of sulfate, chloride, and nitrate. Between high concentrations at shallow depths, human activities probably impacted to the aquifer. However, well depth was positively associated with fluoride concentrations, suggesting that sources of fluoride derived from geological formations. Sulfate concentrations were positively associated with concentrations of chloride and fluoride. Furthermore, chloride concentrations were positively associated with fluoride.

In summary, aquifer depth showed highly positive relationships with concentrations of sulfate, chloride, and fluoride, which are derived from geologic sources, whereas it showed a negative relationship in some decades with nitrate derived mainly from human activities.

Higher levels of contaminants found in the eastern part of the study area probably relate to increased groundwater residence times in the downdip direction. There were also two locally high solute concentration areas at deep-water wells located in Collin and Ellis Counties.

CHAPTER 5

CONCLUSION

The Woodbine Aquifer located in north central Texas is elongate in a north-south direction. Water wells drilled in the eastern part of the aquifer are deeper and pump older groundwater than western wells. In general, the groundwater becomes more mineralized in the down-dip direction. Dissolution of aquifer solids along groundwater flow paths, along with variations in aquifer lithology, largely explain observed trends in fluoride, sulfate, and chloride. In contrast, nitrate in the Woodbine aquifer is controlled primarily by land use practice rather than geologic sources. Overall, geology exerts the major control on concentrations of the solutes studied.

Concentrations of fluoride higher than the primary drinking water standard--4 mg/L, were found in Ellis County in all five decades and in Dallas County in the 1960s. However, only in the 1960s, 1970s, and 1980s, did the contaminated areas of fluoride cover wide areas.

When compared with the secondary drinking water standard--2 mg/L, the contaminated areas extend to Dallas, Denton, Collin, and Hill Counties. Nevertheless, by comparing the median of fluoride concentrations among the five decades, the fluoride concentrations had declined since the 1950s. Apparently, the fluoride concentrations are related to groundwater residence in the aquifer. Higher fluoride concentrations were found in the groundwater at deeper depths (older groundwater) in most counties.

Sulfate levels over the secondary drinking water standard--250 mg/L, were found mainly in the southern part of the study area. The higher concentrations of sulfate were usually found at deeper depths. The Woodbine Formation contains sulfur-bearing minerals that contribute to observed sulfate trends. Sulfate concentrations differed from county to county from the 1950s to 1990s, but not among land uses according to land use data obtained in the 1990s. Shallow monitoring wells in the uppermost of the aquifer account for this trend.

Chloride concentrations in the Woodbine Aquifer above the secondary drinking water standard--250 mg/L, were found in the eastern part of Dallas and Ellis Counties, south of Collin County, and southeastern of Hill County from the 1950s to 1960s. However, in the 1970s to 1990s, Areas exceeding the drinking water standard of chloride concentrations were in small cluster rather than broad parts of the study area, especially in Collin, Dallas, Denton, Grayson, Hill, and Johnson Counties. On the contrary, the concentrations of chloride in Ellis and Tarrant Counties increased.

Higher chloride levels were found in deeper wells in most of the counties prior to the 1990s. Thus, the sources of the chloride contaminations before the 1990s may have come mostly from the underlying rock formations. On the contrary, in the 1990s high chloride concentrations were found in shallow wells in Tarrant County, similar to the pattern observed for chloride, urban land use may have also contributed to this trend.

Statistically, chloride concentrations differed among counties in all five decades, but they were not different among land uses according to the land use data obtained in the 1990s.

There were no major problems caused by nitrate concentrations in the study area during the 1950s-1990s. Only one small area in Tarrant County in the 1990s, where a large number of shallow monitoring wells were recently installed, nitrate concentrations above the primary drinking water standard. Most of high nitrate concentrations were found in the western area where the aquifer is shallow. A negative relationship between well depth and nitrate concentrations was found from the 1970s to 1990s, suggesting a human impact, such as lawn fertilizers and leaking sewer lines. However, there was no difference among primary well uses from the 1950s to 1980s. The difference was significant only in the 1990s. Presumably, there was little contribution to nitrate from geology sources.

This study provided a comprehensive assessment of four water quality constituents in time and space for the Woodbine Aquifer. Potential Beneficiaries of this research include regional planning agencies, city public works departments, water supply agencies, and groundwater consumers in the study area. This research may also be useful to environmental regulatory agencies such as the TNRCC. For example, an area of the Woodbine Aquifer that contains high fluoride or sulfate levels might not necessarily be contaminated by a nearby waste repository, because rocks naturally contribute these solutes to the aquifer.

Finally, the recommendations for future work and protections are listed below:

Protection

1. Should use prior knowledge to site future wells.
2. Should protect human by controlling land use above shallow wells.
3. Should establish groundwater conservation districts to control drawdown. Water deteriorates as water levels drop.
4. Should have localized studies of nitrate at areas that were elevated in the present study, especially in the outcrop zone of the aquifer.
5. Protect against contamination from retention ponds in residential developments, golf courses, and cropland.

Future Work

1. Should have a study in the 2000s to track changes at individual wells over time.
2. Should have some research studying overtime changes of other solutes in the aquifer, such as sodium, calcium, and magnesium.

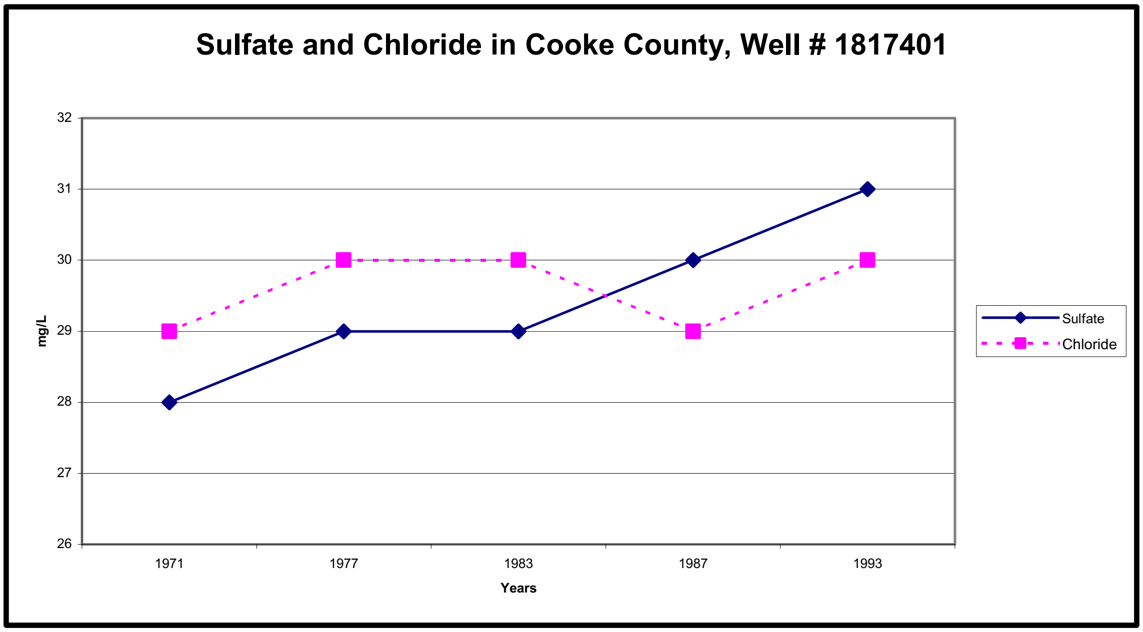
APPENDIX A

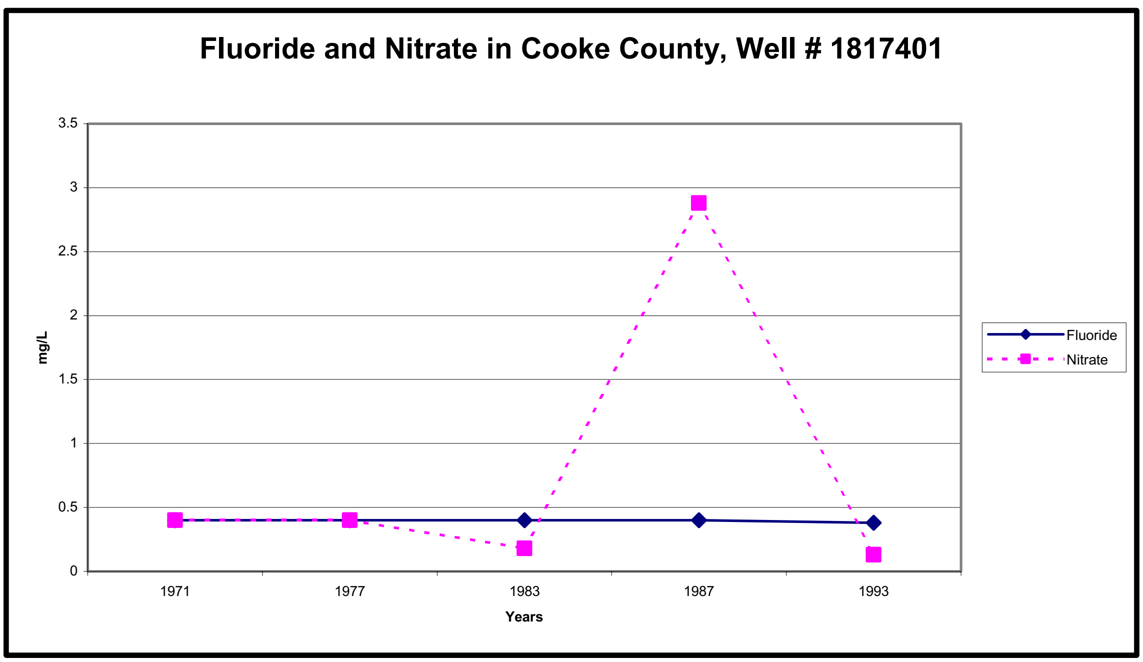
PLOTS THROUGH TIME

OF WELLS

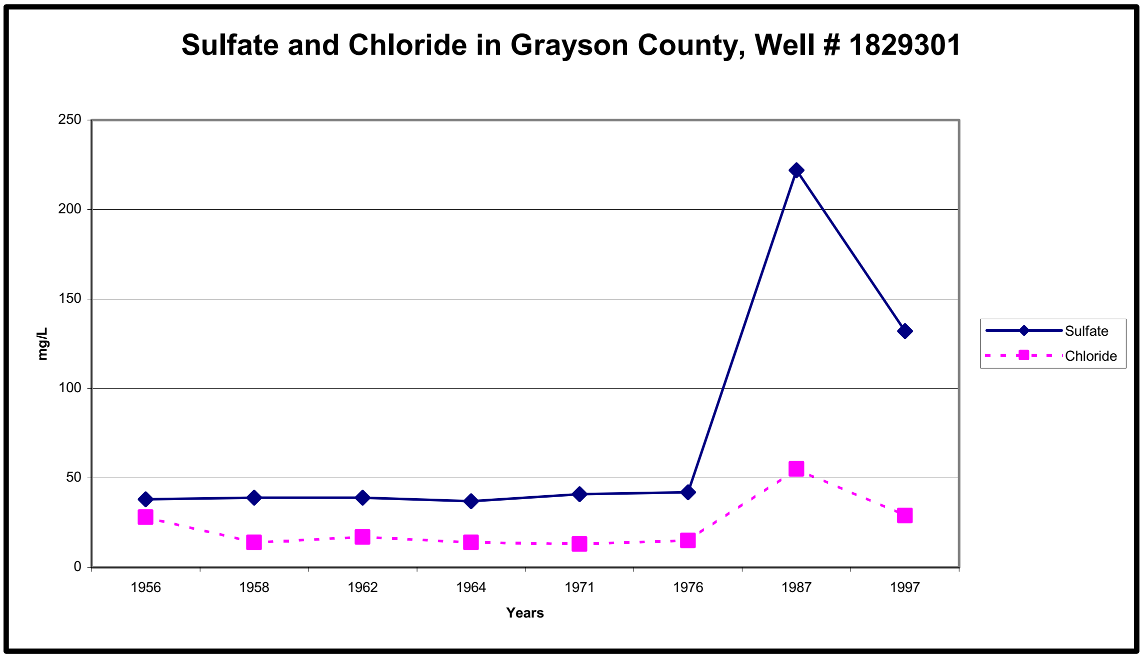
IN THE WOODBINE AQUIFER

Well # A

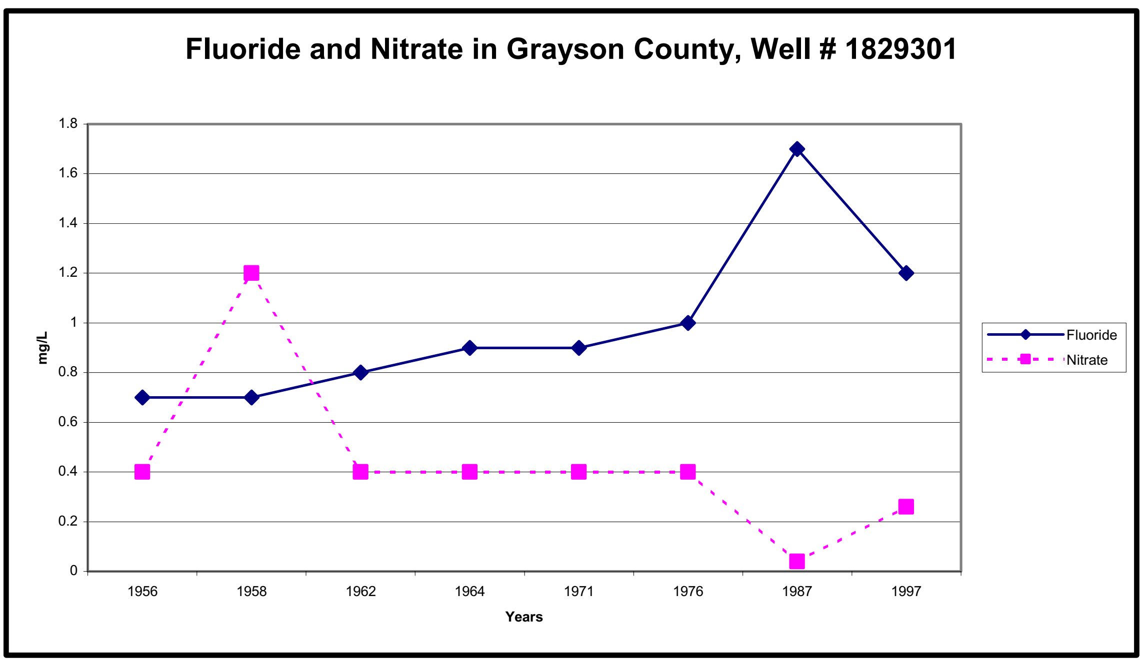

Sulfate and Chloride in Cooke County, Well # 1817401
mg/L
32
31
30
29
28
27
26
1971
1977
1983
1987
1993
Years
Sulfate
Chloride


Fluoride and Nitrate in Cooke County, Well # 1817401
mg/L
3.5
3
2.5
2
1.5
1
0.5
0
1971
1977
1983
1987
1993
Years
Fluoride
Nitrate

Well #B

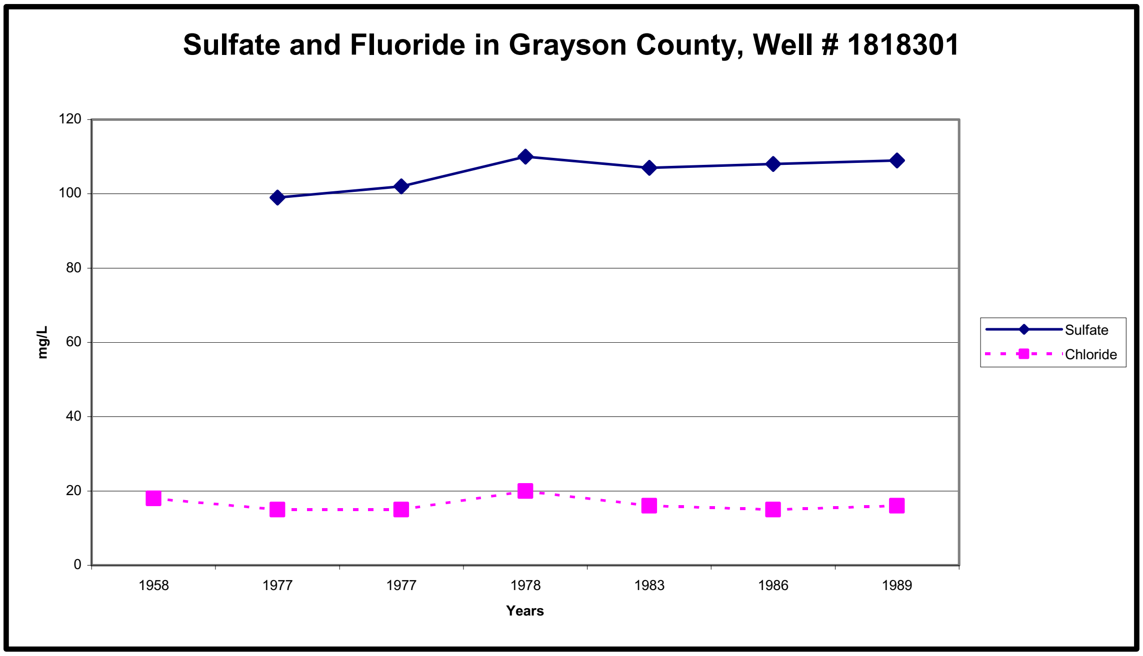


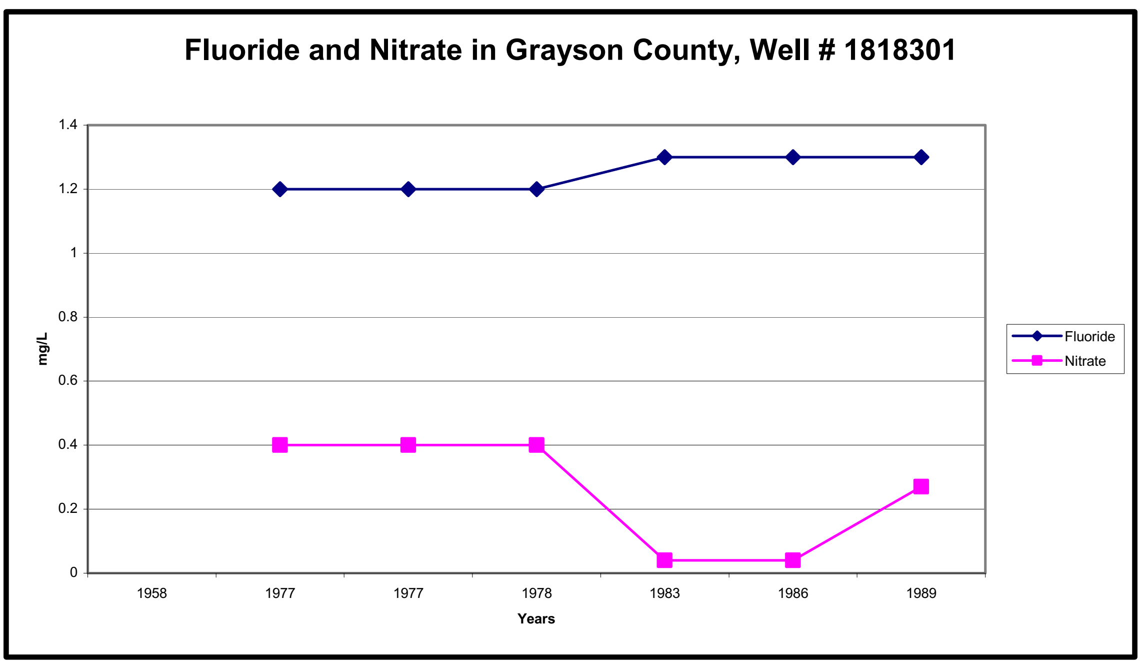
Sulfate and Chloride in Grayson County, Well # 1829301
250
200
150
100
50
0
mg/L
1956
1958
1962
1964
1971
1976
1987
1997
Years
Sulfate
Chloride



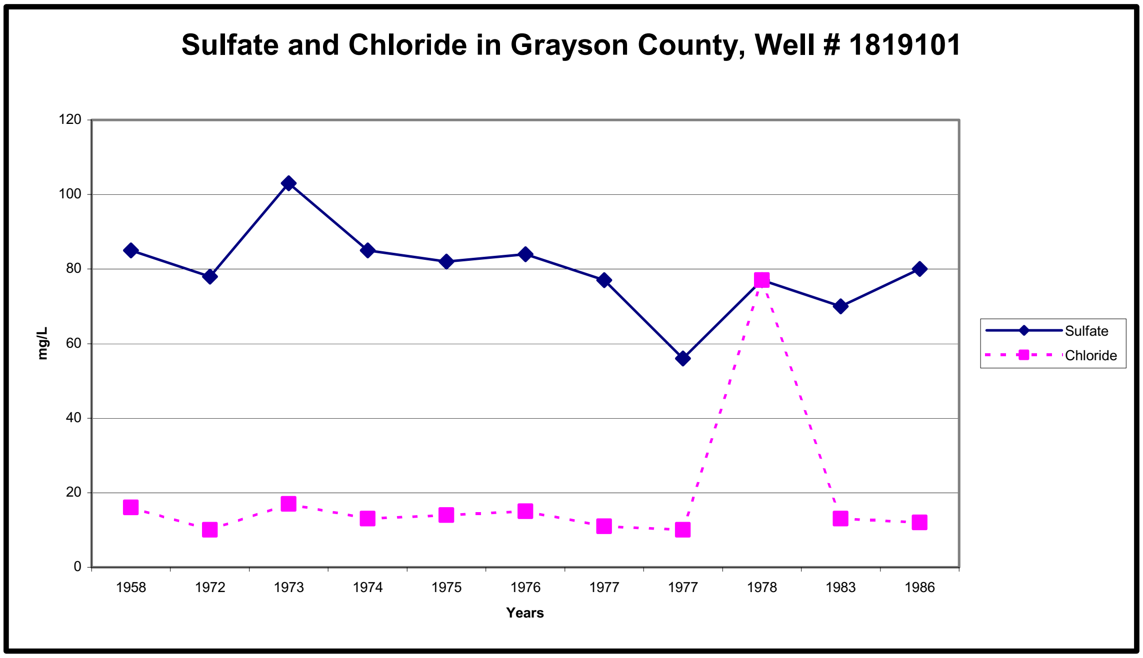
Fluoride and Nitrate in Grayson County, Well # 1829301
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
mg/L
1956
1958
1962
1964
1971
1976
1987
1997
Years
Fluoride
Nitrate

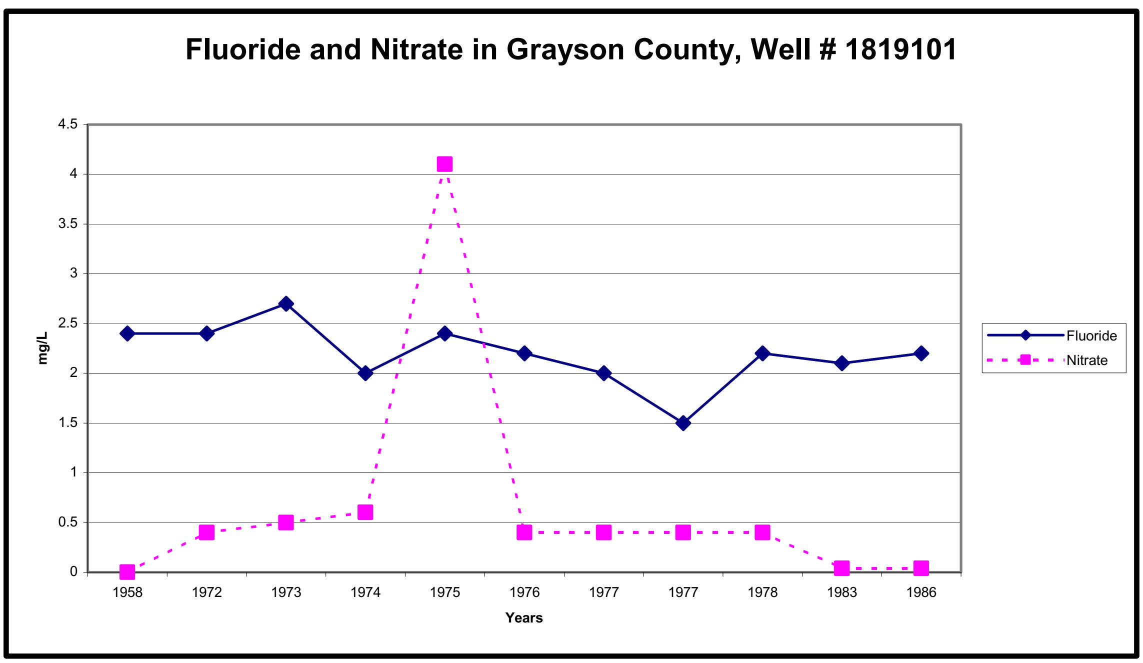
Well # C


Sulfate and Fluoride in Grayson County, Well # 1818301
120
100
80
60
40
20
0
mg/L
1958
1977
1977
1978
1983
1986
1989
Years
Sulfate
Chloride

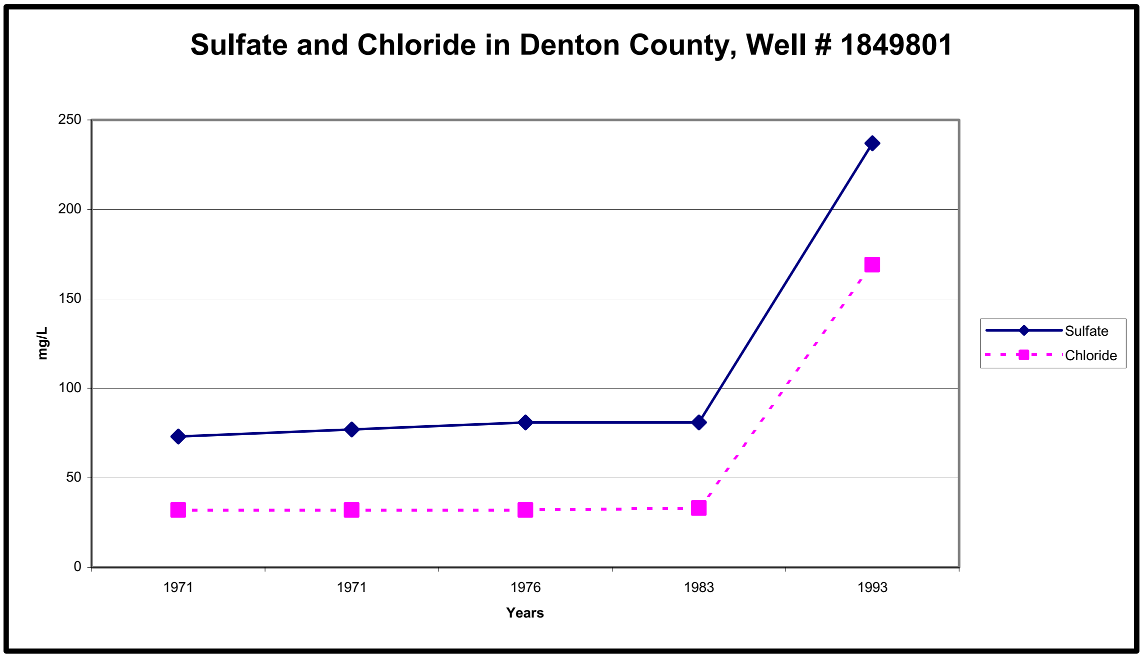

Fluoride and Nitrate in Grayson County, Well # 1818301
1.4
1.2
1
0.8
0.6
0.4
0.2
0
mg/L
1958
1977
1977
1978
1983
1986
1989
Years
Fluoride
Nitrate

Well # D

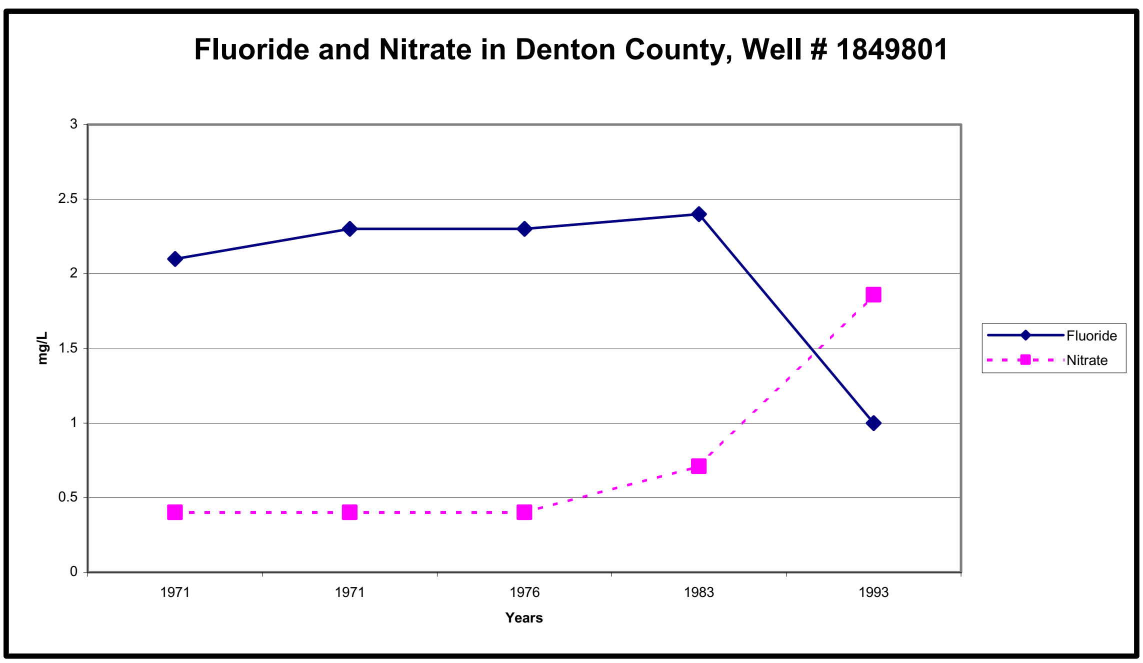

Sulfate and Chloride in Grayson County, Well # 1819101
120
100
80
60
40
20
0
mg/L
1958
1972
1973
1974
1975
1976
1977
1977
1978
1983
1986
Years
Sulfate
Chloride


Fluoride and Nitrate in Grayson County, Well # 1819101
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
mg/L
1958
1972
1973
1974
1975
1976
1977
1977
1978
1983
1986
Years
Fluoride
Nitrate

Well # E

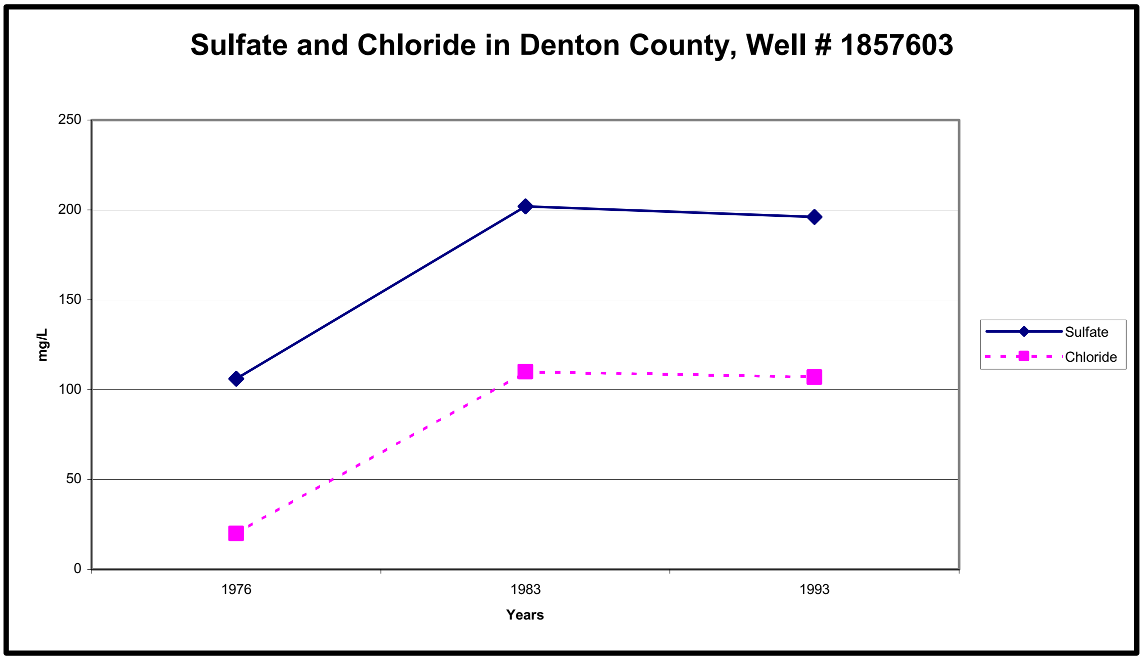


Sulfate and Chloride in Denton County, Well # 1849801
250
200
150
100
50
0
mg/L
1971
1971
1976
1983
1993
Years
Sulfate
Chloride

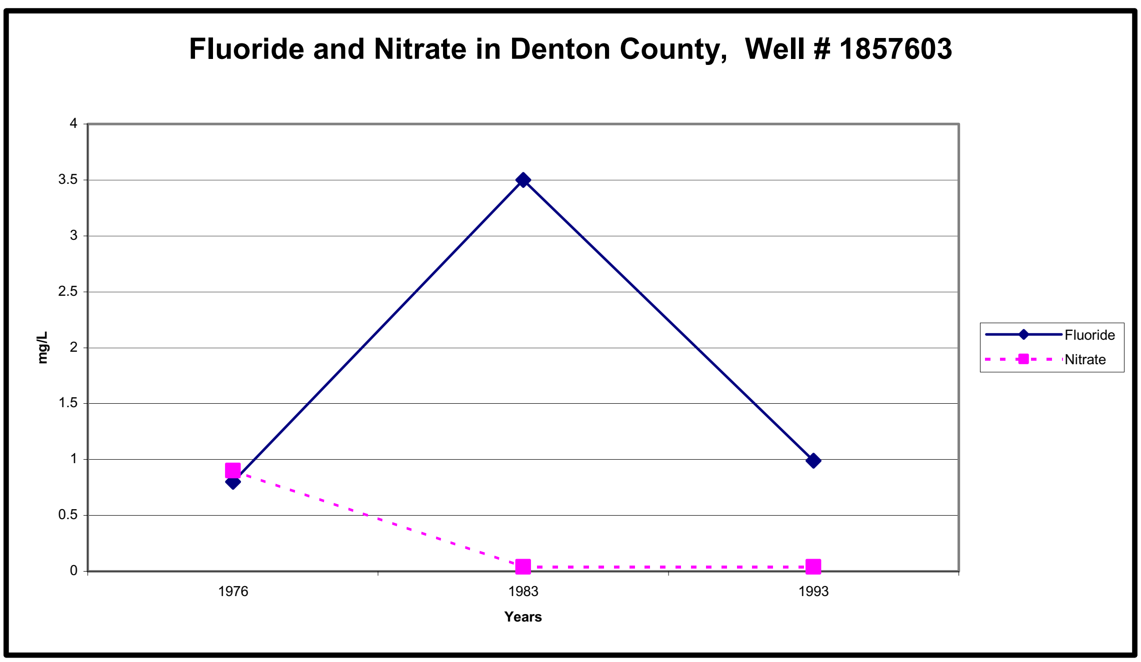


Fluoride and Nitrate in Denton County, Well # 1849801
3
2.5
2
1.5
1
0.5
0
mg/L
1971
1971
1976
1983
1993
Years
Fluoride
Nitrate

Well # F

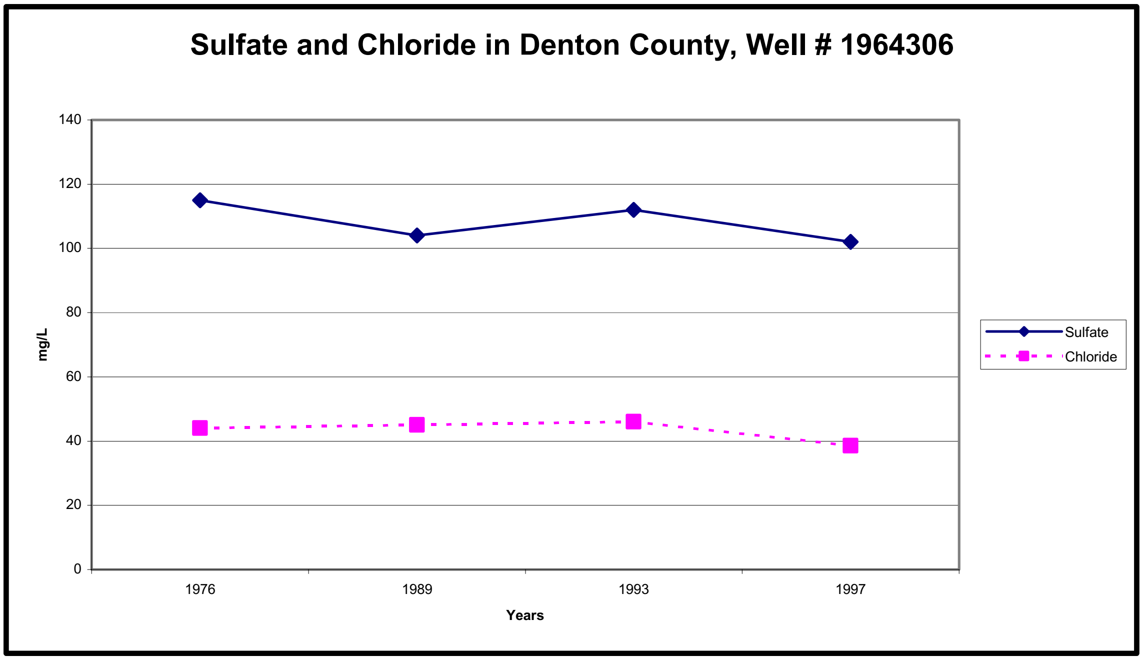


Sulfate and Chloride in Denton County, Well # 1857603
250
200
150
100
50
0
mg/L
1976
1983
1993
Years
Sulfate
Chloride

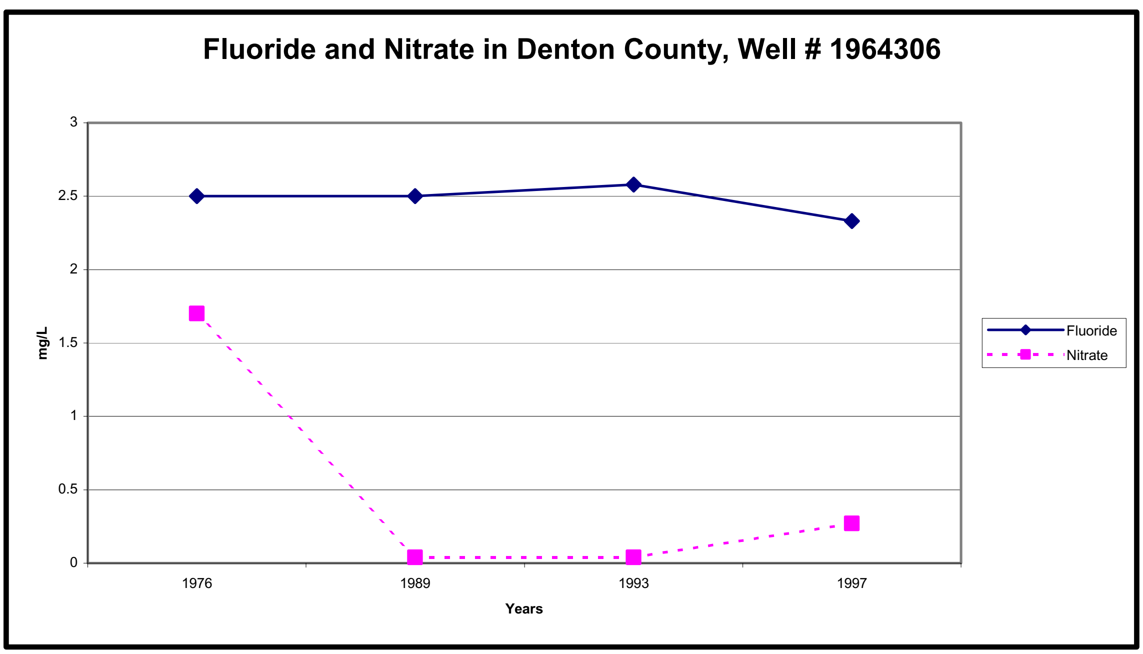


Fluoride and Nitrate in Denton County, Well # 1857603
4
3.5
3
2.5
2
1.5
1
0.5
0
mg/L
1976
1983
1993
Years
Fluoride
Nitrate

Well # G

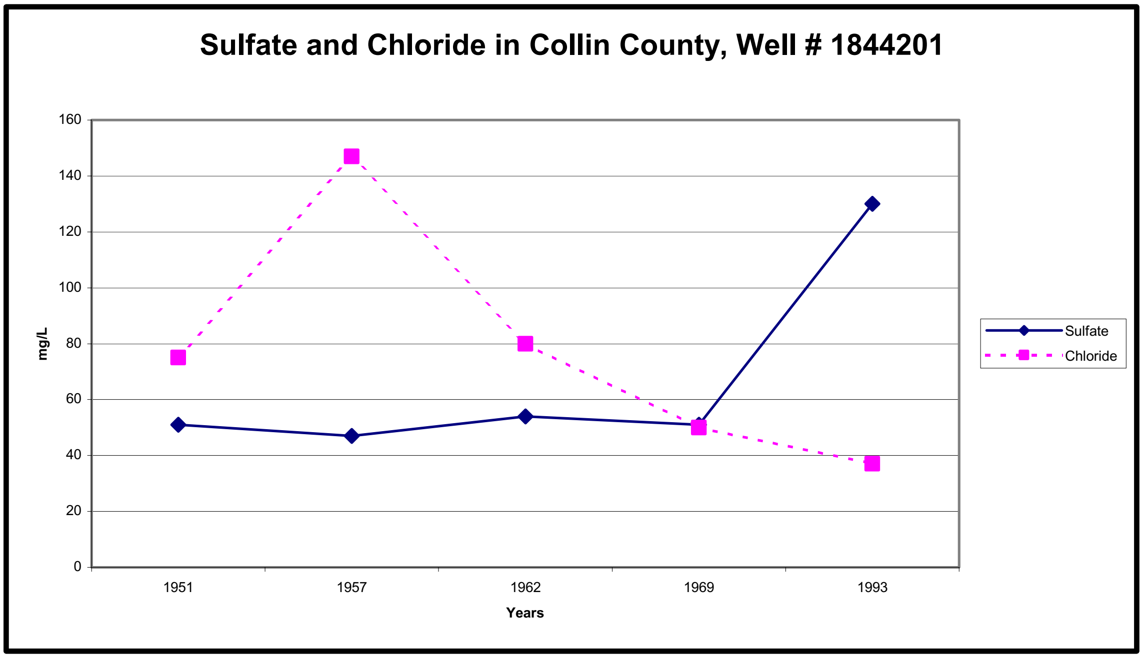


Sulfate and Chloride in Denton County, Well # 1964306
140
120
100
80
60
40
20
0
mg/L
1976
1989
1993
1997
Years
Sulfate
Chloride

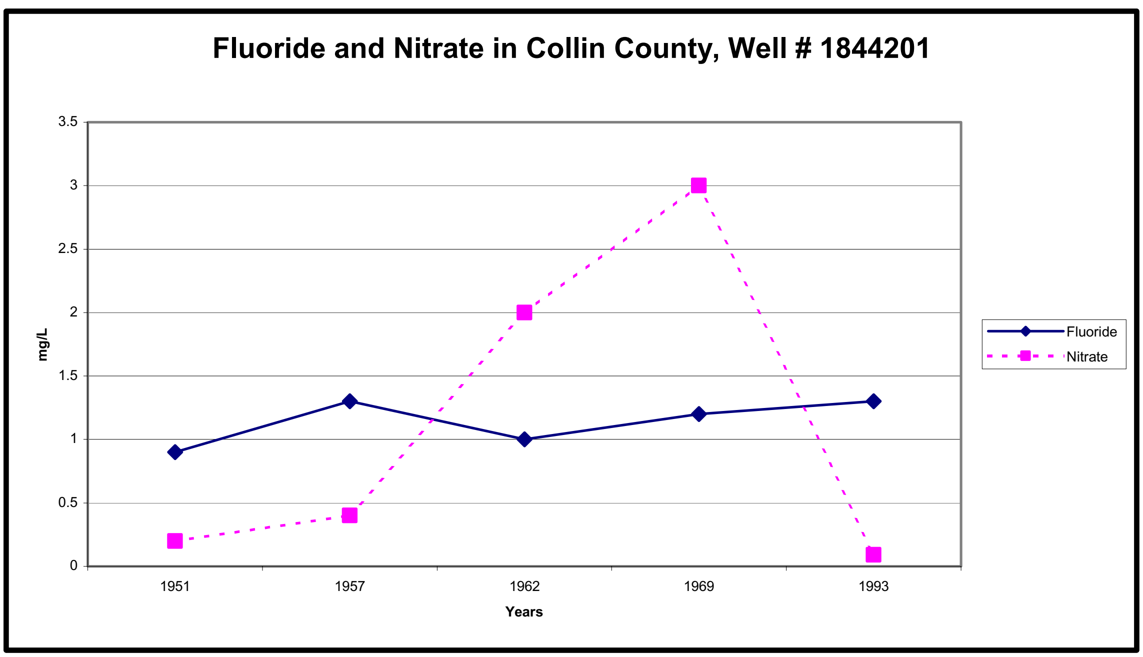


Fluoride and Nitrate in Denton County, Well # 1964306
3
2.5
2
1.5
1
0.5
0
mg/L
1976
1989
1993
1997
Years
Fluoride
Nitrate

Well # H

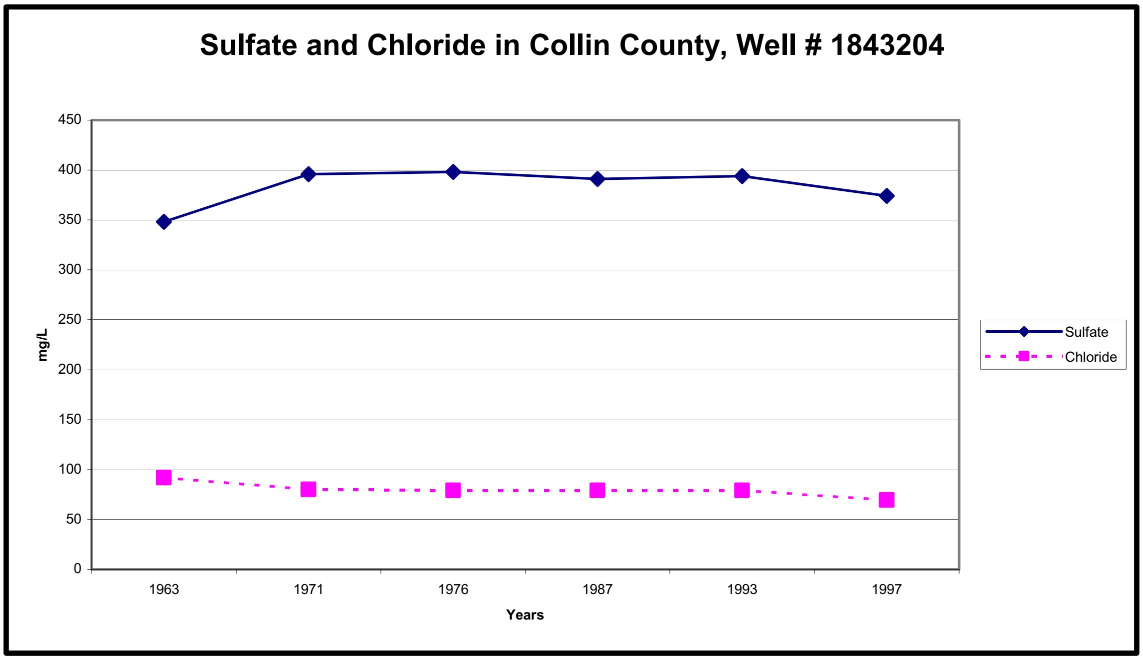


Sulfate and Chloride in Collin County, Well # 1844201
160
140
120
100
80
60
40
20
0
mg/L
1951
1957
1962
1969
1993
Years
Sulfate
Chloride

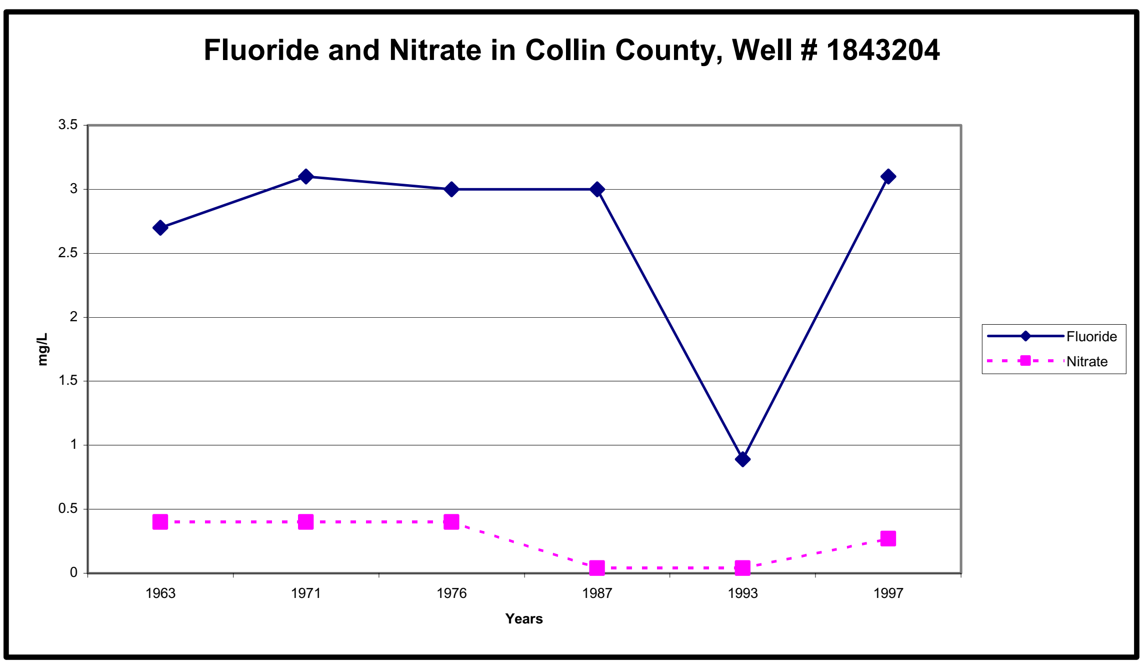


Fluoride and Nitrate in Collin County, Well # 1844201
3.5
3
2.5
2
1.5
1
0.5
0
mg/L
1951
1957
1962
1969
1993
Years
Fluoride
Nitrate

Well # I

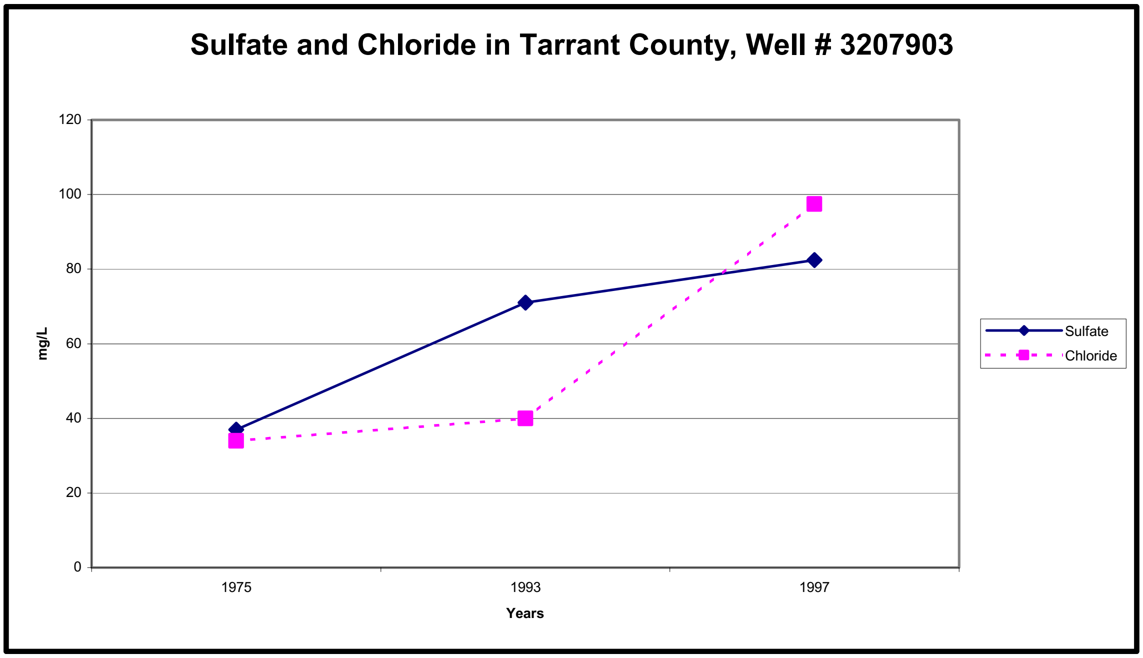


Sulfate and Chloride in Collin County, Well # 1843204
450
400
350
300
250
200
150
100
50
0
mg/L
1963
1971
1976
1987
1993
1997
Years
Sulfate
Chloride

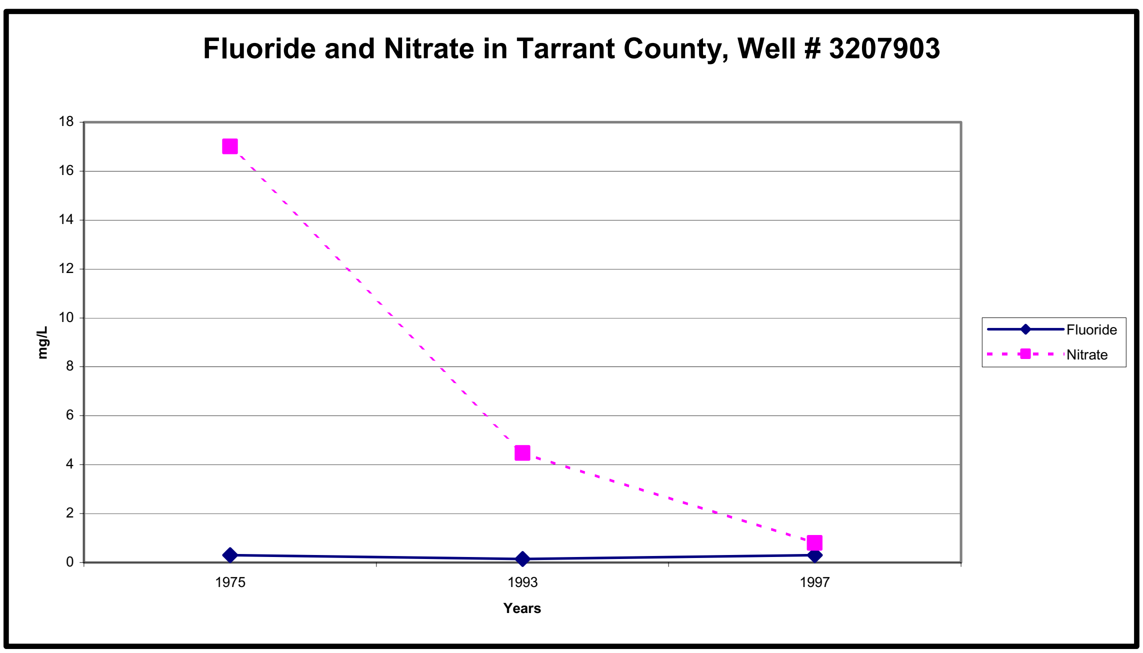


Fluoride and Nitrate in Collin County, Well # 1843204
3.5
3
2.5
2
1.5
1
0.5
0
mg/L
1963
1971
1976
1987
1993
1997
Years
Fluoride
Nitrate

Well # J

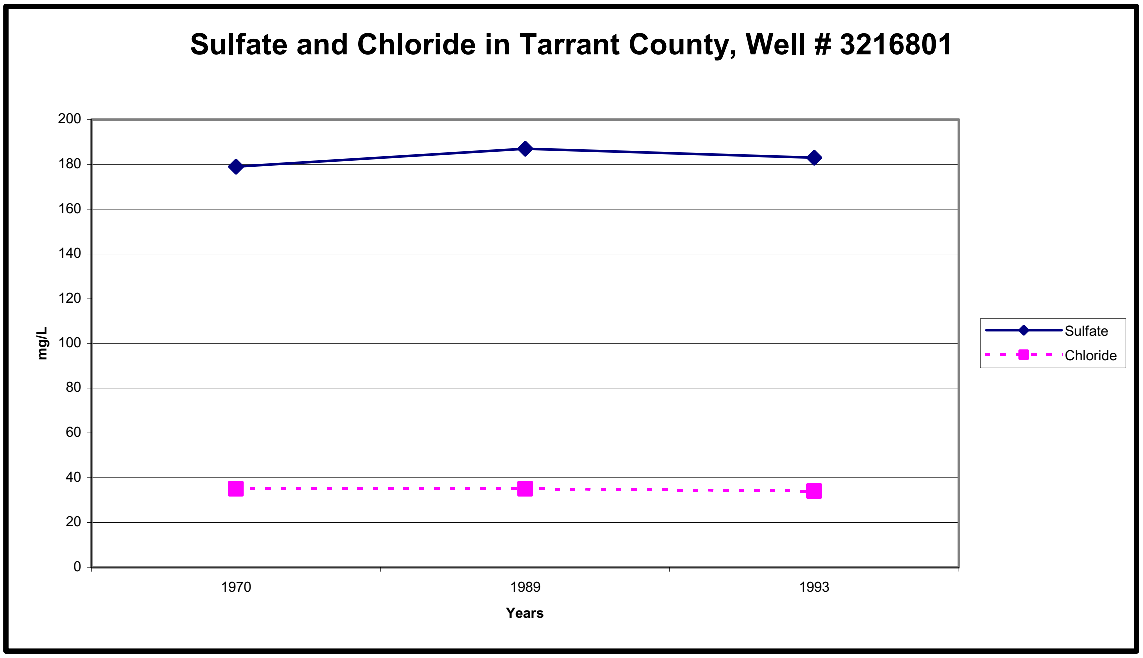


Sulfate and Chloride in Tarrant County, Well # 3207903
120
100
80
60
40
20
0
mg/L
1975
1993
1997
Years
Sulfate
Chloride

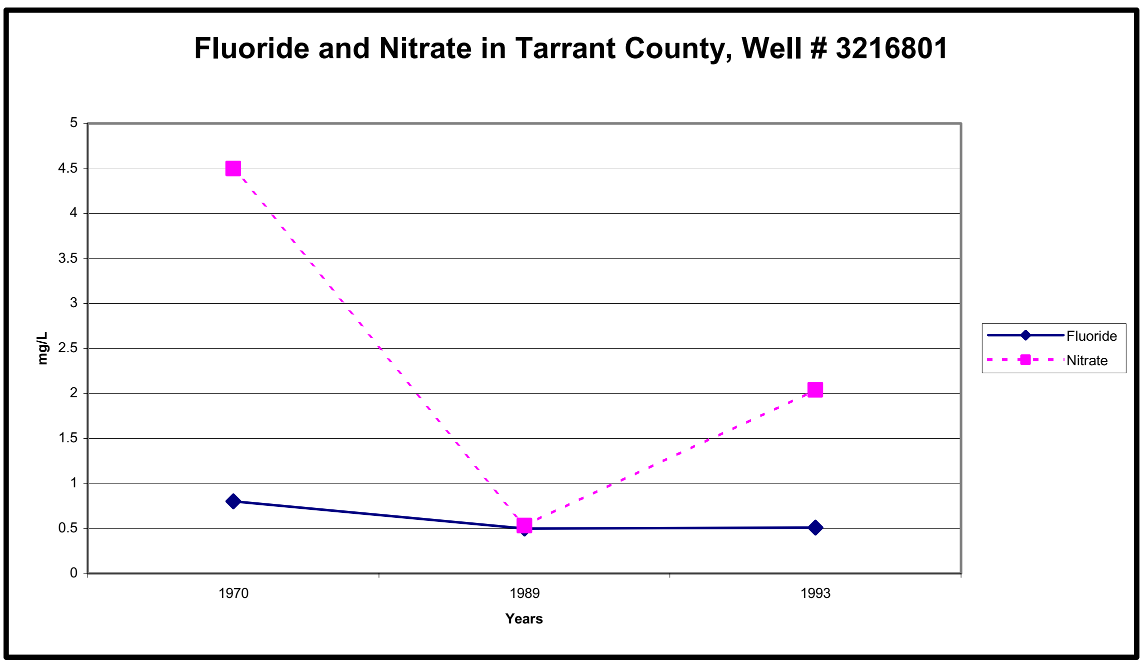


Fluoride and Nitrate in Tarrant County, Well # 3207903
18
16
14
12
10
8
6
4
2
0
mg/L
1975
1993
1997
Years
Fluoride
Nitrate

Well # K

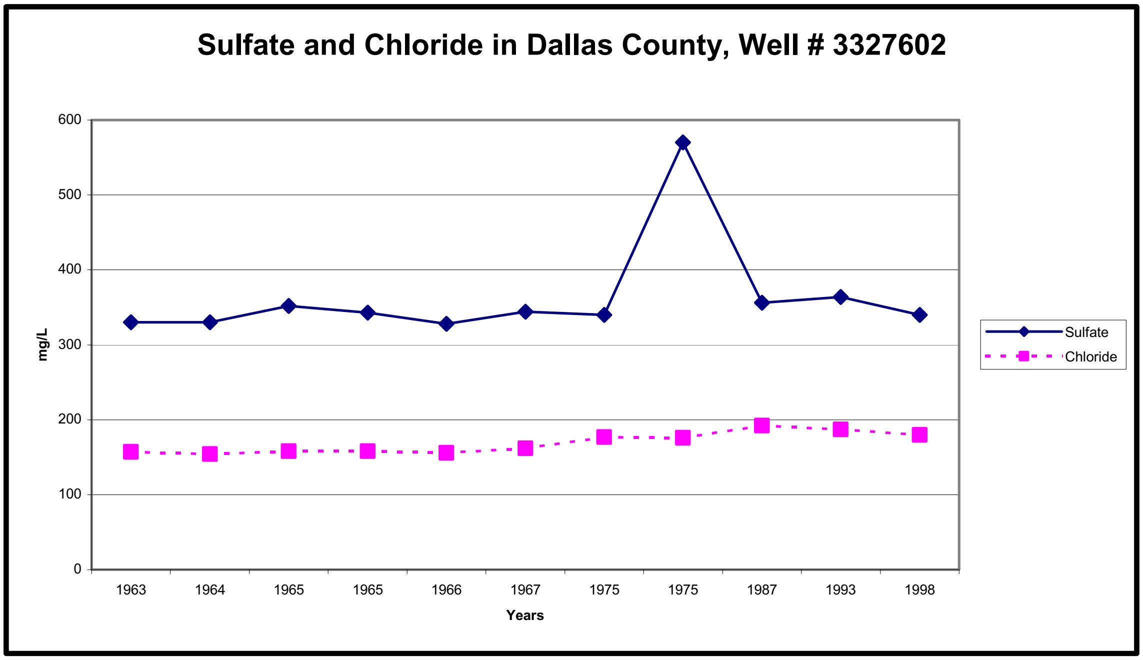


Sulfate and Chloride in Tarrant County, Well # 3216801
200
180
160
140
120
100
80
60
40
20
0
mg/L
1970
1989
1993
Years
Sulfate
Chloride

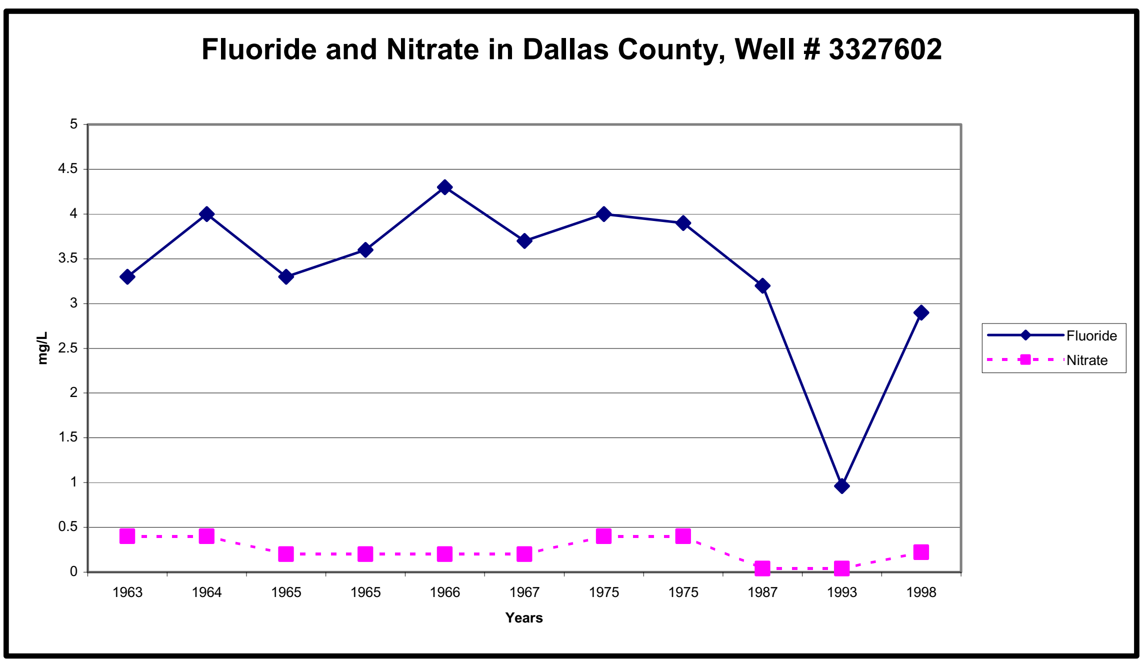


Fluoride and Nitrate in Tarrant County, Well # 3216801
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
mg/L
1970
1989
1993
Years
Fluoride
Nitrate

Well # L

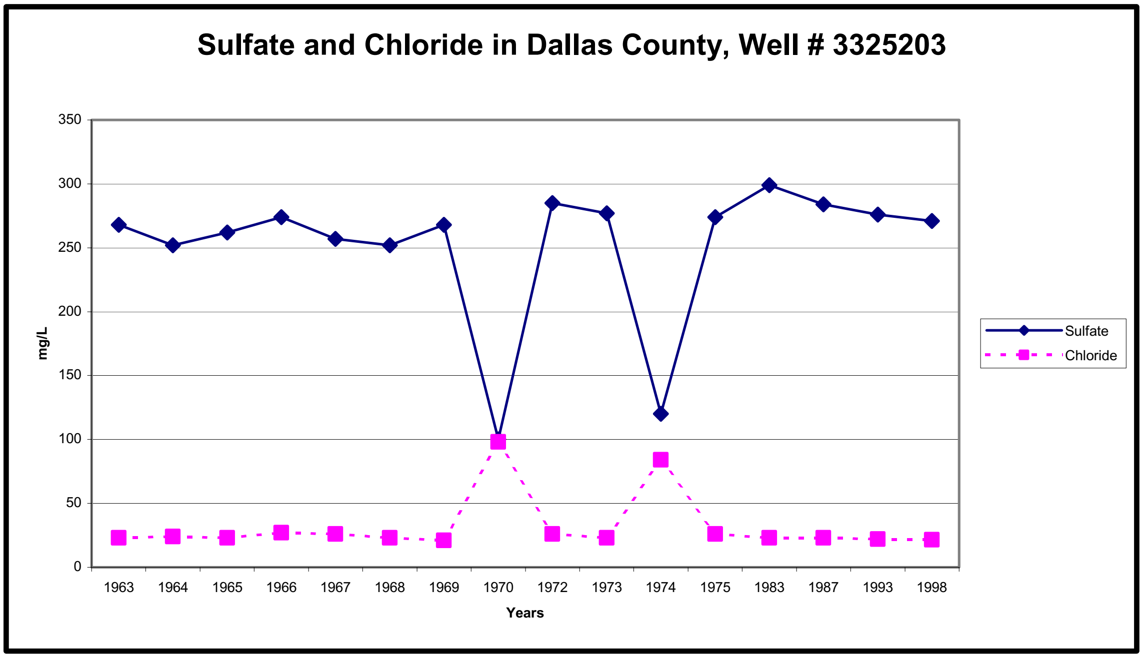


Sulfate and Chloride in Dallas County, Well # 3327602
600
500
400
300
200
100
0
mg/L
1963
1964
1965
1965
1966
1967
1975
1975
1987
1993
1998
Years
Sulfate
Chloride

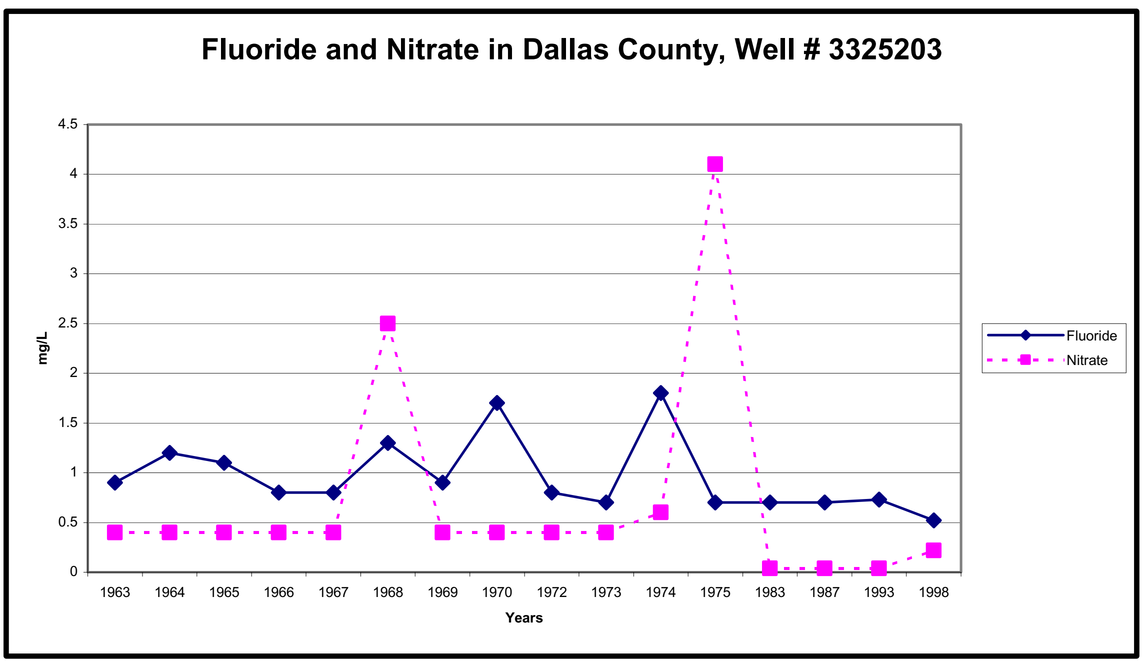


Fluoride and Nitrate in Dallas County, Well # 3327602
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
mg/L
1963
1964
1965
1965
1966
1967
1975
1975
1987
1993
1998
Years
Fluoride
Nitrate

Well # M

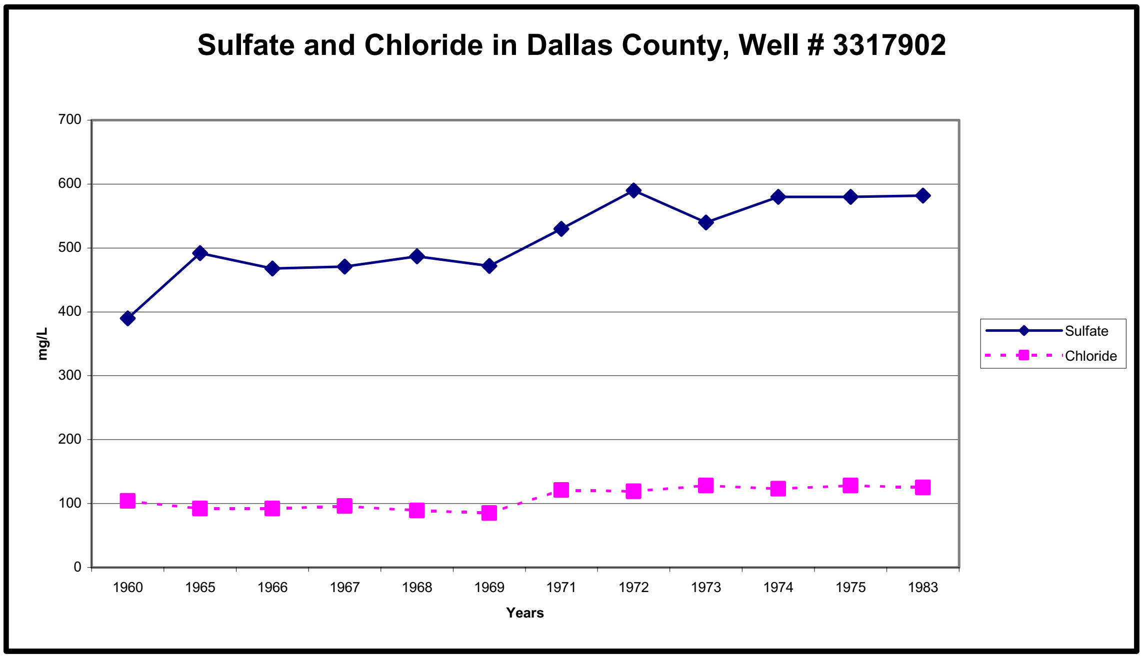


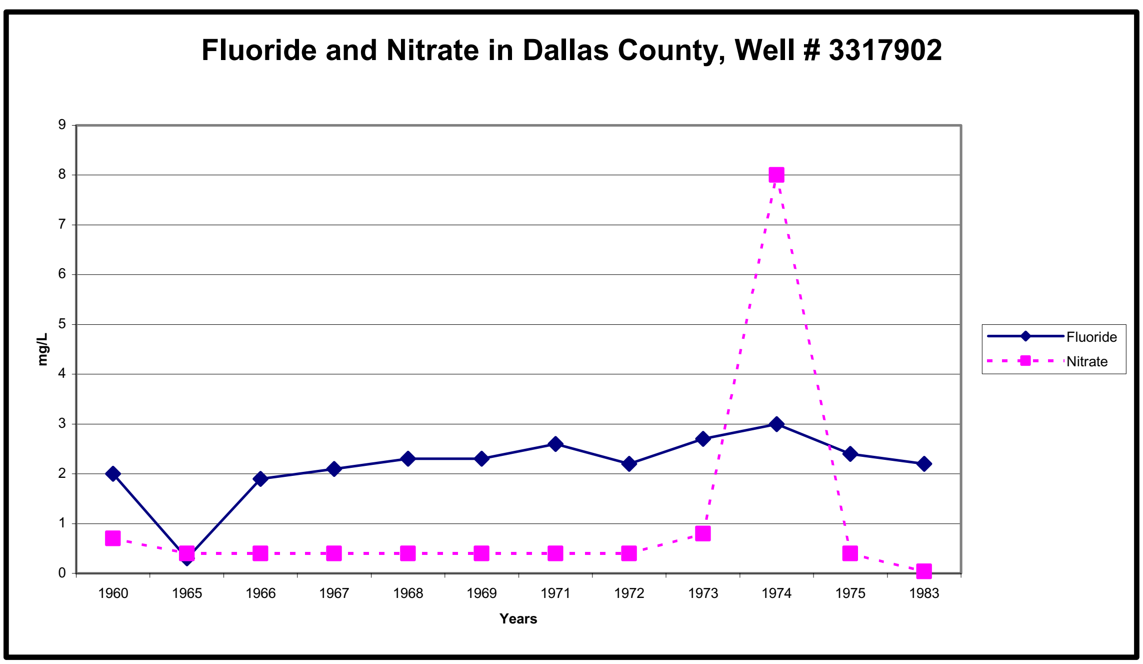
Sulfate and Chloride in Dallas County, Well # 3325203
350
300
250
200
150
100
50
0
mg/L
1963
1964
1965
1966
1967
1968
1969
1970
1972
1973
1974
1975
1983
1987
1993
1998
Years
Sulfate
Chloride



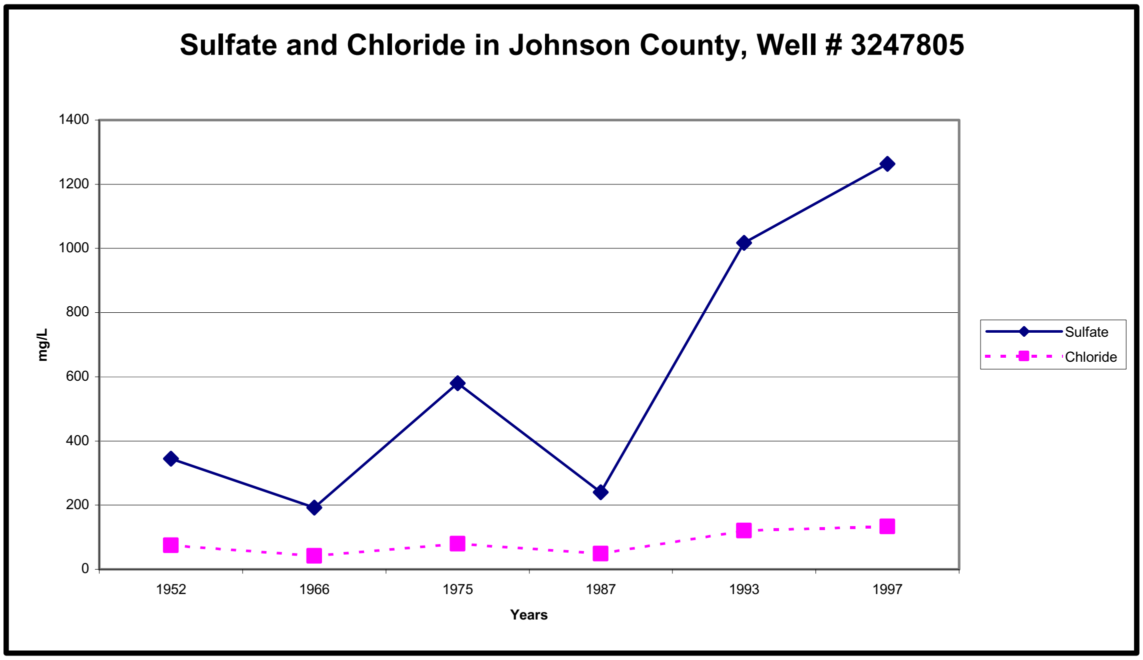
Fluoride and Nitrate in Dallas County, Well # 3325203
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
mg/L
1963
1964
1965
1966
1967
1968
1969
1970
1972
1973
1974
1975
1983
1987
1993
1998
Years
Fluoride
Nitrate

Well # N

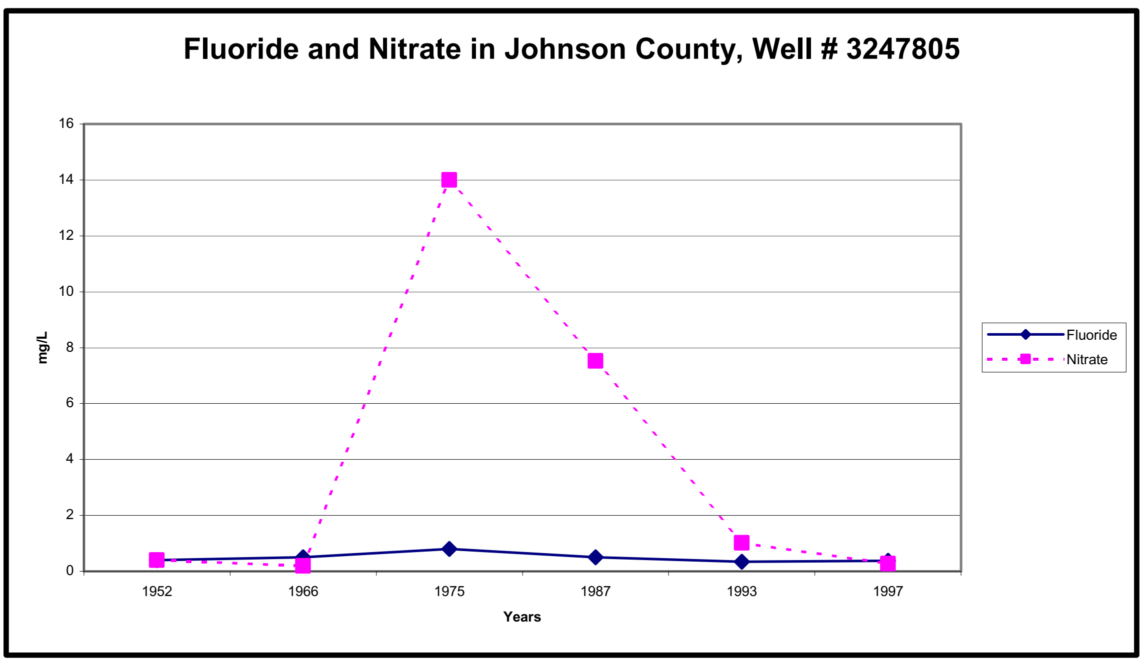

Sulfate and Chloride in Dallas County, Well # 3317902
700
600
500
400
300
200
100
0
mg/L
1960
1965
1966
1967
1968
1969
1971
1972
1973
1974
1975
1983
Years
Sulfate
Chloride


Fluoride and Nitrate in Dallas County, Well # 3317902
9
8
7
6
5
4
3
2
1
0
mg/L
1960
1965
1966
1967
1968
1969
1971
1972
1973
1974
1975
1983
Years
Fluoride
Nitrate

Well # O

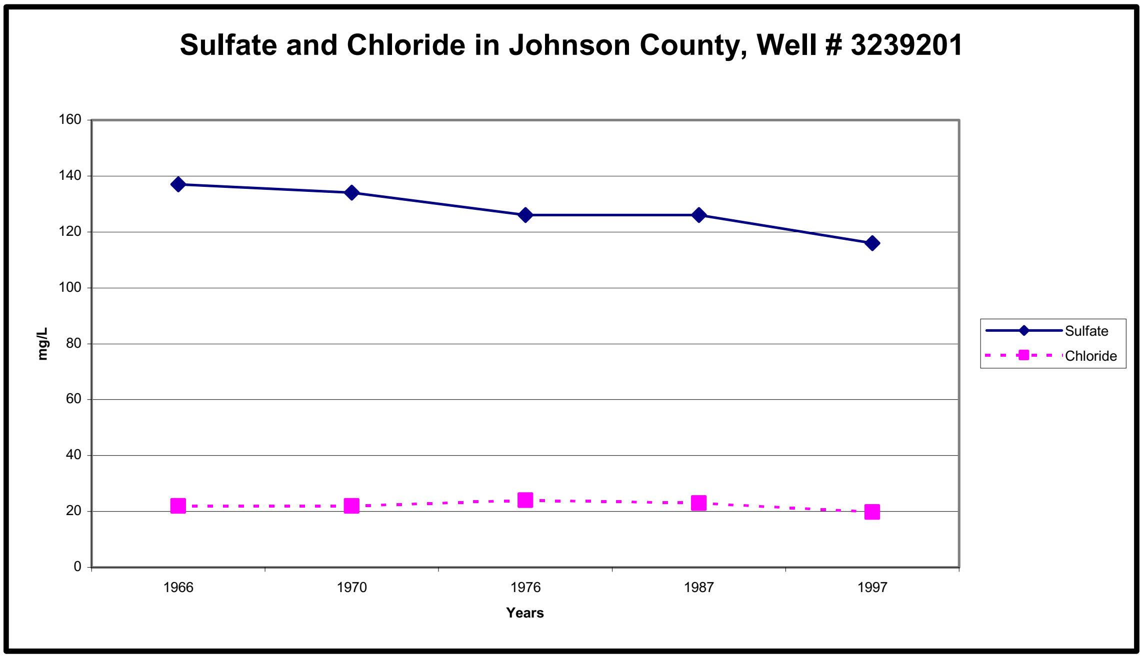


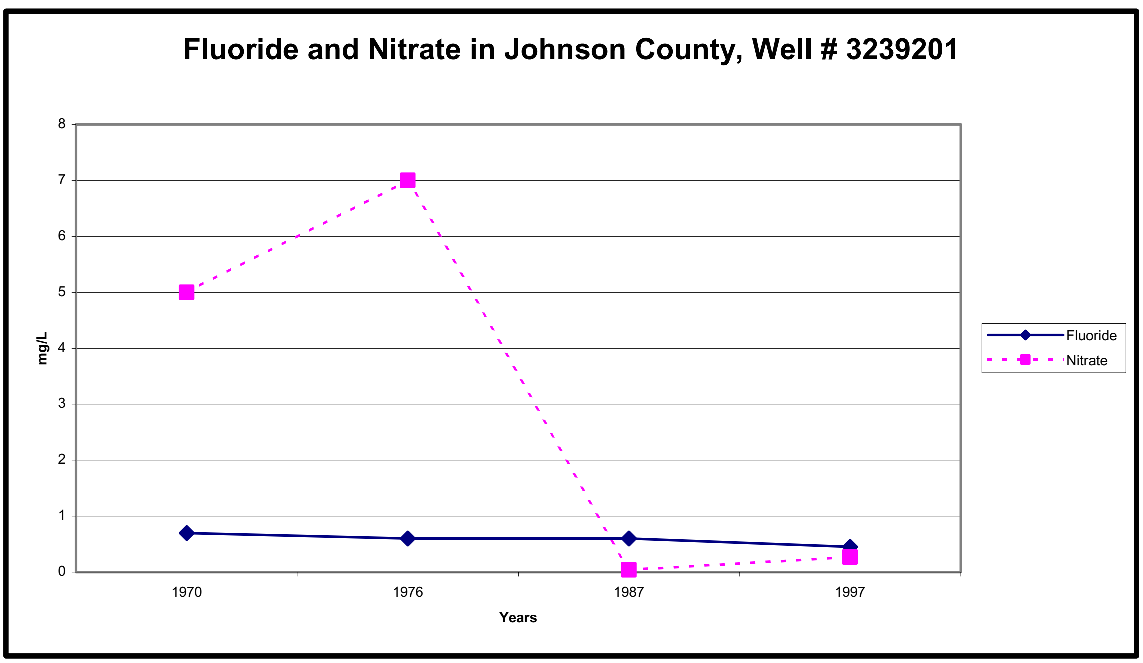
Sulfate and Chloride in Johnson County, Well # 3247805
1400
1200
1000
800
600
400
200
0
mg/L
1952
1966
1975
1987
1993
1997
Years
Sulfate
Chloride



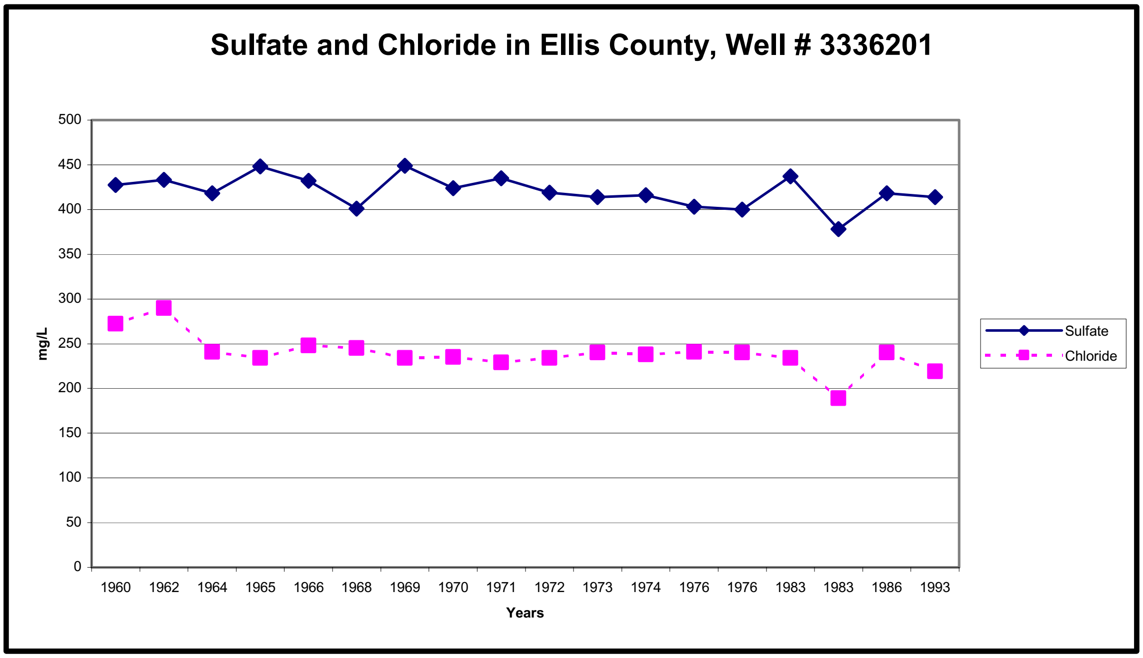
Fluoride and Nitrate in Johnson County, Well # 3247805
16
14
12
10
8
6
4
2
0
mg/L
1952
1966
1975
1987
1993
1997
Years
Fluoride
Nitrate

Well # P

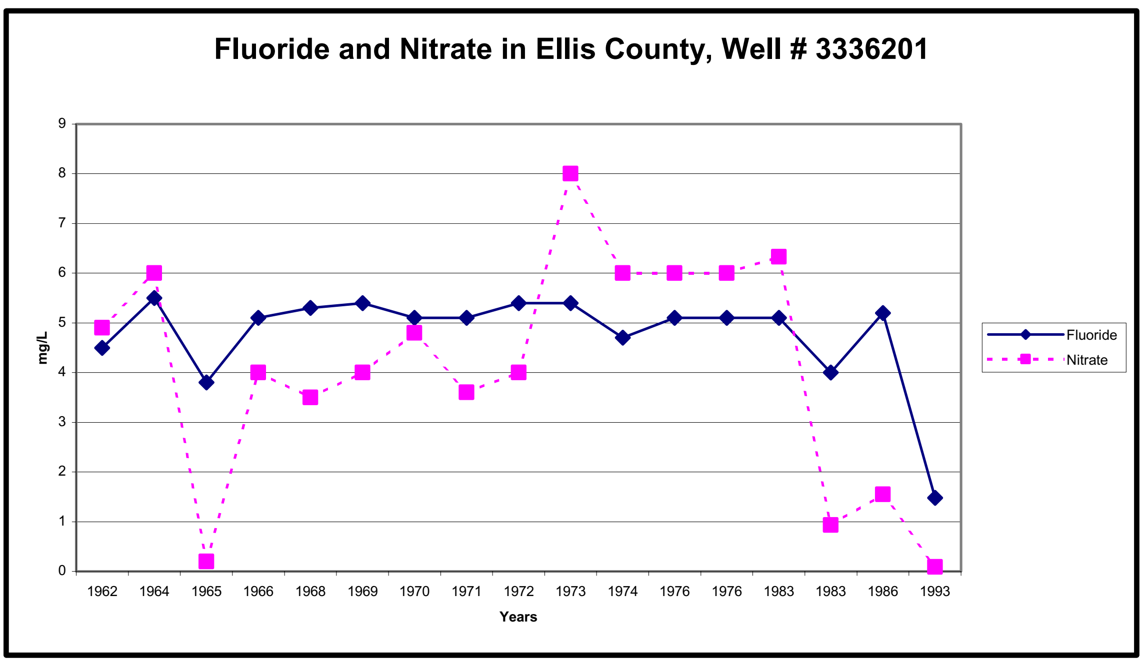

Sulfate and Chloride in Johnson County, Well # 3239201
160
140
120
100
80
60
40
20
0
mg/L
1966
1970
1976
1987
1997
Years
Sulfate
Chloride


Fluoride and Nitrate in Johnson County, Well # 3239201
8
7
6
5
4
3
2
1
0
mg/L
1970
1976
1987
1997
Years
Fluoride
Nitrate

Well # Q

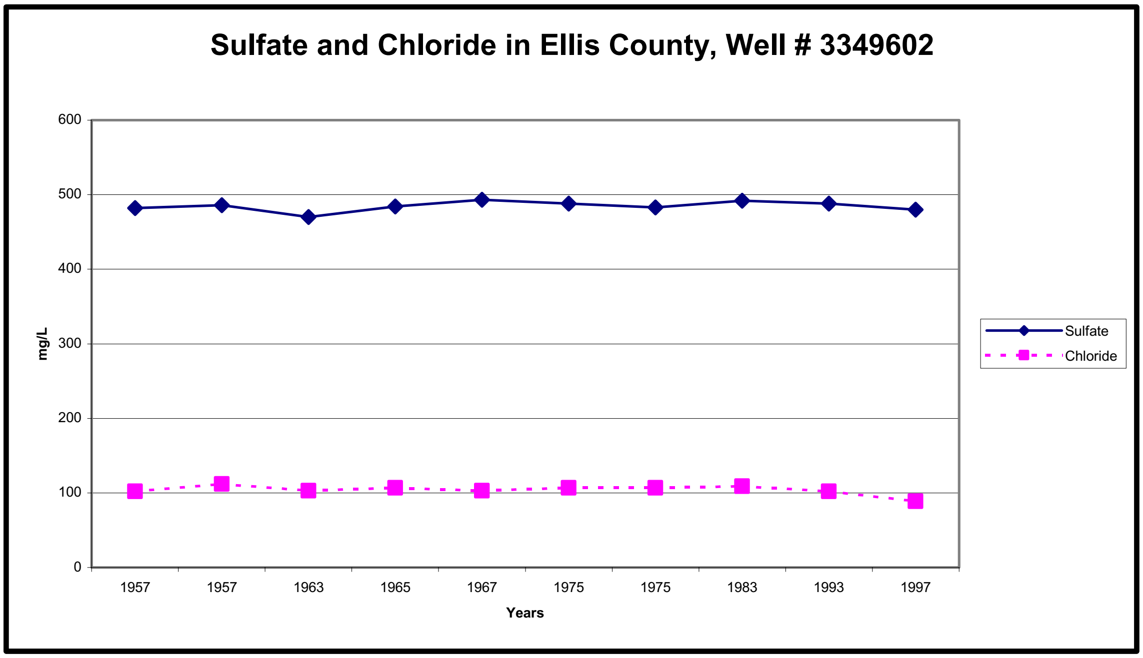


Sulfate and Chloride in Ellis County, Well # 3336201
500
450
400
350
300
250
200
150
100
50
0
mg/L
1960
1962
1964
1965
1966
1968
1969
1970
1971
1972
1973
1974
1976
1976
1983
1983
1986
1993
Years
Sulfate
Chloride

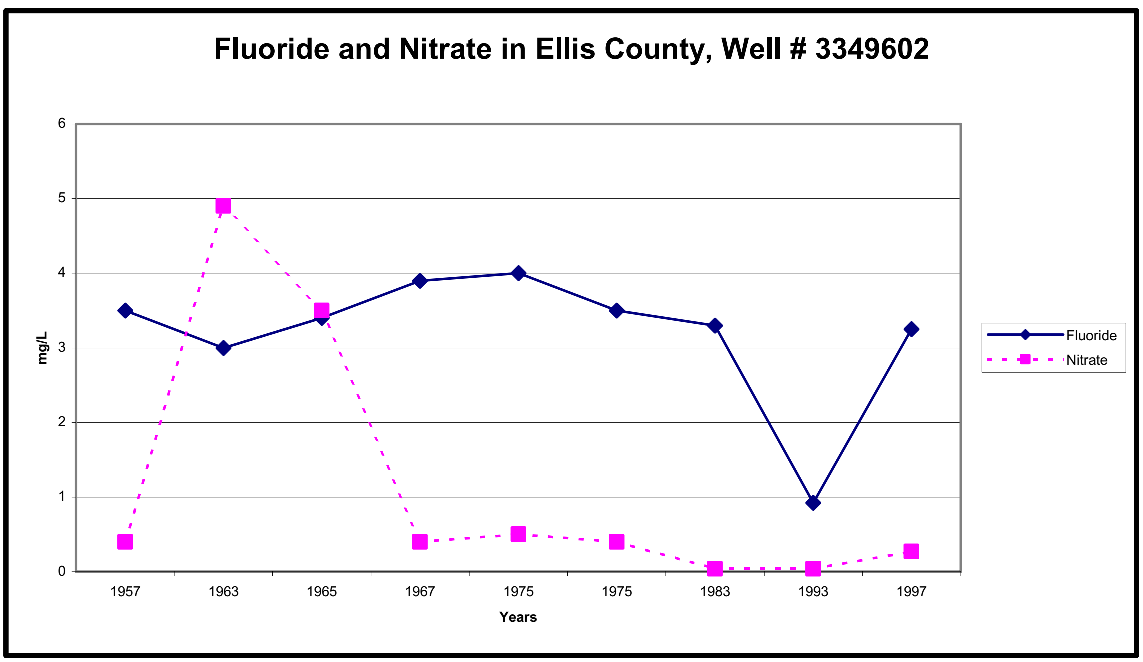


Fluoride and Nitrate in Ellis County, Well # 3336201
9
8
7
6
5
4
3
2
1
0
mg/L
1962
1964
1965
1966
1968
1969
1970
1971
1972
1973
1974
1976
1976
1983
1983
1986
1993
Years
Fluoride
Nitrate

Well # R

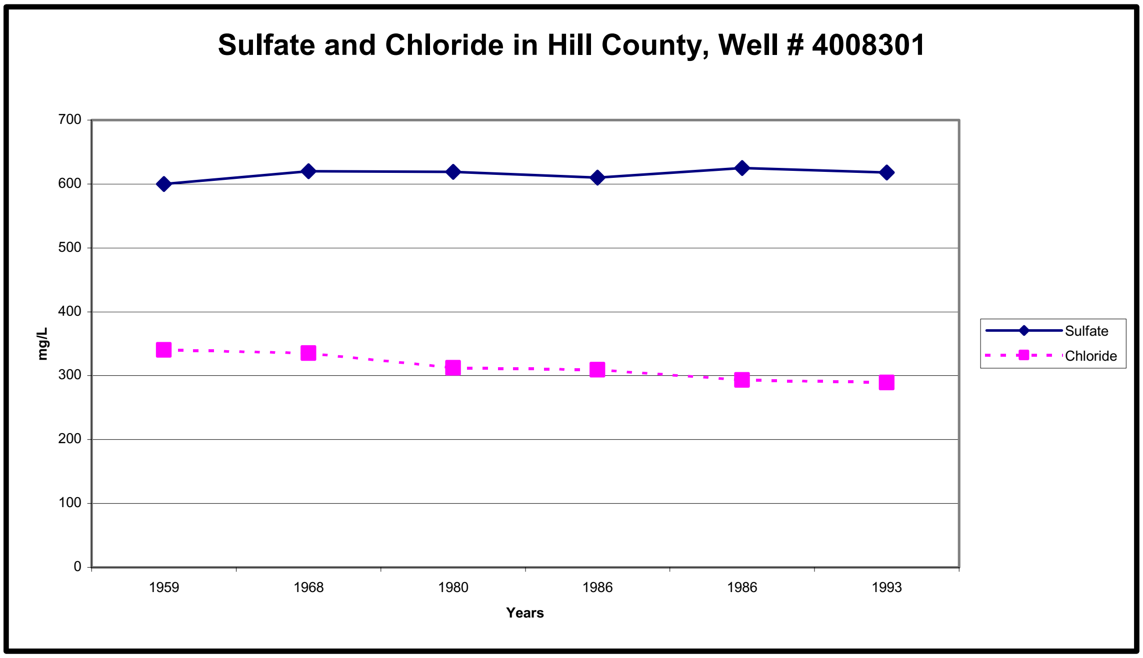


Sulfate and Chloride in Ellis County, Well # 3349602
600
500
400
300
200
100
0
mg/L
1957
1957
1963
1965
1967
1975
1975
1983
1993
1997
Years
Sulfate
Chloride

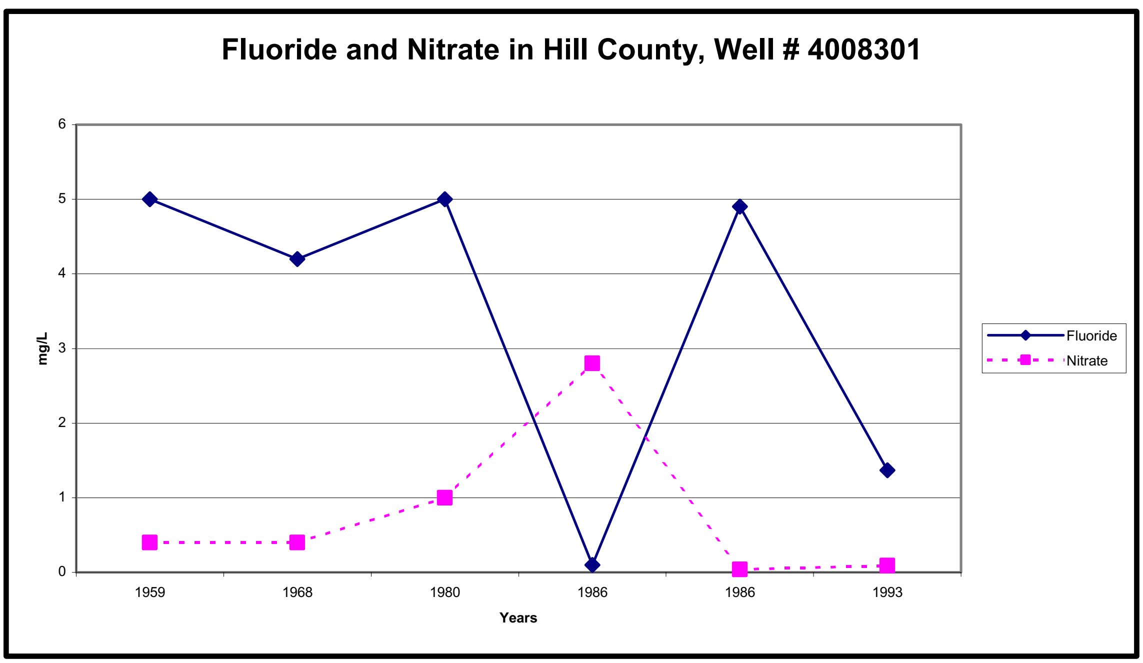


Fluoride and Nitrate in Ellis County, Well # 3349602
6
5
4
3
2
1
0
mg/L
1957
1963
1965
1967
1975
1975
1983
1993
1997
Years
Fluoride
Nitrate

Well # S

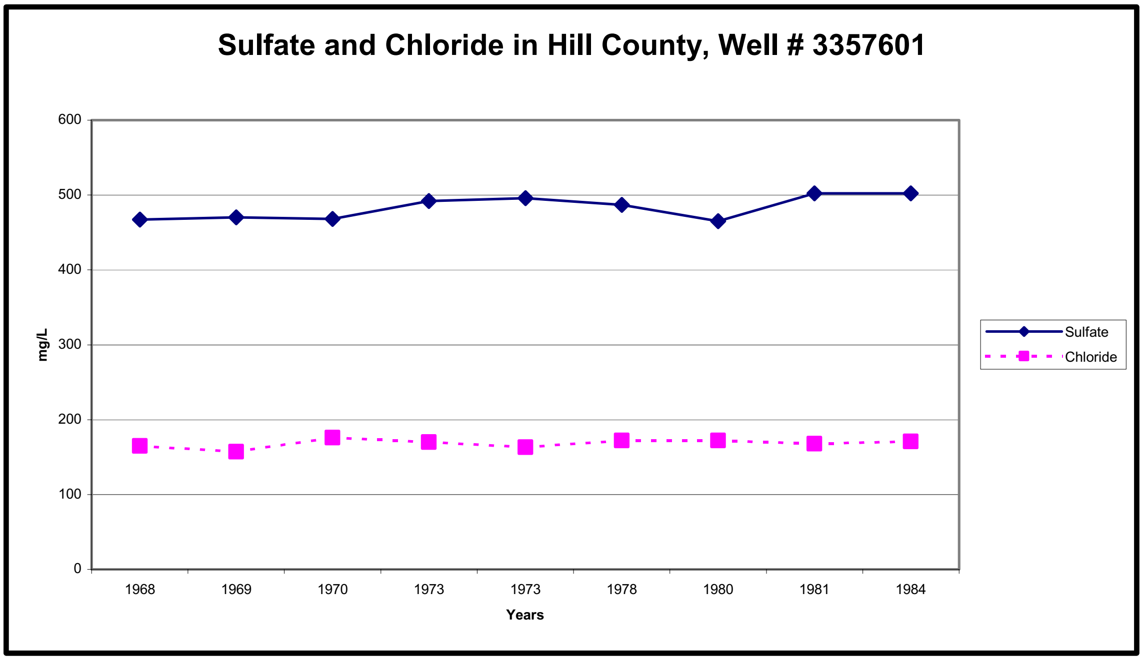


Sulfate and Chloride in Hill County, Well # 4008301
700
600
500
400
300
200
100
0
mg/L
1959
1968
1980
1986
1986
1993
Years
Sulfate
Chloride

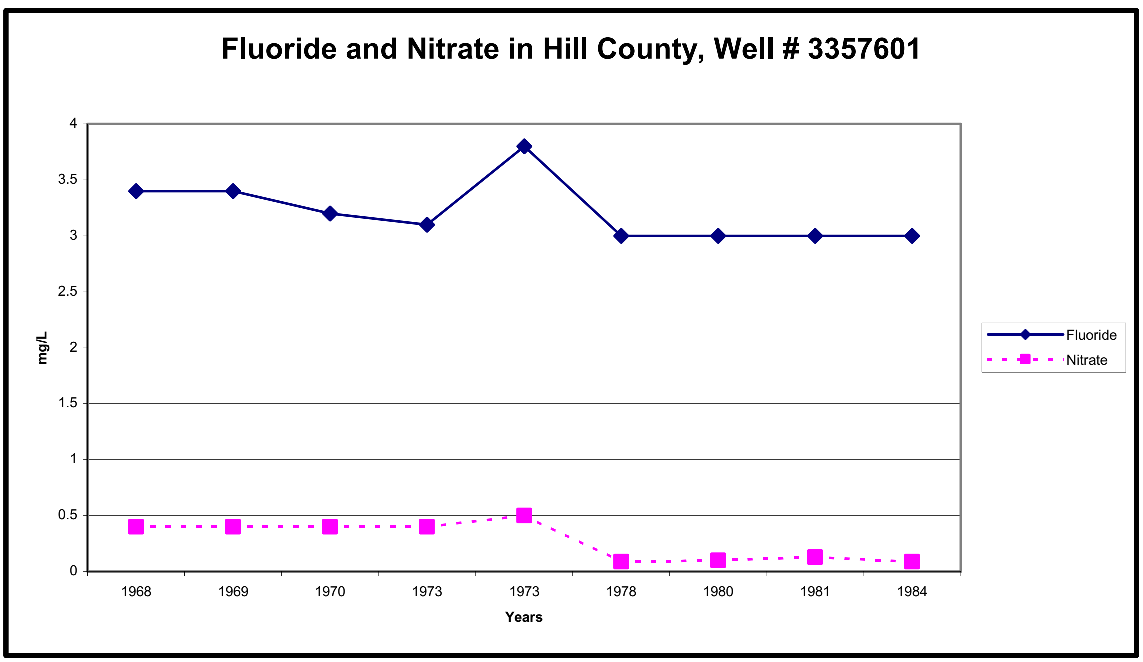


Fluoride and Nitrate in Hill County, Well # 4008301
6
5
4
3
2
1
0
mg/L
1959
1968
1980
1986
1986
1993
Years
Fluoride
Nitrate

Well # T



Sulfate and Chloride in Hill County, Well # 3357601
600
500
400
300
200
100
0
mg/L
1968
1969
1970
1973
1973
1978
1980
1981
1984
Years
Sulfate
Chloride



Fluoride and Nitrate in Hill County, Well # 3357601
4
3.5
3
2.5
2
1.5
1
0.5
0
mg/L
1968
1969
1970
1973
1973
1978
1980
1981
1984
Years
Fluoride
Nitrate

APPENDIX B

WATER QUALITY DATA

OF THE WOODBINE AQUIFER

BY DECADE

Decade	County Name	State Well ID	Longitude	Latitude	Well Depth	Primary Water Use	Year Collected	Sulfate Flag	Sulfate (Mg/L)	Chloride Flag	Chloride (Mg/L)	Fluoride Flag	Fluoride (Mg/L)	Nitrate Flag	Nitrate (Mg/L)
1950s	Collin	1850201	-96.796944	33.233611	619	P	1955		322		302		2.8	<	0.4
	Collin	1842602	-96.784167	33.321389	700	P	1951		57		36		1.2	<	0.4
	Collin	1859701	-96.711944	33.021667	1180	U	1956		437		401		1.4		1.3
	Collin	1852402	-96.608333	33.190833	1272	U	1950		464		192		0.6	<	0.4
	Collin	1859201	-96.675556	33.102222	1300	U	1959		235		139		2.8		2.7
	Collin	1844802	-96.572500	33.284444	1462	U	1952		101		1264		2.2		2.7
	Collin	1844201	-96.547778	33.348056	1470	P	1957		47		147		1.3	<	0.4
	Collin	1844801	-96.571944	33.285278	1563	P	1956		100		37		2.8		3
	Collin	1852601	-96.509722	33.185556	1728	U	1951		221		71		2	<	0.4
	Collin	1845603	-96.401944	33.298333	1853	U	1951		108		43		0.6	<	0.4
	Dallas	3224310	-97.021111	32.742500	283	U	1953		144		89		2.6		0.9
	Dallas	3301602	-96.900833	32.953889	320	U	1953		392		447		3.2	<	0.4
	Dallas	3309510	-96.947500	32.813889	397	U	1953		523		156		1.8	<	0.4
	Dallas	3301604	-96.900833	32.953889	410	U	1953		476		366		3.2	<	0.04
	Dallas	3317119	-96.994167	32.747500	412	U	1953		158		72		2.8		2.3
	Dallas	3317106	-96.960000	32.745000	417	P	1958		123		24		1.8		0
	Dallas	3309702	-96.958333	32.756389	460	U	1957		230		35		1.2	<	0.4
	Dallas	3317107	-96.995556	32.746667	460	Z	1957		116		28		1.6	<	0.4
	Dallas	3317105	-96.960000	32.745000	485	P	1958		157		24		1.6		0
	Dallas	3309509	-96.944722	32.813889	494	U	1953		219		107		2	<	0.4
	Dallas	3301603	-96.896111	32.923611	558	U	1957		132		209		0.9		1.8
	Dallas	3309906	-96.897222	32.787222	787	U	1953		291		238		1.8		31
	Dallas	3318802	-96.814167	32.648056	900	P	1956		612		163		1.8	<	0.4
	Dallas	3326305	-96.751667	32.595278	1057	U	1953		484		114		1.4	<	0.4
	Dallas	3319701	-96.717778	32.646944	1130	P	1957		475		115		2.5		3.5
	Dallas	3318701	-96.838611	32.637222	1140	P	1956		528		110		2		0.4
	Dallas	3326303	-96.757222	32.593056	1200	P	1957		462		92		1.8	<	0.4
	Dallas	3318801	-96.815000	32.633333	1210	P	1956		612		163		1.8		0.4
	Dallas	3303404	-96.724722	32.935000	1254	P	1958		353		269		4		0.4
	Dallas	3319202	-96.681944	32.733333	1260	P	1950		389		195		2.4	<	0.4
	Dallas	3319502	-96.682500	32.703889	1280	P	1950		399		188		2.4	<	0.4
	Dallas	3327601	-96.664722	32.546389	1408	U	1959		359		145		3.2		2.9
	Dallas	3311901	-96.647500	32.751389	1421	U	1957		307		234		4		1.3
	Dallas	3312703	-96.606667	32.767222	1475	U	1950		328		454		3.6	<	0.04
	Dallas	3319203	-96.681944	32.732222	1476	U	1950		371		373		2.6		3.5
	Dallas	3320903	-96.539722	32.638889	1550	U	1950		381		604		4	<	0.4
	Dallas	3320802	-96.570278	32.652500	1855	P	1959		380		206				
	Dallas	3320902	-96.540556	32.639167	1860	U	1954		381		572		4.4	<	0.4
	Ellis	3333103	-96.993611	32.483333	699	U	1956		121		65		1.2		2.7
	Ellis	3357203	-96.920556	32.114167	714	S	1951		642		194				5
	Ellis	3342701	-96.867222	32.256944	843	U	1953		586		181		3.6	<	0.4
	Ellis	3349601	-96.889444	32.182778	881	U	1955		504		117		2.2		4.9
	Ellis	3349602	-96.892778	32.179722	935	P	1957		486		112		3.5	<	0.4
	Ellis	3326801	-96.805278	32.513056	944	P	1950		407		99		2	<	0.4
	Ellis	3343301	-96.654722	32.363056	1350	U	1957		16		1320		2	<	0.4
	Ellis	3327901	-96.666111	32.533056	1493	P	1958		312		172		4	<	0.4
	Ellis	3344401	-96.623056	32.326111	1796	U	1953		505		266		2.4	<	0.4
	Ellis	3343602	-96.638056	32.316111	1806	U	1954		473		270		5.5	<	0.4
	Grayson	1809601	-96.905000	33.811944	50	U	1957				87				
	Grayson	1818421	-96.866944	33.683611	95	H	1957		116		26				
	Grayson	1810101	-96.847222	33.840556	130	U	1957				22				
	Grayson	1818301	-96.770833	33.729722	140	P	1958				18				
	Grayson	1809901	-96.890833	33.780556	180	I	1957		27		18		0.2		0
	Grayson	1810406	-96.873056	33.822500	180	I	1957		40		7.2		0.2		0
	Grayson	1811701	-96.745278	33.777222	192	U	1957		3.8		9.5		0.2		0.2
	Grayson	1833302	-96.913333	33.466944	215	U	1958		24		16		0.4		0
	Grayson	1810801	-96.807222	33.785556	285	H	1957				23				
	Grayson	1819101	-96.749444	33.738333	300	H	1958		85		16		2.4		0
	Grayson	1810405	-96.834167	33.809722	308	P	1957				12				
	Grayson	1810702	-96.848333	33.782778	338	U	1958		21		19		0.2		0
	Grayson	1810802	-96.821944	33.783611	345	I	1958		43		22		0.4		0.2
	Grayson	1810902	-96.785833	33.777778	354	U	1958				14				
	Grayson	1818902	-96.765833	33.630556	410	U	1958		50		20		1.2		1
	Grayson	1811802	-96.668333	33.759722	443	I	1958		31		12		0.4		0.5
	Grayson	1819303	-96.657778	33.714722	620	U	1957		104		18		0.6		0.2
	Grayson	1819602	-96.663889	33.706389	642	U	1957		48		18		0.8		2
	Grayson	1819304	-96.657222	33.709444	688	U	1957		69		21		0.7		1.5
	Grayson	1829301	-96.408333	33.610278	709	P	1958		39		14		0.7		1.2
	Grayson	1820721	-96.595000	33.642222	730	U	1956		72		25				
	Grayson	1835402	-96.734167	33.454167	730	U	1958		42		19		0.4		0
	Grayson	1835401	-96.747222	33.448889	734	U	1953		65		28		1.4		0.4
	Grayson	1835401	-96.747222	33.448889	734	U	1956		1281		114		2		6
	Grayson	1819702	-96.718889	33.627778	770	N	1953		62		17				
	Grayson	1819701	-96.712500	33.627222	772	N	1951		55		15				
	Grayson	1820707	-96.620556	33.646111	786	P	1958		72		66		0.6		0.5
	Grayson	1820710	-96.624167	33.648333	789	P	1958		24		8.5		0.5		0.8
	Grayson	1819307	-96.657222	33.711111	801	U	1957		15		11		0.5		0.2
	Grayson	1820711	-96.593611	33.657222	955	P	1958		32		10		0.5		0
	Grayson	1828103	-96.604722	33.583889	1023	P	1959		62		18				
	Grayson	1828702	-96.611667	33.503611	1069	P	1958		118		33		1.4		3
	Grayson	1829901	-96.389444	33.513056	1160	P	1950		109		138		1.8		
	Grayson	1829701	-96.484722	33.520833	1180	P	1958		99		104		1.6		1
	Grayson	1829902	-96.390000	33.513056	1189	P	1958		108		56		1.4		2
	Grayson	1836502	-96.576111	33.423333	1401	P	1958		74		19		0.8		0
	Grayson	1836506	-96.575833	33.422500	1411	U	1951		85		28		0.9		
	Hill	3263904	-97.143611	32.011111	200	U	1955		173		67		1.1	<	0.4
	Hill	3263905	-97.141111	32.011111	200	U	1955		127		39		0.9		3.5
	Hill	3263906	-97.144722	32.013056	200	U	1955		158		43		0.8		4.9
	Hill	3263901	-97.143056	32.008889	200	U	1957		180		52		1.2		1.8
	Hill	3255901	-97.150556	32.161111	293	U	1953		132		32		0.4	<	0.4

Decade	County Name	State Well ID	Longitude	Latitude	Well Depth	Primary Water Use	Year Collected	Sulfate Flag	Sulfate (Mg/L)	Chloride Flag	Chloride (Mg/L)	Fluoride Flag	Fluoride (Mg/L)	Nitrate Flag	Nitrate (Mg/L)
	Hill	3255903	-97.140556	32.162500	312	P	1955		74		28		0.4	<	0.4
	Hill	4008301	-97.005278	31.967778	726	P	1959		600		340		5	<	0.4
	Johnson	3247801	-97.181111	32.268333	210	P	1952		183		43		0.7		0.4
	Johnson	3247805	-97.181111	32.269167	273	P	1952		345		75		0.4		0.4
	Johnson	3240401	-97.102500	32.431944	380	U	1951		259		28		0.4		0.9
	Johnson	3240402	-97.102500	32.431944	380	P	1959		199		19		0.5	<	0.4
	Tarrant	3207501	-97.204444	32.933889	17	H	1953		179		85		0.8		0
	Tarrant	3215801	-97.190000	32.766111	48	U	1953		52		31		0.2		1.8
	Tarrant	3224601	-97.037500	32.705556	125	H	1953		315		50		0.4		5.9
	Tarrant	3216706	-97.105833	32.777500	150	U	1953		91		37				2.5
	Tarrant	3232101	-97.092778	32.586111	165	H	1953		81		17		1.2		2.5
	Tarrant	3231602	-97.141944	32.565556	200	U	1950		181		40				3.5
	Tarrant	3231601	-97.141389	32.563056	200	U	1956		40		32		0.3		1.6
	Tarrant	3215503	-97.185556	32.808611		H	1951		195		258				6.5
1960s	Collin	1850201	-96.796944	33.233611	619	P	1967		288		294		4.2	<	0.4
	Collin	1843203	-96.669444	33.348333	714	U	1963		348		92		2.7		0.4
	Collin	3302302	-96.785833	32.993056	806	P	1961		438		616		3		0.6
	Collin	1843204	-96.666944	33.347778	1216	P	1963		348		92		2.7	<	0.4
	Collin	1859202	-96.675556	33.102222	1400	P	1967		212		69		2.6		3.7
	Collin	1844201	-96.547778	33.348056	1470	P	1969		51		50		1.2		3
	Collin	1845101	-96.461944	33.363056	1509	P	1969		152		45		1.7	<	0.4
	Collin	1852301	-96.509444	33.232500	1577	P	1968		197		66		1.5	<	0.4
	Collin	1845603	-96.401944	33.298333	1853	U	1960		153		78		0.7	<	0.4
	Collin	1845801	-96.426667	33.277500	1900	P	1966		45		25		0.9	<	0.4
	Dallas	3301602	-96.900833	32.953889	320	U	1962		343		430		3.3	<	0.4
	Dallas	3317103	-96.960278	32.738611	417	P	1963		323		53		2.2	<	0.4
	Dallas	3317106	-96.960000	32.745000	417	P	1963		302		62		2.1	<	0.4
	Dallas	3325104	-96.961944	32.613889	801	P	1961		179		22		0.7		0
	Dallas	3317902	-96.906389	32.652222	810	U	1969		472		85		2.3	<	0.4
	Dallas	3320103	-96.588611	32.722500	840	P	1967		352		378		4.5		1.5
	Dallas	3318202	-96.807500	32.744444	860	N	1961		504		166		3.4		0
	Dallas	3325201	-96.956389	32.589167	892	P	1969		270		21		0.9	<	0.4
	Dallas	3325203	-96.956389	32.588056	895	P	1969		268		21		0.9	<	0.4
	Dallas	3326401	-96.855833	32.552222	946	P	1964		410		95		1.7	<	0.4
	Dallas	3326103	-96.856944	32.589167	950	U	1968		570		133		3	<	0.4
	Dallas	3319501	-96.703333	32.668056	1044	P	1965		492		128		2.7	<	0.4
	Dallas	3319701	-96.717778	32.646944	1130	P	1961		495		109		1.6	<	0.4
	Dallas	3318701	-96.838611	32.637222	1140	P	1962		360		75		1.8		4.9
	Dallas	3326303	-96.757222	32.593056	1200	P	1966		435		94		1.9	<	0.4
	Dallas	3318801	-96.815000	32.633333	1210	P	1962		374		75		2		4.9
	Dallas	3303404	-96.724722	32.935000	1254	P	1967		436		285		3.6		3.5
	Dallas	3311802	-96.681111	32.788611	1330	U	1961		424		131		2.6		0.2
	Dallas	3319704	-96.725000	32.640000	1353	P	1963		500		107		3	<	0.4
	Dallas	3327603	-96.653333	32.563889	1360	H	1965				222				
	Dallas	3304101	-96.623889	32.978889	1388	S	1961		374		375		4.1		0.5
	Dallas	3327602	-96.664444	32.546944	1390	P	1967		344		162		3.7		0.2
	Dallas	3319302	-96.639722	32.734722	1400	P	1962		312		310		3.7		3.8
	Dallas	3311901	-96.647500	32.751389	1421	U	1962		343		237		3.7		4.2
	Dallas	3319601	-96.638056	32.705278	1471	P	1962		348		295		3.3		6
	Dallas	3327501	-96.668611	32.553056	1500	U	1965				180				
	Dallas	3327605	-96.634444	32.565278	1645	N	1969		285		213		3.1		6
	Dallas	3320902	-96.540556	32.639167	1860	U	1963		363		610		4.6	<	0.4
	Denton	1964701	-97.088611	33.018889	62	S	1969		243		199		0.6		24.5
	Denton	1964310	-97.031389	33.095833	144	P	1966		164		38		0.6	<	0.4
	Denton	1964206	-97.069444	33.101111	183	P	1966		30		77		0.3	<	0.4
	Denton	1964311	-97.023889	33.106944	215	P	1966		246		73		2.9	<	0.4
	Denton	1964205	-97.060278	33.108889	235	P	1966		110		52		0.2	<	0.4
	Denton	1964204	-97.043056	33.109167	255	P	1966		36		25		0.2		0.5
	Denton	1964314	-97.006667	33.093889	278	P	1966		500		373		3.2	<	0.4
	Denton	1857506	-96.921111	33.081944	335	P	1966		158		158		3.1	<	0.4
	Denton	1857505	-96.921944	33.075833	363	P	1966		180		150		3.4	<	0.4
	Denton	1849701	-96.959444	33.163056	364	U	1961		61		21		1.5		0.2
	Denton	1857202	-96.941389	33.096944	404	P	1966		169		75		2.7	<	0.4
	Ellis	3248503	-97.071389	32.315278	349	H	1965		94		22				
	Ellis	3248501	-97.072500	32.298889	367	H	1965		118		25		1.3		0.2
	Ellis	3248901	-97.017778	32.258611	384	U	1965		353		51				
	Ellis	3248602	-97.012500	32.307222	410	P	1961		139		38		1.8		
	Ellis	3248903	-97.039167	32.258056	430	H	1965		106		24				
	Ellis	3328702	-96.617500	32.529444	450	H	1965		11		1540				
	Ellis	3333302	-96.912222	32.466667	500	H	1965		344		39				
	Ellis	3248601	-97.013611	32.309444	507	U	1965		144		39		1.9	<	0.4
	Ellis	3232902	-97.029722	32.520278	530	H	1965		292		19		0.7		0.2
	Ellis	3333201	-96.942222	32.471667	619	H	1965		720		192				
	Ellis	3341901	-96.900000	32.278889	620	H	1965		656		151				
	Ellis	3341802	-96.935833	32.269167	632	S	1965		296		76				
	Ellis	3333401	-96.999167	32.429722	642	H	1965		550		101				
	Ellis	3349208	-96.948889	32.248056	668	H	1965		304		63				
	Ellis	3349402	-96.966111	32.177222	672	H	1965		620		104				
	Ellis	3349801	-96.952500	32.151389	680	H	1965		444		274				9.9
	Ellis	3325904	-96.902500	32.537222	688	H	1965		624		140		2.8		0.2
	Ellis	3326701	-96.873333	32.513333	692	H	1965		532		144		2.2		0
	Ellis	3333702	-96.994722	32.410833	695	S	1961		572		82		2.3		4.2
	Ellis	3325501	-96.955556	32.546389	697	H	1965		944		218		1.3		2
	Ellis	3333103	-96.993611	32.483333	699	U	1964		274		51		1.5	<	0.4
	Ellis	3325801	-96.941111	32.510278	709	S	1965		510		299				
	Ellis	3357203	-96.920556	32.114167	714	S	1965		664		270				
	Ellis	3349102	-96.975833	32.237500	719	H	1965		402		85				
	Ellis	3341202	-96.947500	32.346111	727	H	1965		93		25		1.2		0.2
	Ellis	3341401	-96.959722	32.325278	728	S	1965		207		58				
	Ellis	3325901	-96.883889	32.525833	735	P	1965		278		50		1.1		3

Decade	County Name	State Well ID	Longitude	Latitude	Well Depth	Primary Water Use	Year Collected	Sulfate Flag	Sulfate (Mg/L)	Chloride Flag	Chloride (Mg/L)	Fluoride Flag	Fluoride (Mg/L)	Nitrate Flag	Nitrate (Mg/L)
	Ellis	3333202	-96.943333	32.465000	754	H	1965		188		19				
	Ellis	3240601	-97.006111	32.429722	759	S	1965		250		19				
	Ellis	3357205	-96.934444	32.085000	822	H	1965		151		48		1.4		0.2
	Ellis	3325702	-96.987778	32.520833	824	H	1965		470		59		2.1		0
	Ellis	3342404	-96.872778	32.327500	836	H	1965		340		532				
	Ellis	3342701	-96.867222	32.256944	843	U	1961		498		178		3.6		0.8
	Ellis	3357202	-96.945000	32.125000	900	P	1965		516		79		2		0.2
	Ellis	3326702	-96.856944	32.512222	900	H	1965		544		408				3
	Ellis	3334101	-96.853333	32.459722	902	H	1965		492		108				
	Ellis	3349604	-96.899722	32.187778	903	H	1965		480		108				
	Ellis	3349602	-96.892778	32.179722	935	P	1967		493		103		3.9	<	0.4
	Ellis	3334203	-96.828056	32.489167	940	H	1965		404		88				
	Ellis	3326801	-96.805278	32.513056	944	P	1965		398		159		1.8		1.5
	Ellis	3326901	-96.754167	32.531389	950	H	1965		414		134		2.4		0
	Ellis	3334204	-96.833056	32.471944	968	H	1965		300		56		1.6		2.8
	Ellis	3350301	-96.778889	32.247222	990	H	1965		448		300				
	Ellis	3334402	-96.834167	32.439444	997	H	1965		454		135				
	Ellis	3334202	-96.825000	32.482500	1000	H	1965		416		79				
	Ellis	3334404	-96.837778	32.444722	1000	P	1965		440		142		3.2		3.2
	Ellis	3342104	-96.855278	32.338056	1019	H	1965		296		78		2.8		1.8
	Ellis	3342401	-96.850000	32.328056	1026	H	1965		518		82				
	Ellis	3350401	-96.860556	32.185278	1050	H	1965		458		132				
	Ellis	3350101	-96.847500	32.226389	1050	H	1965		388		118				
	Ellis	3334502	-96.793333	32.423889	1080	H	1965		394		140				
	Ellis	3334803	-96.824444	32.398333	1091	H	1965		240		70				
	Ellis	3326805	-96.825000	32.531389	1100	P	1967		421		117		2.2	<	0.4
	Ellis	3326802	-96.803889	32.518611	1171	P	1967		358		79		2		2
	Ellis	3334802	-96.796667	32.408333	1180	H	1965		274		84				
	Ellis	3350503	-96.792500	32.181389	1185	H	1965		382		118		5.2		0.2
	Ellis	3350502	-96.791944	32.204444	1238	U	1965		498		172		5.7		0
	Ellis	3342901	-96.770833	32.291111	1238	P	1965		426		164		4.7		3.5
	Ellis	3343701	-96.736944	32.280556	1240	U	1965		432		210		5.9		0.8
	Ellis	3342201	-96.793889	32.368611	1285	H	1965		304		86		3.5		0.2
	Ellis	3335401	-96.735278	32.441667	1295	Z	1965		344		118		5.1		0
	Ellis	3334601	-96.753611	32.448889	1302	H	1965		464		84		3.2		2.8
	Ellis	3335701	-96.740556	32.377778	1303	U	1965		320		105		4.3		0
	Ellis	3335702	-96.748333	32.386111	1321	P	1965		352		105		3.6		0.2
	Ellis	3343301	-96.654722	32.363056	1350	U	1965		22		1290				4.5
	Ellis	3343401	-96.718889	32.327222	1350	H	1965		340		157				
	Ellis	3327801	-96.706111	32.516111	1447	U	1965		416		146				
	Ellis	3335501	-96.668611	32.429722	1472	U	1961		284		448		3.9		0.2
	Ellis	3327901	-96.666111	32.533056	1493	P	1967		395		197		4.1	<	0.4
	Ellis	3343801	-96.694167	32.265833	1517	P	1961		418		239		5.1		0.2
	Ellis	3343801	-96.694167	32.265833	1517	P	1968		428		256		6.4	<	0.4
	Ellis	3335503	-96.668611	32.430278	1522	P	1965		316		114		4		0
	Ellis	3343901	-96.649167	32.250000	1659	U	1965		480		400				1.2
	Ellis	3336802	-96.576944	32.414444	1703	H	1965		328		940				0.8
	Ellis	3344401	-96.623056	32.326111	1796	U	1966		456		264		5.6	<	0.4
	Ellis	3343602	-96.638056	32.316111	1806	U	1966		468		257		6	<	0.4
	Ellis	3344402	-96.622222	32.325000	1821	U	1966		478		278		6	<	0.4
	Ellis	3336201	-96.569444	32.461667	1982	U	1969		449		234		5.4		4
	Grayson	1818302	-96.751111	33.742500	165	U	1969		26		8		0.8	<	0.4
	Grayson	1811802	-96.668333	33.759722	443	I	1968		24		10		0.4	<	0.4
	Grayson	1811803	-96.669722	33.758611	458	P	1967		24		10		0.4		5
	Grayson	1811805	-96.680833	33.752778	496	N	1962		28		11				
	Grayson	1829301	-96.408333	33.610278	709	P	1964		37		14		0.9	<	0.4
	Grayson	1835401	-96.747222	33.448889	734	U	1967		46		19		0.5	<	0.4
	Grayson	1828301	-96.534722	33.612778	745	H	1966		20		4		0.8	<	0.4
	Grayson	1820707	-96.620556	33.646111	786	P	1966		73		26		0.7	<	0.4
	Grayson	1820710	-96.624167	33.648333	789	P	1969		32		11		0.5	<	0.4
	Grayson	1828503	-96.549444	33.568056	856	U	1965		238		104		0.7	<	0.4
	Grayson	1820711	-96.593611	33.657222	955	P	1969		73		29		0.7	<	0.4
	Grayson	1820401	-96.603889	33.670000	1012	P	1969		21		11		0.5	<	0.4
	Grayson	1835601	-96.644722	33.453333	1023	P	1967		74		29		1.7	<	0.4
	Grayson	1828103	-96.604722	33.583889	1023	P	1969		56		14		0.9		0.5
	Grayson	1820801	-96.577222	33.638889	1025	P	1966		26		9		1.2		0.3
	Grayson	1828104	-96.611111	33.604722	1112	U	1962		149		63				
	Grayson	1829901	-96.389444	33.513056	1160	P	1962		100		87		2	<	0.4
	Grayson	1829701	-96.484722	33.520833	1180	P	1964		97		102		2.1	<	0.4
	Grayson	1829902	-96.390000	33.513056	1189	P	1962		110		45		1.3	<	0.4
	Grayson	1828502	-96.579167	33.555278	1260	P	1967		99		29		1		1.4
	Grayson	1828703	-96.608056	33.510556	1298	P	1968		96		28		1.4		4
	Grayson	1836502	-96.576111	33.423333	1401	P	1962		75		24		0.8		2.8
	Hill	3254501	-97.301111	32.202222	40	U	1960		47		28				9
	Hill	4007501	-97.181111	31.921111	185	S	1968		600		114		2.3		2.5
	Hill	3255304	-97.151111	32.230000	273	U	1968		472		96		0.9	<	0.4
	Hill	3255905	-97.140000	32.149722	300	U	1960		466		56				0.2
	Hill	4008101	-97.084444	31.983889	480	H	1968		494		131		2.9	<	0.4
	Hill	3256101	-97.083889	32.208611	488	U	1960		201		25		0.8		0.2
	Hill	3264801	-97.071667	32.017500	595	H	1968		454		89		4.5		0.5
	Hill	4008301	-97.005278	31.967778	726	P	1968		620		335		4.2	<	0.4
	Hill	3357103	-96.998889	32.086944	727	N	1965		245		64		2.2	<	0.4
	Hill	3357601	-96.896389	32.056389	832	P	1969		470		157		3.4	<	0.4
	Hill	3901102	-96.989722	31.994444	870	S	1968		670		550		4.1	<	0.4
	Hill	3902101	-96.873333	31.991111	915	U	1962		474		481		4.3	<	0.4
	Johnson	3254201	-97.312500	32.234444	18	S	1966		164		78		0.2		0
	Johnson	3246902	-97.260000	32.272500	137	S	1966		261		85				
	Johnson	3247403	-97.233333	32.297222	152	S	1966		500		74		0.5		2
	Johnson	3247504	-97.205556	32.320556	187	H	1966		62		25		0.7		1.2
	Johnson	3239502	-97.172500	32.455278	197	H	1966		656		129				

Decade	County Name	State Well ID	Longitude	Latitude	Well Depth	Primary Water Use	Year Collected	Sulfate Flag	Sulfate (Mg/L)	Chloride Flag	Chloride (Mg/L)	Fluoride Flag	Fluoride (Mg/L)	Nitrate Flag	Nitrate (Mg/L)
	Johnson	3247901	-97.136389	32.286944	210	S	1966		916		78				
	Johnson	3239102	-97.236111	32.467222	215	H	1966		256		31		1		0.2
	Johnson	3247202	-97.169444	32.339722	216	H	1966		147		25		0.4		0.2
	Johnson	3231801	-97.188056	32.504167	217	H	1961		152		90		0.5		0.5
	Johnson	3231901	-97.144167	32.505556	220	H	1966		104		20		0.6		0
	Johnson	3247102	-97.231389	32.364722	220	H	1966		374		105		0.4		0
	Johnson	3247806	-97.181111	32.271944	224	P	1964		120		36		0.7	<	0.4
	Johnson	3239801	-97.186667	32.392222	225	H	1966		108		19				
	Johnson	3255101	-97.217778	32.241667	235	H	1966		194		38				
	Johnson	3247804	-97.166944	32.271944	237	H	1966		415		71		3		0.5
	Johnson	3231802	-97.189167	32.504722	240	H	1966		181		24		1		0
	Johnson	3239103	-97.235833	32.465833	244	H	1966		214		27				
	Johnson	3247302	-97.125000	32.365833	256	H	1966		58		20		0.9		0.2
	Johnson	3239802	-97.199167	32.415833	263	H	1966		298		58				
	Johnson	3248702	-97.118333	32.272778	265	H	1961		70		20		1.1		2.2
	Johnson	3239201	-97.203056	32.483889	270	S	1966		137		22				
	Johnson	3247805	-97.181111	32.269167	273	P	1966		192		42		0.5		0.2
	Johnson	3247601	-97.154722	32.321667	310	H	1966		109		31		1.4		0.5
	Johnson	3239605	-97.125278	32.423889	310	H	1966		207		15				
	Johnson	3240402	-97.102500	32.431944	380	P	1961		223		21		0.7		0
	Johnson	3239101	-97.242222	32.497778		H	1966		242		120		0.4		0
	Tarrant	3208505	-97.079722	32.955278	197	P	1968		33		63				
	Tarrant	3231602	-97.141944	32.565556	200	U	1963		150		32		0.5	<	0.4
	Tarrant	3231604	-97.142500	32.564722	200	U	1965		167		29		0.6		1.5
1970s	Collin	1850201	-96.796944	33.233611	619	P	1976		40		13		1.1		0.6
	Collin	1850201	-96.796944	33.233611	619	P	1977		320		280		3.7	<	0.4
	Collin	1842603	-96.773611	33.328611	771	H	1976		105		115		2.6	<	0.4
	Collin	3302302	-96.785833	32.993056	806	P	1977		479		640		3.3		0.8
	Collin	1859101	-96.739444	33.123056	952	N	1977		190		128		2.6		2.4
	Collin	1850301	-96.783056	33.244444	958	P	1976		48		14		0.9	<	0.4
	Collin	1850901	-96.786667	33.155556	1050	H	1976		171		56		2.8		1.2
	Collin	1858901	-96.788889	33.009444	1067	P	1977		450		393		3.9		1.4
	Collin	1851701	-96.710278	33.152500	1104	H	1976		241		152		2.7	<	0.4
	Collin	1844702	-96.620556	33.260278	1136	N	1976		109		30		1.3		0.5
	Collin	1851901	-96.659722	33.128611	1209	N	1976		316		69		2.2	<	0.4
	Collin	1859501	-96.676389	33.081944	1210	H	1977		333		325		4		7
	Collin	1843204	-96.666944	33.347778	1216	P	1976		398		79		3	<	0.4
	Collin	1859302	-96.626944	33.095000	1415	H	1974		203		59		3.7		3.2
	Collin	1859303	-96.648889	33.099722	1483	P	1975		200		73		2.6		2.6
	Collin	1845101	-96.461944	33.363056	1509	P	1976		136		49		1.3	<	0.4
	Collin	1844202	-96.547500	33.348889	1559	P	1976		119		66		1.3	<	0.4
	Collin	1844801	-96.571944	33.285278	1563	P	1976		85		122		1.5		0.5
	Collin	1852301	-96.509444	33.232500	1577	P	1976		201		64		1.6	<	0.4
	Collin	1844601	-96.501389	33.294167	1783	U	1976		50		16		0.8	<	0.4
	Collin	1845603	-96.401944	33.298333	1853	U	1976		107		60		0.9	<	0.4
	Collin	1845604	-96.401944	33.298333	1900	P	1976		89		36		0.7	<	0.4
	Collin	1845801	-96.426667	33.277500	1900	P	1977		47		22		0.9		0.4
	Collin	1846402	-96.339722	33.302500	2032	P	1976		98		40		1.1	<	0.4
	Cooke	1932802	-97.068333	33.541389	60	U	1972		426		457		0.7	<	0.4
	Cooke	1940101	-97.110833	33.495000	70	H	1976		28		132		0.2		1.9
	Cooke	1940301	-97.003889	33.486389	105	H	1977		68		39		0.2		1.2
	Cooke	1825402	-96.976389	33.545278	190	H	1976		14		31		0.2		0.4
	Cooke	1817401	-96.978333	33.687222	235	S	1977		29		30		0.4	<	0.4
	Dallas	3303802	-96.697500	32.894167	25	U	1971		45		15		0.4	<	0.4
	Dallas	3216907	-97.024722	32.774167	190	I	1975		540		65		1.5		4.7
	Dallas	3309705	-96.999167	32.771944	190	H	1975		184		33		1.7	<	0.4
	Dallas	3216908	-97.023056	32.773889	191	I	1975		216		32		2.2	<	0.4
	Dallas	3317401	-96.992778	32.687222	250	H	1971		98		40		2.7	<	0.4
	Dallas	3301803	-96.916944	32.887222	258	N	1975		421		257		4.4		5.6
	Dallas	3216906	-97.024722	32.775000	286	I	1975		184		39		2.3		2.9
	Dallas	3208602	-97.005278	32.955000	293	U	1972		63		21		0.7	<	0.4
	Dallas	3317403	-96.991111	32.682778	300	I	1976		73		42		2.2		0.6
	Dallas	3232301	-97.031111	32.618056	314	H	1971		44		10		1.6	<	0.4
	Dallas	3224603	-97.026944	32.691111	319	P	1975		142		26		2.7		3.7
	Dallas	3224901	-97.011389	32.642778	356	H	1976		96		17		1.2	<	0.4
	Dallas	3224604	-97.016389	32.668611	391	P	1975		146		31		0.7		2.4
	Dallas	3309511	-96.929167	32.792222	405	P	1975		497		96		1.7		2.7
	Dallas	3216601	-97.011944	32.832500	439	U	1975		428		186		4.2		3
	Dallas	3317408	-96.979444	32.703611	440	I	1976		146		21		1.1		2.6
	Dallas	3224902	-97.013611	32.652222	446	I	1975		84		17		2.2		2.1
	Dallas	3309708	-96.958611	32.767778	450	N	1975		209		35		1.4		3.1
	Dallas	3309801	-96.931944	32.776111	475	N	1975		457		76		2.2		1
	Dallas	3309301	-96.905000	32.873056	490	N	1975		108		61		1.5		2
	Dallas	3317204	-96.953333	32.741944	502	N	1975		137		25		2		1.3
	Dallas	3309512	-96.931111	32.809722	505	N	1975		550		133		3.4		4
	Dallas	3301903	-96.914167	32.875278	523	N	1974		702		240			<	0.4
	Dallas	3317205	-96.922500	32.749722	534	H	1976		405		72		1.6		4.3
	Dallas	3301502	-96.927500	32.916944	550	N	1975		470		218		4.4		3.2
	Dallas	3310503	-96.812222	32.791944	770	N	1975		520		186		3.9		4.6
	Dallas	3309906	-96.897222	32.787222	787	U	1975		145		261		0.6		4.7
	Dallas	3325104	-96.961944	32.613889	801	P	1975		176		16		0.9	<	0.4
	Dallas	3317902	-96.906389	32.652222	810	U	1975		580		128		2.4	<	0.4
	Dallas	3318305	-96.788056	32.746667	817	N	1975		520		137		3.7		5.5
	Dallas	3317904	-96.905000	32.648889	828	I	1975		471		89		2		2.7
	Dallas	3325201	-96.956389	32.589167	892	P	1975		282		30		0.9	<	0.4
	Dallas	3325203	-96.956389	32.588056	895	P	1975		274		26		0.7		4.1
	Dallas	3318308	-96.781944	32.743611	939	N	1975		520		92		2.5		5
	Dallas	3326401	-96.855833	32.552222	946	P	1971		327		63		1.5	<	0.4
	Dallas	3326103	-96.856944	32.589167	950	U	1976		590		133		2.6	<	0.4
	Dallas	3326402	-96.858056	32.556389	958	P	1976		380		100		1.4		5

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	Dallas	3326202	-96.825000	32.603611	1040	N	1975		468		107		2	<	0.4
	Dallas	3326101	-96.856944	32.588889	1046	P	1975		600		128		2.7	<	0.4
	Dallas	3302902	-96.782222	32.912222	1047	I	1975		399		241		4.1	<	0.4
	Dallas	3326406	-96.870556	32.566389	1050	I	1975		448		99		3.7		3.3
	Dallas	3326403	-96.855833	32.551944	1089	P	1975		278		92		1.6		1.6
	Dallas	3326602	-96.773056	32.573333	1121	H	1976		500		94		2.7		5
	Dallas	3319701	-96.717778	32.646944	1130	P	1970		486		114		2.2		4.5
	Dallas	3310301	-96.760833	32.856111	1154	I	1971		415		161		3.8	<	0.4
	Dallas	3326303	-96.757222	32.593056	1200	P	1976		463		98		1.8	<	0.4
	Dallas	3303404	-96.724722	32.935000	1254	P	1977		445		286		3.8	<	0.04
	Dallas	3327203	-96.702222	32.622500	1276	U	1975		445		149		3.5		4.7
	Dallas	3311802	-96.681111	32.788611	1330	U	1976		422		99		2.3	<	0.4
	Dallas	3319704	-96.725000	32.640000	1353	P	1976		471		113		2.3	<	0.4
	Dallas	3327602	-96.664444	32.546944	1390	P	1975		570		176		3.9	<	0.4
	Dallas	3319301	-96.630556	32.731389	1600	P	1971		109		78		1.9		1
	Dallas	3327605	-96.634444	32.565278	1645	N	1975		363		214		4	<	0.4
	Denton	1841202	-96.926389	33.371111	20	H	1971		79		134		0.9		6
	Denton	1964102	-97.107222	33.097222	35	S	1976		319		433		0.8		191
	Denton	1964603	-97.024444	33.076111	40	S	1970		356		492		0.9		294
	Denton	1964103	-97.107500	33.116389	60	H	1976		28		12		0.3		5.4
	Denton	1956602	-97.037500	33.183056	60	I	1977		28		23		0.3		1.9
	Denton	1841301	-96.909167	33.374444	102	H	1971		415		46		2.3	<	0.4
	Denton	1841203	-96.917222	33.361111	125	H	1971		49		20		0.6	<	0.4
	Denton	1833803	-96.936389	33.380278	130	H	1971		62		27		0.3	<	0.4
	Denton	1964702	-97.096944	33.004722	134	P	1974		108		60		0.3		3.5
	Denton	1964801	-97.081389	33.002222	140	P	1974		96		28		1.2		2.5
	Denton	1964310	-97.031389	33.095833	144	P	1976		156		36		0.4	<	0.4
	Denton	1964703	-97.099722	33.001111	150	P	1974		147		53		0.7		3.7
	Denton	3208109	-97.089167	32.997778	150	P	1974		168		68		0.8		3.9
	Denton	1964104	-97.092222	33.109722	150	I	1976		17		38		0.6		0.5
	Denton	3208203	-97.077222	32.995556	160	P	1974		135		45		0.5	<	0.4
	Denton	1833902	-96.912222	33.389444	180	H	1971		66		34		0.4	<	0.4
	Denton	1964704	-97.105556	33.008611	180	P	1974		87		62		0.3		1.7
	Denton	1964206	-97.069444	33.101111	183	P	1976		57		112		0.3	<	0.4
	Denton	1849808	-96.934167	33.129167	200	P	1976		92		45		3.6		2.4
	Denton	1964101	-97.099722	33.083611	200	H	1976		119		83	<	0.1		4.5
	Denton	1833904	-96.904444	33.383889	204	H	1971		384		23		2	<	0.4
	Denton	1841201	-96.928333	33.363333	210	I	1976		69		28		0.4	<	0.4
	Denton	1964315	-97.011111	33.094444	212	P	1976		530		378		2.9		5
	Denton	1964311	-97.023889	33.106944	215	P	1976		226		69		2.3	<	0.4
	Denton	1849905	-96.900833	33.161667	227	H	1976		114		117		1.2	<	0.4
	Denton	1964302	-97.017222	33.110556	235	H	1970		90		34		3.4	<	0.4
	Denton	1964205	-97.060278	33.108889	235	P	1976		93		48		0.2		3.5
	Denton	1964602	-97.035556	33.076111	255	H	1970		148		29		0.6	<	0.4
	Denton	1964901	-97.040278	33.033889	260	H	1976		73		32		1.3	<	0.4
	Denton	1833805	-96.920278	33.390833	270	H	1971		22		12		0.4	<	0.4
	Denton	1849901	-96.886667	33.154167	275	H	1971		408		370		3.4		3.3
	Denton	1964314	-97.006667	33.093889	278	P	1976		510		376		2.8		6
	Denton	1964909	-97.032500	33.023889	280	H	1975		45		15		3.1		0.5
	Denton	1964912	-97.035833	33.022778	280	H	1975		49		12		2.2		2.6
	Denton	1833809	-96.938611	33.376944	280	I	1976		52		20		0.3	<	0.4
	Denton	1833903	-96.912222	33.389444	285	H	1971		70		35		0.4	<	0.4
	Denton	1964910	-97.035278	33.023611	286	H	1975		55		13		1.9		2.7
	Denton	1964911	-97.033889	33.023889	287	H	1975		51		14		2.5		2.7
	Denton	1841205	-96.936389	33.336389	288	I	1976		136		66		0.4	<	0.4
	Denton	1964907	-97.031667	33.023056	290	H	1975		55		17		4.1	<	0.4
	Denton	1841501	-96.948056	33.310278	291	I	1976		77		31		0.3		3.1
	Denton	1964913	-97.035278	33.021111	294	H	1975		50		13		2.1	<	0.4
	Denton	1833802	-96.957778	33.382500	298	H	1971		38		17		0.8	<	0.4
	Denton	1841302	-96.885833	33.361111	300	H	1971		52		21		0.5		1.5
	Denton	1964914	-97.034722	33.020278	300	U	1975		54		19		1.1		4.9
	Denton	1833808	-96.955278	33.388611	300	I	1976		84		39		0.5	<	0.4
	Denton	1964908	-97.031667	33.023889	301	H	1975		42		14		3.4		2.6
	Denton	1964306	-97.004444	33.106389	308	P	1976		115		44		2.5		1.7
	Denton	1964915	-97.017222	33.019722	310	H	1975		371		209		2.6	<	0.4
	Denton	1857506	-96.921111	33.081944	335	P	1976		181		160		3.1		2.8
	Denton	1849505	-96.956667	33.180278	360	P	1977		281		58		0.3	<	0.4
	Denton	1857505	-96.921944	33.075833	363	P	1976		158		145		3.3		0.7
	Denton	1849704	-96.973889	33.136944	365	P	1973		125		43		3.2		0.4
	Denton	1849504	-96.954167	33.175833	368	P	1977		244		55		0.3		3.9
	Denton	1849703	-96.971389	33.142222	372	P	1977		60		24		2.8	<	0.4
	Denton	1849903	-96.898889	33.159167	380	H	1976		67		28		1.5	<	0.4
	Denton	1849904	-96.898611	33.159722	380	H	1976		54		21		1.4		1.1
	Denton	1833804	-96.933611	33.376944	400	I	1971		55		40		0.3	<	0.4
	Denton	1849807	-96.944167	33.142500	402	P	1976		53		26		1.6	<	0.4
	Denton	1857202	-96.941389	33.096944	404	P	1976		163		73		2.4		3
	Denton	1849801	-96.917222	33.141944	420	H	1976		81		32		2.3	<	0.4
	Denton	1857603	-96.911111	33.064167	530	N	1976		106		20		0.8		0.9
	Denton	1849602	-96.890278	33.168611	570	P	1976		288		256		2.4	<	0.4
	Denton	1857303	-96.890278	33.106111	596	P	1975		203		88		2.7		0.8
	Ellis	3232803	-97.062778	32.512222	355	H	1971		168		17		0.7	<	0.4
	Ellis	3232804	-97.062500	32.514722	357	S	1975		181		18		0.8	<	0.4
	Ellis	3248501	-97.072500	32.298889	367	H	1976		162		31		1.4		3.9
	Ellis	3248901	-97.017778	32.258611	384	U	1972		332		53		2.6		2.5
	Ellis	3240305	-97.026389	32.481667	543	U	1972		295		21		0.7	<	0.4
	Ellis	3341101	-96.989167	32.338889	641	P	1978		118		31		1.5		2.43
	Ellis	3240607	-97.026111	32.456389	659	N	1976		142		22		0.5		3.9
	Ellis	3333702	-96.994722	32.410833	695	S	1978		452		68		1		1
	Ellis	3325706	-96.978333	32.532778	700	P	1972		1030		175		2.4	<	0.4
	Ellis	3341202	-96.947500	32.346111	727	H	1971		104		33		1.2		1.5

Decade	County Name	State Well ID	Longitude	Latitude	Well Depth	Primary Water Use	Year Collected	Sulfate Flag	Sulfate (Mg/L)	Chloride Flag	Chloride (Mg/L)	Fluoride Flag	Fluoride (Mg/L)	Nitrate Flag	Nitrate (Mg/L)
	Ellis	3325901	-96.883889	32.525833	735	P	1971		359		59		1.7		3.5
	Ellis	3333106	-96.978056	32.476111	735	N	1975		136		19		0.9		2.6
	Ellis	3325708	-96.982778	32.528889	744	P	1975		429		51		1.9		3.6
	Ellis	3333501	-96.924167	32.455278	780	H	1976		315		34		0.7		2.8
	Ellis	3341502	-96.942778	32.325556	802	P	1975		355		94		4.1		5.1
	Ellis	3357206	-96.944444	32.124444	865	P	1976		533.5		67		1.5		0
	Ellis	3357202	-96.945000	32.125000	900	P	1975		540		67		2.2		4
	Ellis	3325907	-96.891944	32.527778	913	P	1975		348		64		2.1		0.8
	Ellis	3334405	-96.843333	32.457778	922	N	1975		224		56		1.3		4.3
	Ellis	3349602	-96.892778	32.179722	935	P	1975		483		107		3.5	<	0.4
	Ellis	3349606	-96.895556	32.180556	939	N	1975		550		111		3.8	<	0.4
	Ellis	3326801	-96.805278	32.513056	944	P	1976		409		99		1.8	<	0.4
	Ellis	3326901	-96.754167	32.531389	950	H	1970		398		135		2.4	<	0.4
	Ellis	3325601	-96.880000	32.545556	955	P	1975		520		100		1.8		8
	Ellis	3325602	-96.879722	32.542500	960	P	1977		326		61		1.7		0.22
	Ellis	3334205	-96.826667	32.498056	967	S	1971		374		77		1.5	<	0.4
	Ellis	3326705	-96.873611	32.536111	1005	P	1975		323		58		1.8		3.2
	Ellis	3342105	-96.848333	32.336389	1063	P	1977		320		78		2.8		1.1
	Ellis	3326815	-96.826389	32.523056	1100	P	1976		342		50		1.3	<	0.4
	Ellis	3326805	-96.825000	32.531389	1100	P	1977		443		91		1.5		1.09
	Ellis	3326818	-96.811667	32.517222	1158	P	1978		290		98.5		1.3		0
	Ellis	3326802	-96.803889	32.518611	1171	P	1975		394		73		2.3		2
	Ellis	3326802	-96.803889	32.518611	1171	P	1976		344		72		1.9	<	0.4
	Ellis	3350502	-96.791944	32.204444	1238	U	1976		175		176		2.8		0.5
	Ellis	3342901	-96.770833	32.291111	1238	P	1977		395		126		4.8		6.29
	Ellis	3335702	-96.748333	32.386111	1321	P	1979		338		118		4.4		0.31
	Ellis	3343401	-96.718889	32.327222	1350	H	1975		349		160		5.6	<	0.4
	Ellis	3328703	-96.615278	32.524722	1350	P	1976		296		277		4.9		0.4
	Ellis	3343101	-96.726389	32.345278	1370	P	1979		334		118		4.5		0.44
	Ellis	3327801	-96.706111	32.516111	1447	U	1971		142		266		2.8		1.5
	Ellis	3343702	-96.737500	32.280278	1480	P	1977		442		229		5.4		7.57
	Ellis	3327901	-96.666111	32.533056	1493	P	1975		520		181		4.5	<	0.4
	Ellis	3343801	-96.694167	32.265833	1517	P	1977		450		244		5.6		6.99
	Ellis	3335503	-96.668611	32.430278	1522	P	1975		299		118		4.6		9
	Ellis	3336201	-96.569444	32.461667	1982	U	1976		400		240		5.1		6
	Grayson	1810603	-96.782222	33.811667	125	P	1977		15		11	<	0.1		2.6
	Grayson	1818409	-96.862500	33.667778	129	I	1976		456		58		0.5		5.1
	Grayson	1818101	-96.833611	33.708611	135	I	1976		16		6		0.2		0.9
	Grayson	1818301	-96.770833	33.729722	140	P	1978		110		20		1.2	<	0.4
	Grayson	1818410	-96.857222	33.680278	141	I	1976		438		93		0.8		0.9
	Grayson	1818414	-96.858889	33.679167	145	I	1976		413		23		0.7	<	0.4
	Grayson	1818406	-96.857222	33.690833	150	I	1976		436		30		0.5		3.2
	Grayson	1818407	-96.873889	33.667222	160	I	1976		139		24		0.7	<	0.4
	Grayson	1818302	-96.751111	33.742500	165	U	1978		27		17		0.7	<	0.4
	Grayson	1813803	-96.438333	33.754167	200	H	1976		24		11		0.1		19
	Grayson	1809501	-96.942500	33.825000	205	H	1976		9		10		0.2	<	0.4
	Grayson	1833602	-96.916389	33.441111	220	I	1976		129		36		0.3		5.8
	Grayson	1810601	-96.780556	33.793889	234	H	1976		41		11		0.4		0.4
	Grayson	1810103	-96.844722	33.838333	235	H	1977		22		13		1.5		0.4
	Grayson	1818405	-96.856111	33.690833	250	I	1976		201		21		0.4		1.2
	Grayson	1833501	-96.923611	33.436389	279	I	1976		61		23		0.3	<	0.4
	Grayson	1825301	-96.907222	33.587778	280	H	1976		13		25		0.3	<	0.4
	Grayson	1811804	-96.682222	33.775278	281	P	1974		18		11		0.3	<	0.4
	Grayson	1810801	-96.807222	33.785556	285	H	1977		41		20		0.3		2.9
	Grayson	1817601	-96.878333	33.680833	290	I	1976		112		36		0.3		0.9
	Grayson	1818418	-96.847222	33.680833	300	P	1975		152		24		0.5	<	0.4
	Grayson	1825610	-96.891111	33.548056	300	I	1976		17		74		0.2		0.4
	Grayson	1819101	-96.749444	33.738333	300	H	1978		77		77		2.2	<	0.4
	Grayson	1821901	-96.388611	33.653056	301	H	1976		87		17		0.3	<	0.4
	Grayson	1825608	-96.889444	33.559167	309	I	1976		17		21		0.3	<	0.4
	Grayson	1825609	-96.904722	33.580833	310	I	1976		53		19		0.4	<	0.4
	Grayson	1818420	-96.847222	33.682500	310	P	1977		114		33		0.3	<	0.4
	Grayson	1833502	-96.925556	33.420556	317	I	1976		70		17		0.4	<	0.4
	Grayson	1825302	-96.893333	33.584167	320	I	1976		40		23		0.3	<	0.4
	Grayson	1825606	-96.884444	33.569444	320	I	1976		36		22		0.2	<	0.4
	Grayson	1825611	-96.896944	33.571944	321	I	1976		34		23		0.2	<	0.4
	Grayson	1825607	-96.878333	33.560000	330	I	1976		87		23		0.4	<	0.4
	Grayson	1826404	-96.870833	33.546667	340	I	1976		72		22		0.4	<	0.4
	Grayson	1811901	-96.659167	33.765556	341	P	1976		21		7		0.4	<	0.4
	Grayson	1825901	-96.905000	33.530278	352	I	1976		30		21		0.2	<	0.4
	Grayson	1826401	-96.870556	33.554444	355	I	1976		45		22		0.3	<	0.4
	Grayson	1818401	-96.864722	33.684722	356	I	1976		124		20		0.4	<	0.4
	Grayson	1811801	-96.680000	33.763611	375	N	1976		17		7		0.3	<	0.4
	Grayson	1820501	-96.542222	33.698611	380	P	1977		550		107		3.7		4.47
	Grayson	1834601	-96.777778	33.436944	387	U	1973		1300		285		2.5		11
	Grayson	1818901	-96.770556	33.627500	390	H	1976		109		13		1		1.2
	Grayson	1834101	-96.847778	33.458611	400	S	1971		38		14		0.5	<	0.4
	Grayson	1818701	-96.855000	33.657778	420	I	1976		920		41		0.7		7
	Grayson	1818903	-96.769167	33.629444	420	P	1976		42		6		0.9		
	Grayson	1825605	-96.876944	33.573889	425	I	1976		111		12		0.6	<	0.4
	Grayson	1826101	-96.863889	33.621667	446	P	1976		48		20		0.3		4.1
	Grayson	1811803	-96.669722	33.758611	458	P	1977		27		11		0.3	<	0.4
	Grayson	1811805	-96.680833	33.752778	496	N	1977		34		10		0.9	<	0.4
	Grayson	1827701	-96.708611	33.531667	613	H	1976	<	4		890		2.6		4.8
	Grayson	1820101	-96.621944	33.708611	630	H	1971		36		30		0.5	<	0.4
	Grayson	1819801	-96.697500	33.650833	632	H	1977	<	4		910		2.5	<	0.4
	Grayson	1827201	-96.696111	33.623611	670	P	1979		56		28		1.9		3.2
	Grayson	1827204	-96.671389	33.607500	690	H	1979		196		30		2.6		2.9
	Grayson	1829301	-96.408333	33.610278	709	P	1976		42		15		1	<	0.4
	Grayson	1835401	-96.747222	33.448889	734	U	1976		23		20		0.3	<	0.4

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	Grayson	1819701	-96.712500	33.627222	772	N	1977		63		12		0.7	<	0.4
	Grayson	1820707	-96.620556	33.646111	786	P	1977		84		52		0.6	<	0.4
	Grayson	1819301	-96.657500	33.710556	788	U	1976		146		14		0.6	<	0.4
	Grayson	1820710	-96.624167	33.648333	789	P	1977		35		40		0.7		0.4
	Grayson	1819302	-96.657500	33.711667	790	P	1971		124		11		0.6	<	0.4
	Grayson	1819501	-96.670833	33.676111	865	N	1977		19		7		0.8	<	0.4
	Grayson	1819901	-96.657778	33.625556	872	N	1971		30		11		1	<	0.4
	Grayson	1827203	-96.683333	33.621111	900	H	1979		32		882		2.2	<	0.04
	Grayson	1827205	-96.700000	33.619722	945	H	1979		73		13		0.7		1.5
	Grayson	1827801	-96.701667	33.532500	950	P	1973		72		12		0.8		1
	Grayson	1820711	-96.593611	33.657222	955	P	1977		30		11		0.5	<	0.4
	Grayson	1829103	-96.465556	33.603889	970	P	1974		29		10		0.7		1.5
	Grayson	1820401	-96.603889	33.670000	1012	P	1972		19		12		0.4	<	0.4
	Grayson	1828103	-96.604722	33.583889	1023	P	1977		57		14		0.8	<	0.4
	Grayson	1820801	-96.577222	33.638889	1025	P	1977		61		158		0.8	<	0.4
	Grayson	1820804	-96.563889	33.635833	1044	P	1977		40		11		0.9	<	0.4
	Grayson	1828402	-96.612222	33.572778	1050	P	1977		80		17		0.9	<	0.4
	Grayson	1827804	-96.672222	33.525000	1061	P	1979		122		14		0.9	<	0.04
	Grayson	1828702	-96.611667	33.503611	1069	P	1970		94		28		1.7		3.5
	Grayson	1828403	-96.602778	33.547222	1090	P	1977		100		57		1.8	<	0.4
	Grayson	1828705	-96.619444	33.529444	1134	P	1977		53		16		0.8	<	0.4
	Grayson	1829901	-96.389444	33.513056	1160	P	1972		106		75		3	<	0.4
	Grayson	1829701	-96.484722	33.520833	1180	P	1976		141		55		1.6		0.5
	Grayson	1829902	-96.390000	33.513056	1189	P	1972		109		45		1.9	<	0.4
	Grayson	1829703	-96.482222	33.504444	1224	P	1977		324		142		1.5		0
	Grayson	1828603	-96.540556	33.572778	1250	P	1976		70		20		0.9	<	0.4
	Grayson	1829903	-96.398333	33.508611	1257	P	1972		133		34		0.9	<	0.4
	Grayson	1828502	-96.579167	33.555278	1260	P	1977		96		24		1.2	<	0.4
	Grayson	1828703	-96.608056	33.510556	1298	P	1970		60		16		0.9	<	0.4
	Grayson	1829801	-96.441389	33.526111	1331	P	1975		103		26		1		2.2
	Grayson	1829904	-96.390556	33.508611	1388	P	1976		136		30		1	<	0.4
	Grayson	1836502	-96.576111	33.423333	1401	P	1971		75		19		1.2		1
	Grayson	1829702	-96.485000	33.520556	1475	P	1976		142		39		1.5	<	0.4
	Grayson	1837602	-96.401667	33.427778	1598	P	1978		176.7		44.2		1.3		0
	Grayson	1837601	-96.401944	33.422778	1638	P	1977		179		42		1.2		1
	Hill	3255701	-97.226111	32.126389	166	H	1971		251		60		0.6	<	0.4
	Hill	3255903	-97.140556	32.162500	312	P	1974		82		64		1.1		0.8
	Hill	3264704	-97.115278	32.032222	315	H	1970		101		20		0.8		1.5
	Hill	3264307	-97.006944	32.095833	520	S	1970		750		199		2.8	<	0.4
	Hill	3264801	-97.071667	32.017500	595	H	1974		341		85		4.2		3.5
	Hill	3264604	-97.018889	32.058889	700	H	1970		187		52		2.6		3.5
	Hill	3357601	-96.896389	32.056389	832	P	1978		487		172		3	<	0.09
	Johnson	3238501	-97.300833	32.452778	33	H	1970		116		31		0.3		56
	Johnson	3248403	-97.086944	32.293056	135	H	1976		391		71		1.7		3.6
	Johnson	3247807	-97.207500	32.271944	160	H	1970		420		67		2.8	<	0.4
	Johnson	3246209	-97.320000	32.351111	160	I	1975		294		139		0.9		6
	Johnson	3239502	-97.172500	32.455278	197	H	1970		180		57		0.7		3
	Johnson	3247801	-97.181111	32.268333	210	P	1973		192		44		0.7		9
	Johnson	3231902	-97.153333	32.515556	212	N	1975		102		22		0.7		6
	Johnson	3239901	-97.157222	32.385278	220	H	1970		158		29		0.5		7
	Johnson	3247810	-97.179444	32.288333	220	N	1975		117		32		1.4		8
	Johnson	3248101	-97.111944	32.370833	225	H	1970		231		23		0.8	<	0.4
	Johnson	3231802	-97.189167	32.504722	240	H	1976		183		28		0.9		1.5
	Johnson	3232701	-97.114167	32.524722	240	H	1976		126		43		0.4		0.4
	Johnson	3239602	-97.155000	32.421111	250	H	1975		183		22		0.3		8
	Johnson	3247809	-97.175278	32.262778	255	I	1975		118		64		0.5		0.9
	Johnson	3247304	-97.145833	32.347778	260	H	1976		60		22		1	<	0.4
	Johnson	3239201	-97.203056	32.483889	270	S	1976		126		24		0.6		7
	Johnson	3247805	-97.181111	32.269167	273	P	1975		580		80		0.8		14
	Johnson	3239302	-97.145000	32.476944	276	H	1975		102		21		0.6		9
	Johnson	3232704	-97.108611	32.536111	300	H	1976		462		19		0.3	<	0.4
	Johnson	3240402	-97.102500	32.431944	380	P	1976		188		18		0.5	<	0.4
	Johnson	3238701	-97.370556	32.388333	700	H	1970		47		17		0.6	<	0.4
	Tarrant	3215302	-97.135000	32.857222	50	H	1970		42		151		0.3		27
	Tarrant	3231203	-97.179722	32.608056	50	N	1975		34		82		0.3		7
	Tarrant	3208108	-97.121944	32.981944	70	P	1974		48		35		0.4		1.7
	Tarrant	3231311	-97.155833	32.619167	70	I	1978		10		72		0.3		2.4
	Tarrant	3207907	-97.143889	32.895833	87	I	1976		25		67		0.7		2.7
	Tarrant	3223308	-97.155556	32.719722	98	I	1975		70		44		0.4		38
	Tarrant	3207903	-97.142778	32.891111	103	P	1975		37		34		0.3		17
	Tarrant	3208703	-97.122778	32.897500	105	I	1975		3.8		7		0.6	<	0.4
	Tarrant	3208704	-97.118611	32.892500	110	I	1976		47		115		0.1		44
	Tarrant	3208705	-97.123333	32.894167	110	I	1976		40		21		0.1		2.3
	Tarrant	3207102	-97.225278	32.959722	125	P	1974		5		13		0.2		10
	Tarrant	3223601	-97.131389	32.686667	135	U	1970		256		154		0.9	<	0.4
	Tarrant	3208106	-97.101111	32.978056	145	P	1973		131		71		0.4	<	0.4
	Tarrant	3223310	-97.143333	32.713889	160	I	1975		30		16		0.4	<	0.4
	Tarrant	3223906	-97.148611	32.626111	160	I	1978		92		46		0.4		1.1
	Tarrant	3208105	-97.102500	32.965278	170	P	1974		55		56		0.4		2.1
	Tarrant	3231109	-97.223333	32.588611	170	P	1979		41		46		0.2	<	0.1
	Tarrant	3231301	-97.162222	32.590000	171	H	1970		9		13		0.5	<	0.4
	Tarrant	3208104	-97.084722	32.959167	177	P	1973		56		56		0.3	<	0.4
	Tarrant	3223607	-97.143611	32.666944	180	I	1975		219		87		0.7	<	0.4
	Tarrant	3207911	-97.130000	32.891667	185	I	1975		76		132		0.2		22
	Tarrant	3208504	-97.075000	32.955556	187	P	1974		33		42		0.3	<	0.4
	Tarrant	3208107	-97.093056	32.964722	195	P	1974		56		63		0.3	<	0.4
	Tarrant	3208505	-97.079722	32.955278	197	P	1974		65		58		0.3	<	0.4
	Tarrant	3208202	-97.065556	32.982222	200	P	1974		50		28		0.8		2.3
	Tarrant	3223608	-97.141111	32.666944	200	I	1976		228		117		0.3	<	0.4
	Tarrant	3231310	-97.156667	32.618611	210	I	1978		16		18		0.7	<	0.4

Decade	County Name	State Well ID	Longitude	Latitude	Well Depth	Primary Water Use	Year Collected	Sulfate Flag	Sulfate (Mg/L)	Chloride Flag	Chloride (Mg/L)	Fluoride Flag	Fluoride (Mg/L)	Nitrate Flag	Nitrate (Mg/L)
	Tarrant	3231313	-97.153889	32.616667	210	H	1978		49		35		0.4	<	0.4
	Tarrant	3216801	-97.073056	32.778056	217	H	1970		179		35		0.8		4.5
	Tarrant	3208201	-97.066944	32.958333	238	P	1972		40		56		0.3		1.5
	Tarrant	3232404	-97.113611	32.553611	270	H	1975		95		18		0.6	<	0.4
	Tarrant	3216802	-97.072778	32.776111	285	H	1975		168		32		1	<	0.4
	Tarrant	3232202	-97.068056	32.606111	289	P	1975		67		12		1.2		2.2
	Tarrant	3231312	-97.138611	32.616389	295	I	1978								
	Tarrant	3223905	-97.137500	32.636111	310	S	1977		560		47		2.5	<	0.4
	Tarrant	3223901	-97.130000	32.645833	338	N	1975		28		28		0.6		4.7
	Tarrant	3224404	-97.115833	32.676944	344	P	1975		54		25		0.8	<	0.4
	Tarrant	3224502	-97.049722	32.703889	350	N	1972		190		18				
	Tarrant	3224505	-97.050556	32.694722	395	I	1975		144		22		1	<	0.4
1980s	Collin	1850201	-96.796944	33.233611	619	P	1987		42		12		1.1		1.28
	Collin	1842603	-96.773611	33.328611	771	H	1988								
	Collin	1850301	-96.783056	33.244444	958	P	1983		46		16		0.3		0.04
	Collin	1850901	-96.786667	33.155556	1050	H	1983		157		57		2.8		1.24
	Collin	1851701	-96.710278	33.152500	1104	H	1983		251		162		2.7		1.28
	Collin	1859601	-96.633611	33.048611	1130	I	1984		193		1274		3.5	<	0.1
	Collin	1844702	-96.620556	33.260278	1136	N	1983		111		31		1.2		1.82
	Collin	1851901	-96.659722	33.128611	1209	N	1983		228		75		2.2		0.18
	Collin	1843204	-96.666944	33.347778	1216	P	1987		391		79		3	<	0.04
	Collin	1851902	-96.657778	33.151944	1415	H	1983		163		50		1.8		0
	Collin	1859302	-96.626944	33.095000	1415	H	1987		201		60		2.9		0.13
	Collin	1844504	-96.581944	33.295000	1476	P	1985		56		18		1		0
	Collin	1845101	-96.461944	33.363056	1509	P	1983		154		48		1.3	<	0.04
	Collin	1844803	-96.572778	33.283889	1512	P	1987		204		129		1.6		0
	Collin	1844202	-96.547500	33.348889	1559	P	1983		123		70		1.3		2.61
	Collin	1844801	-96.571944	33.285278	1563	P	1983		98		155		1.5		0.53
	Collin	1852301	-96.509444	33.232500	1577	P	1987		183		65		1.5		0.09
	Collin	1852301	-96.509444	33.232500	1577	P	1988		186		60		1.5		0.04
	Collin	1844902	-96.501111	33.290556	1753	N	1983		55		17		0.8		0.93
	Collin	1845603	-96.401944	33.298333	1853	U	1987		7		8521		0.7	<	0.04
	Collin	1845604	-96.401944	33.298333	1900	P	1983		110		64		0.8		0.04
	Collin	1845301	-96.402222	33.338056	1927	P	1988								
	Collin	1845802	-96.421111	33.274444	1954	P	1983		60		28		1.4		0
	Collin	1846402	-96.339722	33.302500	2032	P	1983		106		39		1	<	0.04
	Cooke	1940101	-97.110833	33.495000	70	H	1982		37		69		0.1		9.44
	Cooke	1825402	-96.976389	33.545278	190	H	1983		13		27		0.1		0
	Cooke	1817401	-96.978333	33.687222	235	S	1987		30		29		0.4		2.88
	Dallas	3224901	-97.011389	32.642778	356	H	1983		95		15		1.2		0.35
	Dallas	3317410	-96.991944	32.683056	463	P	1987		61		27		2.2		0.09
	Dallas	3309301	-96.905000	32.873056	490	N	1987		455		229		3.9	<	0.04
	Dallas	3325104	-96.961944	32.613889	801	P	1987		173		18		0.7	<	0.04
	Dallas	3317902	-96.906389	32.652222	810	U	1983		582		125		2.2	<	0.04
	Dallas	3318305	-96.788056	32.746667	817	N	1987		503		175		3.2	<	0.04
	Dallas	3317904	-96.905000	32.648889	828	I	1987		496		84		1.7		0.04
	Dallas	3325203	-96.956389	32.588056	895	P	1987		284		23		0.7	<	0.04
	Dallas	3326401	-96.855833	32.552222	946	P	1987		411		92		1.3	<	0.04
	Dallas	3302903	-96.778611	32.912500	1031	I	1987		428		241		3.6	<	0.04
	Dallas	3318702	-96.843889	32.631111	1045	H	1983		557		112		3.1		0
	Dallas	3319701	-96.717778	32.646944	1130	P	1983		518		117		2.2	<	0.04
	Dallas	3310301	-96.760833	32.856111	1154	I	1983		383		175		3.5	<	0.04
	Dallas	3327602	-96.664444	32.546944	1390	P	1987		356		192		3.2	<	0.04
	Denton	1833803	-96.936389	33.380278	130	H	1989		13		7	<	0.1		0.04
	Denton	1849805	-96.925000	33.158333	150	H	1983		265		97		0.9		0.8
	Denton	1964901	-97.040278	33.033889	260	H	1987		72		34		1.5	<	0.04
	Denton	1833808	-96.955278	33.388611	300	I	1983		91		42		0.5	<	0.04
	Denton	1849104	-96.963333	33.232778	305	H	1989		68		17		3.8	<	0.04
	Denton	1964306	-97.004444	33.106389	308	P	1989		104		45		2.5	<	0.04
	Denton	1849906	-96.909722	33.165833	350	P	1987		112		104		1.8	<	0.04
	Denton	1849403	-96.965833	33.168611	355	P	1987		61		17		1.2		0.01
	Denton	1849701	-96.959444	33.163056	364	U	1989		63		19		1.5	<	0.04
	Denton	1849801	-96.917222	33.141944	420	H	1983		81		33		2.4		0.71
	Denton	1857603	-96.911111	33.064167	530	N	1983		202		110		3.5		0.04
	Denton	1858701	-96.855833	33.024444	858	P	1983		112		16		0.9	<	0.04
	Ellis	3232803	-97.062778	32.512222	355	H	1987		173		18		0.7	<	0.04
	Ellis	3248901	-97.017778	32.258611	384	U	1983		354		54		2.3		0.35
	Ellis	3248602	-97.012500	32.307222	410	P	1987		140		39		1.8	<	0.04
	Ellis	3240309	-97.015278	32.473333	588	N	1985		152		19		0.7		0
	Ellis	3341101	-96.989167	32.338889	641	P	1984		113		32		1.5		3.76
	Ellis	3240307	-97.016667	32.463889	650	N	1987		142		20		0.5	<	0.04
	Ellis	3325901	-96.883889	32.525833	735	P	1983		257		50		1.1		0
	Ellis	3325710	-96.979722	32.529167	772	P	1983		722		138		3.2	<	0.04
	Ellis	3333501	-96.924167	32.455278	780	H	1983		332		34		0.7		1.37
	Ellis	3325406	-96.967500	32.545278	855	H	1983		640		123		2.9	<	0.04
	Ellis	3357206	-96.944444	32.124444	865	P	1983		537		59		1.5	<	0.04
	Ellis	3341204	-96.949444	32.374444	870	N	1983		146		35		1.2	<	0.04
	Ellis	3357202	-96.945000	32.125000	900	P	1987		504		63		1.8	<	0.04
	Ellis	3349602	-96.892778	32.179722	935	P	1988								
	Ellis	3349606	-96.895556	32.180556	939	N	1987		501		110		3.5	<	0.04
	Ellis	3326801	-96.805278	32.513056	944	P	1983		384		223		1.8	<	0.04
	Ellis	3325602	-96.879722	32.542500	960	P	1983		310		63		1.7	<	0.04
	Ellis	3326805	-96.825000	32.531389	1100	P	1986		403		102		1		0.04
	Ellis	3334104	-96.865000	32.481111	1100	P	1987		392		64		1.2		
	Ellis	3334209	-96.829167	32.466389	1110	P	1985		352.9		92		2.4		
	Ellis	3326821	-96.823611	32.530833	1120	P	1988		420		58		1.4		0
	Ellis	3326820	-96.805000	32.524167	1170	P	1987		440		106		2		0
	Ellis	3326822	-96.813056	32.536389	1178	P	1985		450		84		2.6		0
	Ellis	3334211	-96.823889	32.465000	1180	P	1987		333		89.5		2.2		
	Ellis	3326903	-96.781389	32.531389	1195	P	1985		294		318.2		2.8		0

Decade	County Name	State Well ID	Longitude	Latitude	Well Depth	Primary Water Use	Year Collected	Sulfate Flag	Sulfate (Mg/L)	Chloride Flag	Chloride (Mg/L)	Fluoride Flag	Fluoride (Mg/L)	Nitrate Flag	Nitrate (Mg/L)
	Ellis	3350502	-96.791944	32.204444	1238	U	1983		470		181		5.4		0.04
	Ellis	3342901	-96.770833	32.291111	1238	P	1986		362		128		4.6		0.44
	Ellis	3334307	-96.755000	32.473889	1280	P	1988		500		440		5		
	Ellis	3342201	-96.793889	32.368611	1285	H	1987		303		87		3.4	<	0.04
	Ellis	3335702	-96.748333	32.386111	1321	P	1983		334		131		4.4		5.58
	Ellis	3335504	-96.685556	32.433056	1440	P	1985		265.5		100		4.8		0
	Ellis	3343204	-96.690000	32.370278	1445	U	1985		333.5		147.2		4		0
	Ellis	3343802	-96.695000	32.263611	1450	P	1980		370		190		5.3		0
	Ellis	3343702	-96.737500	32.280278	1480	P	1986		465		241		5.2		3.94
	Ellis	3335503	-96.668611	32.430278	1522	P	1988								
	Ellis	3336201	-96.569444	32.461667	1982	U	1986		418		240		5.2		1.55
	Ellis	3336206	-96.564722	32.466111	2020	P	1987		432		242.2		4.5		
	Grayson	1818301	-96.770833	33.729722	140	P	1989		109		16		1.3		0.27
	Grayson	1813803	-96.438333	33.754167	200	H	1989		27		12	<	0.1		10.41
	Grayson	1809501	-96.942500	33.825000	205	H	1983		9		10		0.2	<	0.04
	Grayson	1810601	-96.780556	33.793889	234	H	1983		41		14		0.4		0.04
	Grayson	1811804	-96.682222	33.775278	281	P	1984		10		10		0.5		0.04
	Grayson	1819101	-96.749444	33.738333	300	H	1986		80		12		2.2	<	0.04
	Grayson	1821901	-96.388611	33.653056	301	H	1987		90		18		0.3		0.04
	Grayson	1825607	-96.878333	33.560000	330	I	1983		100		29		0.3	<	0.04
	Grayson	1811801	-96.680000	33.763611	375	N	1987		16		6		0.3	<	0.04
	Grayson	1820501	-96.542222	33.698611	380	P	1983		539		113		3.8		4.4
	Grayson	1818901	-96.770556	33.627500	390	H	1987		114		14		1		0.4
	Grayson	1801902	-96.900000	33.877222	574	P	1987		84		224		1.2	<	0.04
	Grayson	1829301	-96.408333	33.610278	709	P	1987		222		55		1.7		0.04
	Grayson	1820707	-96.620556	33.646111	786	P	1983		110		202		0.7		0.18
	Grayson	1819301	-96.657500	33.710556	788	U	1987		186		14		0.5		0.22
	Grayson	1810503	-96.831389	33.826944	834	P	1987		91		113		1.7		0.58
	Grayson	1820901	-96.503611	33.634167	950	P	1983		32		10		0.8		0
	Grayson	1827801	-96.701667	33.532500	950	P	1983		64		11		0.8		0.66
	Grayson	1820401	-96.603889	33.670000	1012	P	1983		23		10		0.3	<	0.04
	Grayson	1827804	-96.672222	33.525000	1061	P	1987		106		14		0.9	<	0.04
	Grayson	1828403	-96.602778	33.547222	1090	P	1987		93		44		2	<	0.04
	Grayson	1829701	-96.484722	33.520833	1180	P	1987		106		104		1.8		0.13
	Grayson	1829104	-96.490278	33.591111	1196	P	1986		23		14		0.8		0
	Grayson	1828504	-96.551389	33.557222	1202	P	1987		294		75		0.6		0.04
	Grayson	1828802	-96.566667	33.536389	1207	P	1982		86		22		1.7	<	0.1
	Grayson	1828605	-96.532222	33.575000	1265	P	1983		33		22		0.8		1.3
	Grayson	1828604	-96.524167	33.568889	1339	P	1986		90		14		1	<	0.4
	Grayson	1829904	-96.390556	33.508611	1388	P	1987		136		31		1	<	0.04
	Grayson	1836504	-96.571667	33.435833	1425	P	1983		69		17		0.9	<	0.04
	Grayson	1817909	-96.901944	33.663611	1507	P	1989		48		64		0.4		0.13
	Grayson	1828901	-96.509444	33.516389	1520	P	1989		95		20		0.9	<	0.04
	Grayson	1817908	-96.913333	33.652500	1522	P	1987		49		60		0.4		0.09
	Grayson	1837603	-96.401944	33.423333	1800	P	1986		180.6		47.5		0.9		0
	Hill	3255701	-97.226111	32.126389	166	H	1986		300		67		0.3		0.31
	Hill	4007501	-97.181111	31.921111	185	S	1986		411		93		1.4		2.92
	Hill	3255903	-97.140556	32.162500	312	P	1986		174		27		0.5		0.13
	Hill	3264801	-97.071667	32.017500	595	H	1986		88		68		1.2		0.22
	Hill	3264605	-97.041111	32.077500	670	P	1984		692		281		4.5		2.04
	Hill	4008301	-97.005278	31.967778	726	P	1986		625		293		4.9	<	0.04
	Hill	3357601	-96.896389	32.056389	832	P	1984		502		171		3		0.09
	Johnson	3231806	-97.191944	32.533611	93	H	1983		190		61		0.4		0.04
	Johnson	3238810	-97.320000	32.381944	115	H	1983		356		138		0.5	<	0.04
	Johnson	3230910	-97.260000	32.518333	125	I	1983		511		105		0.3	<	0.04
	Johnson	3239505	-97.181667	32.453611	210	H	1989		193		57		0.5		
	Johnson	3231902	-97.153333	32.515556	212	N	1983		98		21		0.6		2.22
	Johnson	3247202	-97.169444	32.339722	216	H	1989		132		46		0.7		
	Johnson	3239901	-97.157222	32.385278	220	H	1987		160		30		0.4	<	0.04
	Johnson	3247806	-97.181111	32.271944	224	P	1989		251		60		0.3		
	Johnson	3231802	-97.189167	32.504722	240	H	1987		173		72		0.6	<	0.04
	Johnson	3232701	-97.114167	32.524722	240	H	1989		126		39		0.4		1.24
	Johnson	3239705	-97.213889	32.386944	251	H	1983		102		27		1.4		0.71
	Johnson	3247304	-97.145833	32.347778	260	H	1987		78		52		1		1.15
	Johnson	3239106	-97.220556	32.467500	264	P	1985		167		53		0.5		2.48
	Johnson	3239201	-97.203056	32.483889	270	S	1987		126		23		0.6		0.04
	Johnson	3247805	-97.181111	32.269167	273	P	1987		240		49		0.5		7.53
	Johnson	3239309	-97.134722	32.472222	296	P	1983		157		23		0.5		1.33
	Johnson	3239107	-97.209167	32.481944	309	P	1984		136		43		0.5		1.37
	Johnson	3239205	-97.180000	32.498333	309	P	1984		164		32		0.9		0.62
	Johnson	3240410	-97.095833	32.417778	395	P	1984		198		18		0.4		0.3
	Tarrant	3207907	-97.143889	32.895833	87	I	1989		49		40		1.1		0.97
	Tarrant	3223601	-97.131389	32.686667	135	U	1986		211		91		0.7		0.84
	Tarrant	3208106	-97.101111	32.978056	145	P	1983		48		27		0.2	<	0.93
	Tarrant	3223608	-97.141111	32.666944	200	I	1987		214		87		0.4	<	0.04
	Tarrant	3216801	-97.073056	32.778056	217	H	1989		187		35		0.5		0.53
	Tarrant	3231609	-97.132778	32.552222	230	H	1983		341		33		0.5		2.6
	Tarrant	3232404	-97.113611	32.553611	270	H	1983		106		18		0.5		0.09
	Tarrant	3224804	-97.080278	32.628056	271	H	1983		325		38		0.3		0.89
	Tarrant	3232205	-97.066944	32.614722	320	H	1983		47		29		0.6	<	0.04
	Tarrant	3224803	-97.077778	32.648056	336	H	1989		39		19		1		0.31
1990s	Collin	1842602	-96.784167	33.321389	700	P	1997		47.7		40		1.74	<	0.27
	Collin	1850301	-96.783056	33.244444	958	P	1997		52.8		14		0.78	<	0.27
	Collin	1844702	-96.620556	33.260278	1136	N	1993		113		30		1.18		1.78
	Collin	1843204	-96.666944	33.347778	1216	P	1997		374		69.6		3.1	<	0.27
	Collin	1851902	-96.657778	33.151944	1415	H	1997		147		37.4		1.62	<	0.27
	Collin	1844201	-96.547778	33.348056	1470	P	1993		130		37		1.3		0.09
	Collin	1844803	-96.572778	33.283889	1512	P	1997		136		139		1.57	<	0.27
	Collin	1845803	-96.431667	33.276944	1890	P	1991		50		26.9		1		0
	Collin	1845604	-96.401944	33.298333	1900	P	1993		106		65		0.8		0.04

Decade	County Name	State Well ID	Longitude	Latitude	Well Depth	Primary Water Use	Year Collected	Sulfate Flag	Sulfate (Mg/L)	Chloride Flag	Chloride (Mg/L)	Fluoride Flag	Fluoride (Mg/L)	Nitrate Flag	Nitrate (Mg/L)
	Cooke	1932304	-97.013056	33.610000	45	I	1997		522		369		1.34		7.39
	Cooke	1940301	-97.003889	33.486389	105	H	1997		61.2		37.4	<	0.3		1.06
	Cooke	1817401	-96.978333	33.687222	235	S	1993		31		30		0.38		0.13
	Dallas	3224911	-97.017778	32.643611	350	H	1993		46		12		1		0.04
	Dallas	3224909	-97.024167	32.642778	381	P	1998		36.8		18.4		0.97		0.24
	Dallas	3325203	-96.956389	32.588056	895	P	1998		271		21.4		0.52	<	0.22
	Dallas	3326505	-96.817500	32.574444	988	P	1998		428		86.2		1.31	<	0.22
	Dallas	3326408	-96.843889	32.559444	1100	P	1993		339		63		1.2	<	0.04
	Dallas	3303201	-96.701944	32.971667	1277	N	1993		368		235		1.04		0.04
	Dallas	3319704	-96.725000	32.640000	1353	P	1998		490		102		2.09	<	0.22
	Dallas	3327602	-96.664444	32.546944	1390	P	1998		340		180		2.9	<	0.22
	Denton	1956602	-97.037500	33.183056	60	I	1994		45		11.8		0.29		
	Denton	1841207	-96.941667	33.371111	220	I	1998		55.3		23		0.35	<	0.22
	Denton	1964306	-97.004444	33.106389	308	P	1997		102		38.6		2.33	<	0.27
	Denton	1849802	-96.941389	33.162500	317	P	1997		43		14		1.16	<	0.27
	Denton	1849708	-96.969722	33.160556	377	P	1994		58.2		20.9		1.4		0
	Denton	1833804	-96.933611	33.376944	400	I	1993		59		28		0.49		0.04
	Denton	1849801	-96.917222	33.141944	420	H	1993		237		169		1		1.86
	Denton	1857603	-96.911111	33.064167	530	N	1993		196		107		0.99		0.04
	Denton	1858701	-96.855833	33.024444	858	P	1997		347		371		3.74	<	0.27
	Ellis	3248602	-97.012500	32.307222	410	P	1997		144		34.4		1.99	<	0.27
	Ellis	3248605	-97.011111	32.311389	462	P	1993		729		128		1.9		0.09
	Ellis	3357202	-96.945000	32.125000	900	P	1997		521		52.7		1.73	<	0.27
	Ellis	3349602	-96.892778	32.179722	935	P	1997		480		88.7		3.25	<	0.27
	Ellis	3334209	-96.829167	32.466389	1110	P	1993		335		76		0.58		1.64
	Ellis	3334211	-96.823889	32.465000	1180	P	1997		326		64.4		2.34	<	0.27
	Ellis	3326903	-96.781389	32.531389	1195	P	1993		315		306		0.66		0.04
	Ellis	3335504	-96.685556	32.433056	1440	P	1997		309		122		4.01	<	0.27
	Ellis	3343802	-96.695000	32.263611	1450	P	1997		380		188		6.27	<	0.27
	Ellis	3336201	-96.569444	32.461667	1982	U	1993		414		219		1.48		0.09
	Grayson	1810605	-96.782778	33.810833	130	P	1994		39		17		0.2		0.18
	Grayson	1821901	-96.388611	33.653056	301	H	1993		98		18		0.22		0.8
	Grayson	1811801	-96.680000	33.763611	375	N	1993		17		6		0.24		1.46
	Grayson	1811806	-96.668889	33.758611	470	P	1997		27		6.73	<	0.3		2.13
	Grayson	1829301	-96.408333	33.610278	709	P	1997		132		28.9		1.2	<	0.26
	Grayson	1819302	-96.657500	33.711667	790	P	1993		103		11		0.62		0.09
	Grayson	1827801	-96.701667	33.532500	950	P	1997		73.4		9.89		0.68	<	0.27
	Grayson	1820805	-96.560000	33.641667	1022	P	1994		17.5		13.4		0.3		0
	Grayson	1820801	-96.577222	33.638889	1025	P	1997		18.2		8.76		0.34	<	0.27
	Grayson	1828403	-96.602778	33.547222	1090	P	1997		92.8		30		1.64	<	0.27
	Grayson	1829702	-96.485000	33.520556	1475	P	1997		138		29.8		1.16	<	0.27
	Grayson	1828902	-96.518333	33.515000	1502	P	1991		89.2		20		0.9		0
	Grayson	1817909	-96.901944	33.663611	1507	P	1997		40		83		0.32	<	0.27
	Grayson	1817908	-96.913333	33.652500	1522	P	1993		47		69		0.38		0.22
	Grayson	1836602	-96.503056	33.431389	1527	P	1991		105		26.6		1.3		0
	Hill	4007501	-97.181111	31.921111	185	S	1993		553		104		0.83		0.04
	Hill	3255907	-97.150278	32.160833	290	P	1997		61.7		15		0.46	<	0.27
	Hill	3255602	-97.132500	32.169167	340	P	1993		61		16		0.62		0.04
	Hill	3264309	-97.025556	32.085278	575	P	1998		93.6		24.1		0.85	<	0.22
	Hill	3264203	-97.058889	32.084167	640	P	1998		95.9		29.4		0.79		0.36
	Hill	4008301	-97.005278	31.967778	726	P	1993		618		289		1.37		0.09
	Hill	3357602	-96.896389	32.056111	934	P	1998		207		61.5		1.82	<	0.22
	Johnson	3247202	-97.169444	32.339722	216	H	1997		113		40.3		0.53	<	0.27
	Johnson	3239201	-97.203056	32.483889	270	S	1997		116		19.8		0.45	<	0.27
	Johnson	3247805	-97.181111	32.269167	273	P	1997		1263		134		0.38	<	0.27
	Johnson	3240101	-97.113333	32.460000	305	H	1994		309		33		0.4	<	0.04
	Johnson	3239107	-97.209167	32.481944	309	P	1993		141		42		0.46		0.04
	Johnson	3240408	-97.103056	32.432500	390	P	1993		206		17		0.58		0.04
	Tarrant	3224114	-97.121389	32.744444	14	Z	1993		1300		41		1.1	<	0.22
	Tarrant	3224112	-97.091944	32.734722	17	Z	1995		390		76		1.5		31.43
	Tarrant	3216207	-97.074722	32.855833	18	Z	1993		810		57		0.7		0.62
	Tarrant	3223315	-97.150000	32.722500	21	Z	1993		27		11		0.5	<	0.22
	Tarrant	3224115	-97.121389	32.744444	23	Z	1993		1900		73		0.2		2.21
	Tarrant	3216206	-97.083056	32.873611	25	Z	1993		2100		120		5		2.04
	Tarrant	3216208	-97.067222	32.862222	25	Z	1993		340		150		0.3		0.25
	Tarrant	3223206	-97.180556	32.711944	25	Z	1993		2000		1000		0.5	<	0.22
	Tarrant	3223316	-97.139722	32.709444	25	Z	1993		910		410		0.4	<	0.22
	Tarrant	3223508	-97.192778	32.677778	25	Z	1993		2000		3100		0.5	<	0.22
	Tarrant	3223509	-97.183889	32.668611	25	Z	1995		800		110		0.8	<	0.22
	Tarrant	3215608	-97.127778	32.831111	26	Z	1993		81		110		0.3	<	0.22
	Tarrant	3215208	-97.179167	32.860278	27	Z	1993		440		460		0.3	<	0.22
	Tarrant	3216109	-97.087778	32.845278	27	Z	1993		55		67		1		0.38
	Tarrant	3215310	-97.154722	32.853611	28	Z	1995		240		120		0.3		43.8
	Tarrant	3216106	-97.097500	32.833611	29	Z	1993		400		85		2		0.4
	Tarrant	3224111	-97.109722	32.734444	29	Z	1993		360		390		1.7		102
	Tarrant	3224113	-97.091944	32.734722	29	Z	1995		2000		250		1		0.9
	Tarrant	3215309	-97.158611	32.853056	30	Z	1995		3300		1700		0.7	<	0.2
	Tarrant	3223317	-97.135000	32.724444	31	Z	1993		470		150		0.4		43.38
	Tarrant	3216209	-97.067222	32.862222	34	Z	1993		230		100		0.4	<	0.22
	Tarrant	3223510	-97.183889	32.668611	37	Z	1995		260		70		0.2		0.22
	Tarrant	3216205	-97.082500	32.845278	38	Z	1993		74		37		0.6	<	0.22
	Tarrant	3215609	-97.127778	32.831111	42	Z	1993		19		56		0.2	<	0.22
	Tarrant	3216110	-97.087778	32.845278	43	Z	1993		65		120		0.7	<	0.22
	Tarrant	3215311	-97.154722	32.853611	47	Z	1993		360		190		0.4	<	0.22
	Tarrant	3216107	-97.097500	32.833611	49	Z	1993		470		220		1.3		2.26
	Tarrant	3215312	-97.154722	32.853611	58	Z	1993		420		190		0.5	<	0.22
	Tarrant	3224118	-97.121111	32.726944	68	I	1993		180		92		1.2		38.07
	Tarrant	3224116	-97.104722	32.732778	85	I	1993		1400		550		0.3	<	0.22
	Tarrant	3223511	-97.175000	32.672500	100	I	1993		650		300		0.4	<	0.22
	Tarrant	3224203	-97.083333	32.727778	100	I	1993		470		62		1.6		0.24

Decade	County Name	State Well ID	Longitude	Latitude	Well Depth	Primary Water Use	Year Collected	Sulfate Flag	Sulfate (Mg/L)	Chloride Flag	Chloride (Mg/L)	Fluoride Flag	Fluoride (Mg/L)	Nitrate Flag	Nitrate (Mg/L)
	Tarrant	3207903	-97.142778	32.891111	103	P	1997		82.4		97.4	<	0.3		0.8
	Tarrant	3216112	-97.085833	32.859444	120	I	1993		55		38		0.3	<	0.22
	Tarrant	3216111	-97.087778	32.863333	129	I	1993		42		39		0.2	<	0.22
	Tarrant	3215313	-97.143333	32.857500	150	I	1993		55		31		0.5		0.3
	Tarrant	3216210	-97.082778	32.859722	158	I	1993		52		42		0.2	<	0.22
	Tarrant	3231301	-97.162222	32.590000	171	H	1997		5.42		10.8	<	0.3	<	0.27
	Tarrant	3223607	-97.143611	32.666944	180	I	1993		205		81		0.41		0.09
	Tarrant	3215314	-97.146667	32.856944	180	I	1993		61		49		0.4	<	0.22
	Tarrant	3216801	-97.073056	32.778056	217	H	1993		183		34		0.51		2.04
	Tarrant	3224117	-97.112222	32.709167	225	I	1997		101		37.9	<	0.3		6.42
	Tarrant	3207806	-97.203333	32.908611	700	P	1994		54		10		0.67		0.04

NOTE: **Codes For Primary Well Uses**

Code	Primary Well Use Types
H	Domestics
I	Irrigation
N	Industrial
P	Public Supply
S	Stock
U	Unused
Z	Other (refers to miscellaneous uses not included in the listed categories)

APPENDIX C

WATER QUALITY DATA

OF THE WOODBINE AQUIFER

BY COUNTY

County Name	State Well ID	Longitude	Latitude	Well Depth	Primary Water Uses	Year Collected	Sulfate Flag	Sulfate (Mg/L)	Chloride Flag	Chloride (Mg/L)	Fluoride Flag	Fluoride (Mg/L)	Nitrate Flag	Nitrate (Mg/L)
Collin	1850201	-96.796944	33.233611	619	P	1955		322		302		2.8	<	0.4
Collin	1850201	-96.796944	33.233611	619	P	1967		288		294		4.2	<	0.4
Collin	1850201	-96.796944	33.233611	619	P	1976		40		13		1.1		0.6
Collin	1850201	-96.796944	33.233611	619	P	1977		320		280		3.7	<	0.4
Collin	1850201	-96.796944	33.233611	619	P	1987		42		12		1.1		1.28
Collin	1842602	-96.784167	33.321389	700	P	1951		57		36		1.2	<	0.4
Collin	1842602	-96.784167	33.321389	700	P	1997		47.7		40		1.74	<	0.27
Collin	1843203	-96.669444	33.348333	714	U	1963		348		92		2.7		0.4
Collin	1842603	-96.773611	33.328611	771	H	1976		105		115		2.6	<	0.4
Collin	1842603	-96.773611	33.328611	771	H	1988								
Collin	3302302	-96.785833	32.993056	806	P	1961		438		616		3		0.6
Collin	3302302	-96.785833	32.993056	806	P	1977		479		640		3.3		0.8
Collin	1859101	-96.739444	33.123056	952	N	1977		190		128		2.6		2.4
Collin	1850301	-96.783056	33.244444	958	P	1976		48		14		0.9	<	0.4
Collin	1850301	-96.783056	33.244444	958	P	1983		46		16		0.3		0.04
Collin	1850301	-96.783056	33.244444	958	P	1997		52.8		14		0.78	<	0.27
Collin	1850901	-96.786667	33.155556	1050	H	1976		171		56		2.8		1.2
Collin	1850901	-96.786667	33.155556	1050	H	1983		157		57		2.8		1.24
Collin	1858901	-96.788889	33.009444	1067	P	1977		450		393		3.9		1.4
Collin	1851701	-96.710278	33.152500	1104	H	1976		241		152		2.7	<	0.4
Collin	1851701	-96.710278	33.152500	1104	H	1983		251		162		2.7		1.28
Collin	1859601	-96.633611	33.048611	1130	I	1984		193		1274		3.5	<	0.1
Collin	1844702	-96.620556	33.260278	1136	N	1976		109		30		1.3		0.5
Collin	1844702	-96.620556	33.260278	1136	N	1983		111		31		1.2		1.82
Collin	1844702	-96.620556	33.260278	1136	N	1993		113		30		1.18		1.78
Collin	1859701	-96.711944	33.021667	1180	U	1956		437		401		1.4		1.3
Collin	1851901	-96.659722	33.128611	1209	N	1976		316		69		2.2	<	0.4
Collin	1851901	-96.659722	33.128611	1209	N	1983		228		75		2.2		0.18
Collin	1859501	-96.676389	33.081944	1210	H	1977		333		325		4		7
Collin	1843204	-96.666944	33.347778	1216	P	1963		348		92		2.7	<	0.4
Collin	1843204	-96.666944	33.347778	1216	P	1976		398		79		3	<	0.4
Collin	1843204	-96.666944	33.347778	1216	P	1987		391		79		3	<	0.04
Collin	1843204	-96.666944	33.347778	1216	P	1997		374		69.6		3.1	<	0.27
Collin	1852402	-96.608333	33.190833	1272	U	1950		464		192		0.6	<	0.4
Collin	1859201	-96.675556	33.102222	1300	U	1959		235		139		2.8		2.7
Collin	1859202	-96.675556	33.102222	1400	P	1967		212		69		2.6		3.7
Collin	1859302	-96.626944	33.095000	1415	H	1974		203		59		3.7		3.2
Collin	1851902	-96.657778	33.151944	1415	H	1983		163		50		1.8		0
Collin	1859302	-96.626944	33.095000	1415	H	1987		201		60		2.9		0.13
Collin	1851902	-96.657778	33.151944	1415	H	1997		147		37.4		1.62	<	0.27
Collin	1844802	-96.572500	33.284444	1462	U	1952		101		1264		2.2		2.7
Collin	1844201	-96.547778	33.348056	1470	P	1957		47		147		1.3	<	0.4
Collin	1844201	-96.547778	33.348056	1470	P	1969		51		50		1.2		3
Collin	1844201	-96.547778	33.348056	1470	P	1993		130		37		1.3		0.09
Collin	1844504	-96.581944	33.295000	1476	P	1985		56		18		1		0
Collin	1859303	-96.648889	33.099722	1483	P	1975		200		73		2.6		2.6
Collin	1845101	-96.461944	33.363056	1509	P	1969		152		45		1.7	<	0.4
Collin	1845101	-96.461944	33.363056	1509	P	1976		136		49		1.3	<	0.4
Collin	1845101	-96.461944	33.363056	1509	P	1983		154		48		1.3	<	0.04
Collin	1844803	-96.572778	33.283889	1512	P	1987		204		129		1.6		0
Collin	1844803	-96.572778	33.283889	1512	P	1997		136		139		1.57	<	0.27
Collin	1844202	-96.547500	33.348889	1559	P	1976		119		66		1.3	<	0.4
Collin	1844202	-96.547500	33.348889	1559	P	1983		123		70		1.3		2.61
Collin	1844801	-96.571944	33.285278	1563	P	1956		100		37		2.8		3
Collin	1844801	-96.571944	33.285278	1563	P	1976		85		122		1.5		0.5
Collin	1844801	-96.571944	33.285278	1563	P	1983		98		155		1.5		0.53
Collin	1852301	-96.509444	33.232500	1577	P	1968		197		66		1.5	<	0.4
Collin	1852301	-96.509444	33.232500	1577	P	1976		201		64		1.6	<	0.4
Collin	1852301	-96.509444	33.232500	1577	P	1987		183		65		1.5		0.09
Collin	1852301	-96.509444	33.232500	1577	P	1988		186		60		1.5		0.04
Collin	1852601	-96.509722	33.185556	1728	U	1951		221		71		2	<	0.4
Collin	1844902	-96.501111	33.290556	1753	N	1983		55		17		0.8		0.93
Collin	1844601	-96.501389	33.294167	1783	U	1976		50		16		0.8	<	0.4
Collin	1845603	-96.401944	33.298333	1853	U	1951		108		43		0.6	<	0.4
Collin	1845603	-96.401944	33.298333	1853	U	1960		153		78		0.7	<	0.4
Collin	1845603	-96.401944	33.298333	1853	U	1976		107		60		0.9	<	0.4
Collin	1845603	-96.401944	33.298333	1853	U	1987		7		8521		0.7	<	0.04
Collin	1845803	-96.431667	33.276944	1890	P	1991		50		26.9		1		0
Collin	1845801	-96.426667	33.277500	1900	P	1966		45		25		0.9	<	0.4
Collin	1845604	-96.401944	33.298333	1900	P	1976		89		36		0.7	<	0.4
Collin	1845801	-96.426667	33.277500	1900	P	1977		47		22		0.9		0.4
Collin	1845604	-96.401944	33.298333	1900	P	1983		110		64		0.8		0.04
Collin	1845604	-96.401944	33.298333	1900	P	1993		106		65		0.8		0.04
Collin	1845301	-96.402222	33.338056	1927	P	1988								
Collin	1845802	-96.421111	33.274444	1954	P	1983		60		28		1.4		0
Collin	1846402	-96.339722	33.302500	2032	P	1976		98		40		1.1	<	0.4
Collin	1846402	-96.339722	33.302500	2032	P	1983		106		39		1	<	0.04
Cooke	1932304	-97.013056	33.610000	45	I	1997		522		369		1.34		7.39
Cooke	1932802	-97.068333	33.541389	60	U	1972		426		457		0.7	<	0.4
Cooke	1940101	-97.110833	33.495000	70	H	1976		28		132		0.2		1.9
Cooke	1940101	-97.110833	33.495000	70	H	1982		37		69		0.1		9.44
Cooke	1940301	-97.003889	33.486389	105	H	1977		68		39		0.2		1.2
Cooke	1940301	-97.003889	33.486389	105	H	1997		61.2		37.4	<	0.3		1.06
Cooke	1825402	-96.976389	33.545278	190	H	1976		14		31		0.2		0.4
Cooke	1825402	-96.976389	33.545278	190	H	1983		13		27		0.1		0
Cooke	1817401	-96.978333	33.687222	235	S	1977		29		30		0.4	<	0.4
Cooke	1817401	-96.978333	33.687222	235	S	1987		30		29		0.4		2.88
Cooke	1817401	-96.978333	33.687222	235	S	1993		31		30		0.38		0.13
Dallas	3303802	-96.697500	32.894167	25	U	1971		45		15		0.4	<	0.4
Dallas	3216907	-97.024722	32.774167	190	I	1975		540		65		1.5		4.7

County Name	State Well ID	Longitude	Latitude	Well Depth	Primary Water Uses	Year Collected	Sulfate Flag	Sulfate (Mg/L)	Chloride Flag	Chloride (Mg/L)	Fluoride Flag	Fluoride (Mg/L)	Nitrate Flag	Nitrate (Mg/L)
Dallas	3309705	-96.999167	32.771944	190	H	1975		184		33		1.7	<	0.4
Dallas	3216908	-97.023056	32.773889	191	I	1975		216		32		2.2	<	0.4
Dallas	3317401	-96.992778	32.687222	250	H	1971		98		40		2.7	<	0.4
Dallas	3301803	-96.916944	32.887222	258	N	1975		421		257		4.4		5.6
Dallas	3224310	-97.021111	32.742500	283	U	1953		144		89		2.6		0.9
Dallas	3216906	-97.024722	32.775000	286	I	1975		184		39		2.3		2.9
Dallas	3208602	-97.005278	32.955000	293	U	1972		63		21		0.7	<	0.4
Dallas	3317403	-96.991111	32.682778	300	I	1976		73		42		2.2		0.6
Dallas	3232301	-97.031111	32.618056	314	H	1971		44		10		1.6	<	0.4
Dallas	3224603	-97.026944	32.691111	319	P	1975		142		26		2.7		3.7
Dallas	3301602	-96.900833	32.953889	320	U	1953		392		447		3.2	<	0.4
Dallas	3301602	-96.900833	32.953889	320	U	1962		343		430		3.3	<	0.4
Dallas	3224911	-97.017778	32.643611	350	H	1993		46		12		1		0.04
Dallas	3224901	-97.011389	32.642778	356	H	1976		96		17		1.2	<	0.4
Dallas	3224901	-97.011389	32.642778	356	H	1983		95		15		1.2		0.35
Dallas	3224909	-97.024167	32.642778	381	P	1998		36.8		18.4		0.97		0.24
Dallas	3224604	-97.016389	32.668611	391	P	1975		146		31		0.7		2.4
Dallas	3309510	-96.947500	32.813889	397	U	1953		523		156		1.8	<	0.4
Dallas	3309511	-96.929167	32.792222	405	P	1975		497		96		1.7		2.7
Dallas	3301604	-96.900833	32.953889	410	U	1953		476		366		3.2	<	0.04
Dallas	3317119	-96.994167	32.747500	412	U	1953		158		72		2.8		2.3
Dallas	3317106	-96.960000	32.745000	417	P	1958		123		24		1.8		0
Dallas	3317103	-96.960278	32.738611	417	P	1963		323		53		2.2	<	0.4
Dallas	3317106	-96.960000	32.745000	417	P	1963		302		62		2.1	<	0.4
Dallas	3216601	-97.011944	32.832500	439	U	1975		428		186		4.2		3
Dallas	3317408	-96.979444	32.703611	440	I	1976		146		21		1.1		2.6
Dallas	3224902	-97.013611	32.652222	446	I	1975		84		17		2.2		2.1
Dallas	3309708	-96.958611	32.767778	450	N	1975		209		35		1.4		3.1
Dallas	3309702	-96.958333	32.756389	460	U	1957		230		35		1.2	<	0.4
Dallas	3317107	-96.995556	32.746667	460	Z	1957		116		28		1.6	<	0.4
Dallas	3317410	-96.991944	32.683056	463	P	1987		61		27		2.2		0.09
Dallas	3309801	-96.931944	32.776111	475	N	1975		457		76		2.2		1
Dallas	3317105	-96.960000	32.745000	485	P	1958		157		24		1.6		0
Dallas	3309301	-96.905000	32.873056	490	N	1975		108		61		1.5		2
Dallas	3309301	-96.905000	32.873056	490	N	1987		455		229		3.9	<	0.04
Dallas	3309509	-96.944722	32.813889	494	U	1953		219		107		2	<	0.4
Dallas	3317204	-96.953333	32.741944	502	N	1975		137		25		2		1.3
Dallas	3309512	-96.931111	32.809722	505	N	1975		550		133		3.4		4
Dallas	3301903	-96.914167	32.875278	523	N	1974		702		240			<	0.4
Dallas	3317205	-96.922500	32.749722	534	H	1976		405		72		1.6		4.3
Dallas	3301502	-96.927500	32.916944	550	N	1975		470		218		4.4		3.2
Dallas	3301603	-96.896111	32.923611	558	U	1957		132		209		0.9		1.8
Dallas	3310503	-96.812222	32.791944	770	N	1975		520		186		3.9		4.6
Dallas	3309906	-96.897222	32.787222	787	U	1953		291		238		1.8		31
Dallas	3309906	-96.897222	32.787222	787	U	1975		145		261		0.6		4.7
Dallas	3325104	-96.961944	32.613889	801	P	1961		179		22		0.7		0
Dallas	3325104	-96.961944	32.613889	801	P	1975		176		16		0.9	<	0.4
Dallas	3325104	-96.961944	32.613889	801	P	1987		173		18		0.7	<	0.04
Dallas	3317902	-96.906389	32.652222	810	U	1969		472		85		2.3	<	0.4
Dallas	3317902	-96.906389	32.652222	810	U	1975		580		128		2.4	<	0.4
Dallas	3317902	-96.906389	32.652222	810	U	1983		582		125		2.2	<	0.04
Dallas	3318305	-96.788056	32.746667	817	N	1975		520		137		3.7		5.5
Dallas	3318305	-96.788056	32.746667	817	N	1987		503		175		3.2	<	0.04
Dallas	3317904	-96.905000	32.648889	828	I	1975		471		89		2		2.7
Dallas	3317904	-96.905000	32.648889	828	I	1987		496		84		1.7		0.04
Dallas	3320103	-96.588611	32.722500	840	P	1967		352		378		4.5		1.5
Dallas	3318202	-96.807500	32.744444	860	N	1961		504		166		3.4		0
Dallas	3325201	-96.956389	32.589167	892	P	1969		270		21		0.9	<	0.4
Dallas	3325201	-96.956389	32.589167	892	P	1975		282		30		0.9	<	0.4
Dallas	3325203	-96.956389	32.588056	895	P	1969		268		21		0.9	<	0.4
Dallas	3325203	-96.956389	32.588056	895	P	1975		274		26		0.7		4.1
Dallas	3325203	-96.956389	32.588056	895	P	1987		284		23		0.7	<	0.04
Dallas	3325203	-96.956389	32.588056	895	P	1998		271		21.4		0.52	<	0.22
Dallas	3318802	-96.814167	32.648056	900	P	1956		612		163		1.8	<	0.4
Dallas	3318308	-96.781944	32.743611	939	N	1975		520		92		2.5		5
Dallas	3326401	-96.855833	32.552222	946	P	1964		410		95		1.7	<	0.4
Dallas	3326401	-96.855833	32.552222	946	P	1971		327		63		1.5	<	0.4
Dallas	3326401	-96.855833	32.552222	946	P	1987		411		92		1.3	<	0.04
Dallas	3326103	-96.856944	32.589167	950	U	1968		570		133		3	<	0.4
Dallas	3326103	-96.856944	32.589167	950	U	1976		590		133		2.6	<	0.4
Dallas	3326402	-96.858056	32.556389	958	P	1976		380		100		1.4		5
Dallas	3326505	-96.817500	32.574444	988	P	1998		428		86.2		1.31	<	0.22
Dallas	3302903	-96.778611	32.912500	1031	I	1987		428		241		3.6	<	0.04
Dallas	3326202	-96.825000	32.603611	1040	N	1975		468		107		2	<	0.4
Dallas	3319501	-96.703333	32.668056	1044	P	1965		492		128		2.7	<	0.4
Dallas	3318702	-96.843889	32.631111	1045	H	1983		557		112		3.1		0
Dallas	3326101	-96.856944	32.588889	1046	P	1975		600		128		2.7	<	0.4
Dallas	3302902	-96.782222	32.912222	1047	I	1975		399		241		4.1	<	0.4
Dallas	3326406	-96.870556	32.566389	1050	I	1975		448		99		3.7		3.3
Dallas	3326305	-96.751667	32.595278	1057	U	1953		484		114		1.4	<	0.4
Dallas	3326403	-96.855833	32.551944	1089	P	1975		278		92		1.6		1.6
Dallas	3326408	-96.843889	32.559444	1100	P	1993		339		63		1.2	<	0.04
Dallas	3326602	-96.773056	32.573333	1121	H	1976		500		94		2.7		5
Dallas	3319701	-96.717778	32.646944	1130	P	1957		475		115		2.5		3.5
Dallas	3319701	-96.717778	32.646944	1130	P	1961		495		109		1.6	<	0.4
Dallas	3319701	-96.717778	32.646944	1130	P	1970		486		114		2.2		4.5
Dallas	3319701	-96.717778	32.646944	1130	P	1983		518		117		2.2	<	0.04
Dallas	3318701	-96.838611	32.637222	1140	P	1956		528		110		2		0.4
Dallas	3318701	-96.838611	32.637222	1140	P	1962		360		75		1.8		4.9
Dallas	3310301	-96.760833	32.856111	1154	I	1971		415		161		3.8	<	0.4

County Name	State Well ID	Longitude	Latitude	Well Depth	Primary Water Uses	Year Collected	Sulfate Flag	Sulfate (Mg/L)	Chloride Flag	Chloride (Mg/L)	Fluoride Flag	Fluoride (Mg/L)	Nitrate Flag	Nitrate (Mg/L)
Dallas	3310301	-96.760833	32.856111	1154	I	1983		383		175		3.5	<	0.04
Dallas	3326303	-96.757222	32.593056	1200	P	1957		462		92		1.8	<	0.4
Dallas	3326303	-96.757222	32.593056	1200	P	1966		435		94		1.9	<	0.4
Dallas	3326303	-96.757222	32.593056	1200	P	1976		463		98		1.8	<	0.4
Dallas	3318801	-96.815000	32.633333	1210	P	1956		612		163		1.8		0.4
Dallas	3318801	-96.815000	32.633333	1210	P	1962		374		75		2		4.9
Dallas	3303404	-96.724722	32.935000	1254	P	1958		353		269		4		0.4
Dallas	3303404	-96.724722	32.935000	1254	P	1967		436		285		3.6		3.5
Dallas	3303404	-96.724722	32.935000	1254	P	1977		445		286		3.8	<	0.04
Dallas	3319202	-96.681944	32.733333	1260	P	1950		389		195		2.4	<	0.4
Dallas	3327203	-96.702222	32.622500	1276	U	1975		445		149		3.5		4.7
Dallas	3303201	-96.701944	32.971667	1277	N	1993		368		235		1.04		0.04
Dallas	3319502	-96.682500	32.703889	1280	P	1950		399		188		2.4	<	0.4
Dallas	3311802	-96.681111	32.788611	1330	U	1961		424		131		2.6		0.2
Dallas	3311802	-96.681111	32.788611	1330	U	1976		422		99		2.3	<	0.4
Dallas	3319704	-96.725000	32.640000	1353	P	1963		500		107		3	<	0.4
Dallas	3319704	-96.725000	32.640000	1353	P	1976		471		113		2.3	<	0.4
Dallas	3319704	-96.725000	32.640000	1353	P	1998		490		102		2.09	<	0.22
Dallas	3327603	-96.653333	32.563889	1360	H	1965				222				
Dallas	3304101	-96.623889	32.978889	1388	S	1961		374		375		4.1		0.5
Dallas	3327602	-96.664444	32.546944	1390	P	1967		344		162		3.7		0.2
Dallas	3327602	-96.664444	32.546944	1390	P	1975		570		176		3.9	<	0.4
Dallas	3327602	-96.664444	32.546944	1390	P	1987		356		192		3.2	<	0.04
Dallas	3327602	-96.664444	32.546944	1390	P	1998		340		180		2.9	<	0.22
Dallas	3319302	-96.639722	32.734722	1400	P	1962		312		310		3.7		3.8
Dallas	3327601	-96.664722	32.546389	1408	U	1959		359		145		3.2		2.9
Dallas	3311901	-96.647500	32.751389	1421	U	1957		307		234		4		1.3
Dallas	3311901	-96.647500	32.751389	1421	U	1962		343		237		3.7		4.2
Dallas	3319601	-96.638056	32.705278	1471	P	1962		348		295		3.3		6
Dallas	3312703	-96.606667	32.767222	1475	U	1950		328		454		3.6	<	0.04
Dallas	3319203	-96.681944	32.732222	1476	U	1950		371		373		2.6		3.5
Dallas	3327501	-96.668611	32.553056	1500	U	1965				180				
Dallas	3320903	-96.539722	32.638889	1550	U	1950		381		604		4	<	0.4
Dallas	3319301	-96.630556	32.731389	1600	P	1971		109		78		1.9		1
Dallas	3327605	-96.634444	32.565278	1645	N	1969		285		213		3.1		6
Dallas	3327605	-96.634444	32.565278	1645	N	1975		363		214		4	<	0.4
Dallas	3320802	-96.570278	32.652500	1855	P	1959		380		206				
Dallas	3320902	-96.540556	32.639167	1860	U	1954		381		572		4.4	<	0.4
Dallas	3320902	-96.540556	32.639167	1860	U	1963		363		610		4.6	<	0.4
Denton	1841202	-96.926389	33.371111	20	H	1971		79		134		0.9		6
Denton	1964102	-97.107222	33.097222	35	S	1976		319		433		0.8		191
Denton	1964603	-97.024444	33.076111	40	S	1970		356		492		0.9		294
Denton	1964103	-97.107500	33.116389	60	H	1976		28		12		0.3		5.4
Denton	1956602	-97.037500	33.183056	60	I	1977		28		23		0.3		1.9
Denton	1956602	-97.037500	33.183056	60	I	1994		45		11.8		0.29		
Denton	1964701	-97.088611	33.018889	62	S	1969		243		199		0.6		24.5
Denton	1841301	-96.909167	33.374444	102	H	1971		415		46		2.3	<	0.4
Denton	1841203	-96.917222	33.361111	125	H	1971		49		20		0.6	<	0.4
Denton	1833803	-96.936389	33.380278	130	H	1971		62		27		0.3	<	0.4
Denton	1833803	-96.936389	33.380278	130	H	1989		13		7	<	0.1		0.04
Denton	1964702	-97.096944	33.004722	134	P	1974		108		60		0.3		3.5
Denton	1964801	-97.081389	33.002222	140	P	1974		96		28		1.2		2.5
Denton	1964310	-97.031389	33.095833	144	P	1966		164		38		0.6	<	0.4
Denton	1964310	-97.031389	33.095833	144	P	1976		156		36		0.4	<	0.4
Denton	1964703	-97.099722	33.001111	150	P	1974		147		53		0.7		3.7
Denton	3208109	-97.089167	32.997778	150	P	1974		168		68		0.8		3.9
Denton	1964104	-97.092222	33.109722	150	I	1976		17		38		0.6		0.5
Denton	1849805	-96.925000	33.158333	150	H	1983		265		97		0.9		0.8
Denton	3208203	-97.077222	32.995556	160	P	1974		135		45		0.5	<	0.4
Denton	1833902	-96.912222	33.389444	180	H	1971		66		34		0.4	<	0.4
Denton	1964704	-97.105556	33.008611	180	P	1974		87		62		0.3		1.7
Denton	1964206	-97.069444	33.101111	183	P	1966		30		77		0.3	<	0.4
Denton	1964206	-97.069444	33.101111	183	P	1976		57		112		0.3	<	0.4
Denton	1849808	-96.934167	33.129167	200	P	1976		92		45		3.6		2.4
Denton	1964101	-97.099722	33.083611	200	H	1976		119		83	<	0.1		4.5
Denton	1833904	-96.904444	33.383889	204	H	1971		384		23		2	<	0.4
Denton	1841201	-96.928333	33.363333	210	I	1976		69		28		0.4	<	0.4
Denton	1964315	-97.011111	33.094444	212	P	1976		530		378		2.9		5
Denton	1964311	-97.023889	33.106944	215	P	1966		246		73		2.9	<	0.4
Denton	1964311	-97.023889	33.106944	215	P	1976		226		69		2.3	<	0.4
Denton	1841207	-96.941667	33.371111	220	I	1998		55.3		23		0.35	<	0.22
Denton	1849905	-96.900833	33.161667	227	H	1976		114		117		1.2	<	0.4
Denton	1964205	-97.060278	33.108889	235	P	1966		110		52		0.2	<	0.4
Denton	1964302	-97.017222	33.110556	235	H	1970		90		34		3.4	<	0.4
Denton	1964205	-97.060278	33.108889	235	P	1976		93		48		0.2		3.5
Denton	1964204	-97.043056	33.109167	255	P	1966		36		25		0.2		0.5
Denton	1964602	-97.035556	33.076111	255	H	1970		148		29		0.6	<	0.4
Denton	1964901	-97.040278	33.033889	260	H	1976		73		32		1.3	<	0.4
Denton	1964901	-97.040278	33.033889	260	H	1987		72		34		1.5	<	0.04
Denton	1833805	-96.920278	33.390833	270	H	1971		22		12		0.4	<	0.4
Denton	1849901	-96.886667	33.154167	275	H	1971		408		370		3.4		3.3
Denton	1964314	-97.006667	33.093889	278	P	1966		500		373		3.2	<	0.4
Denton	1964314	-97.006667	33.093889	278	P	1976		510		376		2.8		6
Denton	1964909	-97.032500	33.023889	280	H	1975		45		15		3.1		0.5
Denton	1964912	-97.035833	33.022778	280	H	1975		49		12		2.2		2.6
Denton	1833809	-96.938611	33.376944	280	I	1976		52		20		0.3	<	0.4
Denton	1833903	-96.912222	33.389444	285	H	1971		70		35		0.4	<	0.4
Denton	1964910	-97.035278	33.023611	286	H	1975		55		13		1.9		2.7
Denton	1964911	-97.033889	33.023889	287	H	1975		51		14		2.5		2.7
Denton	1841205	-96.936389	33.336389	288	I	1976		136		66		0.4	<	0.4

County Name	State Well ID	Longitude	Latitude	Well Depth	Primary Water Uses	Year Collected	Sulfate Flag	Sulfate (Mg/L)	Chloride Flag	Chloride (Mg/L)	Fluoride Flag	Fluoride (Mg/L)	Nitrate Flag	Nitrate (Mg/L)
Denton	1964907	-97.031667	33.023056	290	H	1975		55		17		4.1	<	0.4
Denton	1841501	-96.948056	33.310278	291	I	1976		77		31		0.3		3.1
Denton	1964913	-97.035278	33.021111	294	H	1975		50		13		2.1	<	0.4
Denton	1833802	-96.957778	33.382500	298	H	1971		38		17		0.8	<	0.4
Denton	1841302	-96.885833	33.361111	300	H	1971		52		21		0.5		1.5
Denton	1964914	-97.034722	33.020278	300	U	1975		54		19		1.1		4.9
Denton	1833808	-96.955278	33.388611	300	I	1976		84		39		0.5	<	0.4
Denton	1833808	-96.955278	33.388611	300	I	1983		91		42		0.5	<	0.04
Denton	1964908	-97.031667	33.023889	301	H	1975		42		14		3.4		2.6
Denton	1849104	-96.963333	33.232778	305	H	1989		68		17		3.8	<	0.04
Denton	1964306	-97.004444	33.106389	308	P	1976		115		44		2.5		1.7
Denton	1964306	-97.004444	33.106389	308	P	1989		104		45		2.5	<	0.04
Denton	1964306	-97.004444	33.106389	308	P	1997		102		38.6		2.33	<	0.27
Denton	1964915	-97.017222	33.019722	310	H	1975		371		209		2.6	<	0.4
Denton	1849802	-96.941389	33.162500	317	P	1997		43		14		1.16	<	0.27
Denton	1857506	-96.921111	33.081944	335	P	1966		158		158		3.1	<	0.4
Denton	1857506	-96.921111	33.081944	335	P	1976		181		160		3.1		2.8
Denton	1849906	-96.909722	33.165833	350	P	1987		112		104		1.8	<	0.04
Denton	1849403	-96.965833	33.168611	355	P	1987		61		17		1.2		0.01
Denton	1849505	-96.956667	33.180278	360	P	1977		281		58		0.3	<	0.4
Denton	1857505	-96.921944	33.075833	363	P	1966		180		150		3.4	<	0.4
Denton	1857505	-96.921944	33.075833	363	P	1976		158		145		3.3		0.7
Denton	1849701	-96.959444	33.163056	364	U	1961		61		21		1.5		0.2
Denton	1849701	-96.959444	33.163056	364	U	1989		63		19		1.5	<	0.04
Denton	1849704	-96.973889	33.136944	365	P	1973		125		43		3.2		0.4
Denton	1849504	-96.954167	33.175833	368	P	1977		244		55		0.3		3.9
Denton	1849703	-96.971389	33.142222	372	P	1977		60		24		2.8	<	0.4
Denton	1849708	-96.969722	33.160556	377	P	1994		58.2		20.9		1.4		0
Denton	1849903	-96.898889	33.159167	380	H	1976		67		28		1.5	<	0.4
Denton	1849904	-96.898611	33.159722	380	H	1976		54		21		1.4		1.1
Denton	1833804	-96.933611	33.376944	400	I	1971		55		40		0.3	<	0.4
Denton	1833804	-96.933611	33.376944	400	I	1993		59		28		0.49		0.04
Denton	1849807	-96.944167	33.142500	402	P	1976		53		26		1.6	<	0.4
Denton	1857202	-96.941389	33.096944	404	P	1966		169		75		2.7	<	0.4
Denton	1857202	-96.941389	33.096944	404	P	1976		163		73		2.4		3
Denton	1849801	-96.917222	33.141944	420	H	1976		81		32		2.3	<	0.4
Denton	1849801	-96.917222	33.141944	420	H	1983		81		33		2.4		0.71
Denton	1849801	-96.917222	33.141944	420	H	1993		237		169		1		1.86
Denton	1857603	-96.911111	33.064167	530	N	1976		106		20		0.8		0.9
Denton	1857603	-96.911111	33.064167	530	N	1983		202		110		3.5		0.04
Denton	1857603	-96.911111	33.064167	530	N	1993		196		107		0.99		0.04
Denton	1849602	-96.890278	33.168611	570	P	1976		288		256		2.4	<	0.4
Denton	1857303	-96.890278	33.106111	596	P	1975		203		88		2.7		0.8
Denton	1858701	-96.855833	33.024444	858	P	1983		112		16		0.9	<	0.04
Denton	1858701	-96.855833	33.024444	858	P	1997		347		371		3.74	<	0.27
Ellis	3248503	-97.071389	32.315278	349	H	1965		94		22				
Ellis	3232803	-97.062778	32.512222	355	H	1971		168		17		0.7	<	0.4
Ellis	3232803	-97.062778	32.512222	355	H	1987		173		18		0.7	<	0.04
Ellis	3232804	-97.062500	32.514722	357	S	1975		181		18		0.8	<	0.4
Ellis	3248501	-97.072500	32.298889	367	H	1965		118		25		1.3		0.2
Ellis	3248501	-97.072500	32.298889	367	H	1976		162		31		1.4		3.9
Ellis	3248901	-97.017778	32.258611	384	U	1965		353		51				
Ellis	3248901	-97.017778	32.258611	384	U	1972		332		53		2.6		2.5
Ellis	3248901	-97.017778	32.258611	384	U	1983		354		54		2.3		0.35
Ellis	3248602	-97.012500	32.307222	410	P	1961		139		38		1.8		
Ellis	3248602	-97.012500	32.307222	410	P	1987		140		39		1.8	<	0.04
Ellis	3248602	-97.012500	32.307222	410	P	1997		144		34.4		1.99	<	0.27
Ellis	3248903	-97.039167	32.258056	430	H	1965		106		24				
Ellis	3328702	-96.617500	32.529444	450	H	1965		11		1540				
Ellis	3248605	-97.011111	32.311389	462	P	1993		729		128		1.9		0.09
Ellis	3333302	-96.912222	32.466667	500	H	1965		344		39				
Ellis	3248601	-97.013611	32.309444	507	U	1965		144		39		1.9	<	0.4
Ellis	3232902	-97.029722	32.520278	530	H	1965		292		19		0.7		0.2
Ellis	3240305	-97.026389	32.481667	543	U	1972		295		21		0.7	<	0.4
Ellis	3240309	-97.015278	32.473333	588	N	1985		152		19		0.7		0
Ellis	3333201	-96.942222	32.471667	619	H	1965		720		192				
Ellis	3341901	-96.900000	32.278889	620	H	1965		656		151				
Ellis	3341802	-96.935833	32.269167	632	S	1965		296		76				
Ellis	3341101	-96.989167	32.338889	641	P	1978		118		31		1.5		2.43
Ellis	3341101	-96.989167	32.338889	641	P	1984		113		32		1.5		3.76
Ellis	3333401	-96.999167	32.429722	642	H	1965		550		101				
Ellis	3240307	-97.016667	32.463889	650	N	1987		142		20		0.5	<	0.04
Ellis	3240607	-97.026111	32.456389	659	N	1976		142		22		0.5		3.9
Ellis	3349208	-96.948889	32.248056	668	H	1965		304		63				
Ellis	3349402	-96.966111	32.177222	672	H	1965		620		104				
Ellis	3349801	-96.952500	32.151389	680	H	1965		444		274				9.9
Ellis	3325904	-96.902500	32.537222	688	H	1965		624		140		2.8		0.2
Ellis	3326701	-96.873333	32.513333	692	H	1965		532		144		2.2		0
Ellis	3333702	-96.994722	32.410833	695	S	1961		572		82		2.3		4.2
Ellis	3333702	-96.994722	32.410833	695	S	1978		452		68		1		1
Ellis	3325501	-96.955556	32.546389	697	H	1965		944		218		1.3		2
Ellis	3333103	-96.993611	32.483333	699	U	1956		121		65		1.2		2.7
Ellis	3333103	-96.993611	32.483333	699	U	1964		274		51		1.5	<	0.4
Ellis	3325706	-96.978333	32.532778	700	P	1972		1030		175		2.4	<	0.4
Ellis	3325801	-96.941111	32.510278	709	S	1965		510		299				
Ellis	3357203	-96.920556	32.114167	714	S	1951		642		194				5
Ellis	3357203	-96.920556	32.114167	714	S	1965		664		270				
Ellis	3349102	-96.975833	32.237500	719	H	1965		402		85				
Ellis	3341202	-96.947500	32.346111	727	H	1965		93		25		1.2		0.2
Ellis	3341202	-96.947500	32.346111	727	H	1971		104		33		1.2		1.5

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Ellis	3341401	-96.959722	32.325278	728	S	1965		207		58				
Ellis	3325901	-96.883889	32.525833	735	P	1965		278		50		1.1		3
Ellis	3325901	-96.883889	32.525833	735	P	1971		359		59		1.7		3.5
Ellis	3333106	-96.978056	32.476111	735	N	1975		136		19		0.9		2.6
Ellis	3325901	-96.883889	32.525833	735	P	1983		257		50		1.1		0
Ellis	3325708	-96.982778	32.528889	744	P	1975		429		51		1.9		3.6
Ellis	3333202	-96.943333	32.465000	754	H	1965		188		19				
Ellis	3240601	-97.006111	32.429722	759	S	1965		250		19				
Ellis	3325710	-96.979722	32.529167	772	P	1983		722		138		3.2	<	0.04
Ellis	3333501	-96.924167	32.455278	780	H	1976		315		34		0.7		2.8
Ellis	3333501	-96.924167	32.455278	780	H	1983		332		34		0.7		1.37
Ellis	3341502	-96.942778	32.325556	802	P	1975		355		94		4.1		5.1
Ellis	3357205	-96.934444	32.085000	822	H	1965		151		48		1.4		0.2
Ellis	3325702	-96.987778	32.520833	824	H	1965		470		59		2.1		0
Ellis	3342404	-96.872778	32.327500	836	H	1965		340		532				
Ellis	3342701	-96.867222	32.256944	843	U	1953		586		181		3.6	<	0.4
Ellis	3342701	-96.867222	32.256944	843	U	1961		498		178		3.6		0.8
Ellis	3325406	-96.967500	32.545278	855	H	1983		640		123		2.9	<	0.04
Ellis	3357206	-96.944444	32.124444	865	P	1976		533.5		67		1.5		0
Ellis	3357206	-96.944444	32.124444	865	P	1983		537		59		1.5	<	0.04
Ellis	3341204	-96.949444	32.374444	870	N	1983		146		35		1.2	<	0.04
Ellis	3349601	-96.889444	32.182778	881	U	1955		504		117		2.2		4.9
Ellis	3357202	-96.945000	32.125000	900	P	1965		516		79		2		0.2
Ellis	3326702	-96.856944	32.512222	900	H	1965		544		408				3
Ellis	3357202	-96.945000	32.125000	900	P	1975		540		67		2.2		4
Ellis	3357202	-96.945000	32.125000	900	P	1987		504		63		1.8	<	0.04
Ellis	3357202	-96.945000	32.125000	900	P	1997		521		52.7		1.73	<	0.27
Ellis	3334101	-96.853333	32.459722	902	H	1965		492		108				
Ellis	3349604	-96.899722	32.187778	903	H	1965		480		108				
Ellis	3325907	-96.891944	32.527778	913	P	1975		348		64		2.1		0.8
Ellis	3334405	-96.843333	32.457778	922	N	1975		224		56		1.3		4.3
Ellis	3349602	-96.892778	32.179722	935	P	1957		486		112		3.5	<	0.4
Ellis	3349602	-96.892778	32.179722	935	P	1967		493		103		3.9	<	0.4
Ellis	3349602	-96.892778	32.179722	935	P	1975		483		107		3.5	<	0.4
Ellis	3349602	-96.892778	32.179722	935	P	1988								
Ellis	3349602	-96.892778	32.179722	935	P	1997		480		88.7		3.25	<	0.27
Ellis	3349606	-96.895556	32.180556	939	N	1975		550		111		3.8	<	0.4
Ellis	3349606	-96.895556	32.180556	939	N	1987		501		110		3.5	<	0.04
Ellis	3334203	-96.828056	32.489167	940	H	1965		404		88				
Ellis	3326801	-96.805278	32.513056	944	P	1950		407		99		2	<	0.4
Ellis	3326801	-96.805278	32.513056	944	P	1965		398		159		1.8		1.5
Ellis	3326801	-96.805278	32.513056	944	P	1976		409		99		1.8	<	0.4
Ellis	3326801	-96.805278	32.513056	944	P	1983		384		223		1.8	<	0.04
Ellis	3326901	-96.754167	32.531389	950	H	1965		414		134		2.4		0
Ellis	3326901	-96.754167	32.531389	950	H	1970		398		135		2.4	<	0.4
Ellis	3325601	-96.880000	32.545556	955	P	1975		520		100		1.8		8
Ellis	3325602	-96.879722	32.542500	960	P	1977		326		61		1.7		0.22
Ellis	3325602	-96.879722	32.542500	960	P	1983		310		63		1.7	<	0.04
Ellis	3334205	-96.826667	32.498056	967	S	1971		374		77		1.5	<	0.4
Ellis	3334204	-96.833056	32.471944	968	H	1965		300		56		1.6		2.8
Ellis	3350301	-96.778889	32.247222	990	H	1965		448		300				
Ellis	3334402	-96.834167	32.439444	997	H	1965		454		135				
Ellis	3334202	-96.825000	32.482500	1000	H	1965		416		79				
Ellis	3334404	-96.837778	32.444722	1000	P	1965		440		142		3.2		3.2
Ellis	3326705	-96.873611	32.536111	1005	P	1975		323		58		1.8		3.2
Ellis	3342104	-96.855278	32.338056	1019	H	1965		296		78		2.8		1.8
Ellis	3342401	-96.850000	32.328056	1026	H	1965		518		82				
Ellis	3350401	-96.860556	32.185278	1050	H	1965		458		132				
Ellis	3350101	-96.847500	32.226389	1050	H	1965		388		118				
Ellis	3342105	-96.848333	32.336389	1063	P	1977		320		78		2.8		1.1
Ellis	3334502	-96.793333	32.423889	1080	H	1965		394		140				
Ellis	3334803	-96.824444	32.398333	1091	H	1965		240		70				
Ellis	3326805	-96.825000	32.531389	1100	P	1967		421		117		2.2	<	0.4
Ellis	3326815	-96.826389	32.523056	1100	P	1976		342		50		1.3	<	0.4
Ellis	3326805	-96.825000	32.531389	1100	P	1977		443		91		1.5		1.09
Ellis	3326805	-96.825000	32.531389	1100	P	1986		403		102		1		0.04
Ellis	3334104	-96.865000	32.481111	1100	P	1987		392		64		1.2		
Ellis	3334209	-96.829167	32.466389	1110	P	1985		352.9		92		2.4		
Ellis	3334209	-96.829167	32.466389	1110	P	1993		335		76		0.58		1.64
Ellis	3326821	-96.823611	32.530833	1120	P	1988		420		58		1.4		0
Ellis	3326818	-96.811667	32.517222	1158	P	1978		290		98.5		1.3		0
Ellis	3326820	-96.805000	32.524167	1170	P	1987		440		106		2		0
Ellis	3326802	-96.803889	32.518611	1171	P	1967		358		79		2		2
Ellis	3326802	-96.803889	32.518611	1171	P	1975		394		73		2.3		2
Ellis	3326802	-96.803889	32.518611	1171	P	1976		344		72		1.9	<	0.4
Ellis	3326822	-96.813056	32.536389	1178	P	1985		450		84		2.6		0
Ellis	3334802	-96.796667	32.408333	1180	H	1965		274		84				
Ellis	3334211	-96.823889	32.465000	1180	P	1987		333		89.5		2.2		
Ellis	3334211	-96.823889	32.465000	1180	P	1997		326		64.4		2.34	<	0.27
Ellis	3350503	-96.792500	32.181389	1185	H	1965		382		118		5.2		0.2
Ellis	3326903	-96.781389	32.531389	1195	P	1985		294		318.2		2.8		0
Ellis	3326903	-96.781389	32.531389	1195	P	1993		315		306		0.66		0.04
Ellis	3350502	-96.791944	32.204444	1238	U	1965		498		172		5.7		0
Ellis	3342901	-96.770833	32.291111	1238	P	1965		426		164		4.7		3.5
Ellis	3350502	-96.791944	32.204444	1238	U	1976		175		176		2.8		0.5
Ellis	3342901	-96.770833	32.291111	1238	P	1977		395		126		4.8		6.29
Ellis	3350502	-96.791944	32.204444	1238	U	1983		470		181		5.4		0.04
Ellis	3342901	-96.770833	32.291111	1238	P	1986		362		128		4.6		0.44
Ellis	3343701	-96.736944	32.280556	1240	U	1965		432		210		5.9		0.8
Ellis	3334307	-96.755000	32.473889	1280	P	1988		500		440		5		

County Name	State Well ID	Longitude	Latitude	Well Depth	Primary Water Uses	Year Collected	Sulfate Flag	Sulfate (Mg/L)	Chloride Flag	Chloride (Mg/L)	Fluoride Flag	Fluoride (Mg/L)	Nitrate Flag	Nitrate (Mg/L)
Ellis	3342201	-96.793889	32.368611	1285	H	1965		304		86		3.5		0.2
Ellis	3342201	-96.793889	32.368611	1285	H	1987		303		87		3.4	<	0.04
Ellis	3335401	-96.735278	32.441667	1295	Z	1965		344		118		5.1		0
Ellis	3334601	-96.753611	32.448889	1302	H	1965		464		84		3.2		2.8
Ellis	3335701	-96.740556	32.377778	1303	U	1965		320		105		4.3		0
Ellis	3335702	-96.748333	32.386111	1321	P	1965		352		105		3.6		0.2
Ellis	3335702	-96.748333	32.386111	1321	P	1979		338		118		4.4		0.31
Ellis	3335702	-96.748333	32.386111	1321	P	1983		334		131		4.4		5.58
Ellis	3343301	-96.654722	32.363056	1350	U	1957		16		1320		2	<	0.4
Ellis	3343301	-96.654722	32.363056	1350	U	1965		22		1290				4.5
Ellis	3343401	-96.718889	32.327222	1350	H	1965		340		157				
Ellis	3343401	-96.718889	32.327222	1350	H	1975		349		160		5.6	<	0.4
Ellis	3328703	-96.615278	32.524722	1350	P	1976		296		277		4.9		0.4
Ellis	3343101	-96.726389	32.345278	1370	P	1979		334		118		4.5		0.44
Ellis	3335504	-96.685556	32.433056	1440	P	1985		265.5		100		4.8		0
Ellis	3335504	-96.685556	32.433056	1440	P	1997		309		122		4.01	<	0.27
Ellis	3343204	-96.690000	32.370278	1445	U	1985		333.5		147.2		4		0
Ellis	3327801	-96.706111	32.516111	1447	U	1965		416		146				
Ellis	3327801	-96.706111	32.516111	1447	U	1971		142		266		2.8		1.5
Ellis	3343802	-96.695000	32.263611	1450	P	1980		370		190		5.3		0
Ellis	3343802	-96.695000	32.263611	1450	P	1997		380		188		6.27	<	0.27
Ellis	3335501	-96.668611	32.429722	1472	U	1961		284		448		3.9		0.2
Ellis	3343702	-96.737500	32.280278	1480	P	1977		442		229		5.4		7.57
Ellis	3343702	-96.737500	32.280278	1480	P	1986		465		241		5.2		3.94
Ellis	3327901	-96.666111	32.533056	1493	P	1958		312		172		4	<	0.4
Ellis	3327901	-96.666111	32.533056	1493	P	1967		395		197		4.1	<	0.4
Ellis	3327901	-96.666111	32.533056	1493	P	1975		520		181		4.5	<	0.4
Ellis	3343801	-96.694167	32.265833	1517	P	1961		418		239		5.1		0.2
Ellis	3343801	-96.694167	32.265833	1517	P	1968		428		256		6.4	<	0.4
Ellis	3343801	-96.694167	32.265833	1517	P	1977		450		244		5.6		6.99
Ellis	3335503	-96.668611	32.430278	1522	P	1965		316		114		4		0
Ellis	3335503	-96.668611	32.430278	1522	P	1975		299		118		4.6		9
Ellis	3335503	-96.668611	32.430278	1522	P	1988								
Ellis	3343901	-96.649167	32.250000	1659	U	1965		480		400				1.2
Ellis	3336802	-96.576944	32.414444	1703	H	1965		328		940				0.8
Ellis	3344401	-96.623056	32.326111	1796	U	1953		505		266		2.4	<	0.4
Ellis	3344401	-96.623056	32.326111	1796	U	1966		456		264		5.6	<	0.4
Ellis	3343602	-96.638056	32.316111	1806	U	1954		473		270		5.5	<	0.4
Ellis	3343602	-96.638056	32.316111	1806	U	1966		468		257		6	<	0.4
Ellis	3344402	-96.622222	32.325000	1821	U	1966		478		278		6	<	0.4
Ellis	3336201	-96.569444	32.461667	1982	U	1969		449		234		5.4		4
Ellis	3336201	-96.569444	32.461667	1982	U	1976		400		240		5.1		6
Ellis	3336201	-96.569444	32.461667	1982	U	1986		418		240		5.2		1.55
Ellis	3336201	-96.569444	32.461667	1982	U	1993		414		219		1.48		0.09
Ellis	3336206	-96.564722	32.466111	2020	P	1987		432		242.2		4.5		
Grayson	1809601	-96.905000	33.811944	50	U	1957				87				
Grayson	1818421	-96.866944	33.683611	95	H	1957		116		26				
Grayson	1810603	-96.782222	33.811667	125	P	1977		15		11	<	0.1		2.6
Grayson	1818409	-96.862500	33.667778	129	I	1976		456		58		0.5		5.1
Grayson	1810101	-96.847222	33.840556	130	U	1957				22				
Grayson	1810605	-96.782778	33.810833	130	P	1994		39		17		0.2		0.18
Grayson	1818101	-96.833611	33.708611	135	I	1976		16		6		0.2		0.9
Grayson	1818301	-96.770833	33.729722	140	P	1958				18				
Grayson	1818301	-96.770833	33.729722	140	P	1978		110		20		1.2	<	0.4
Grayson	1818301	-96.770833	33.729722	140	P	1989		109		16		1.3		0.27
Grayson	1818410	-96.857222	33.680278	141	I	1976		438		93		0.8		0.9
Grayson	1818414	-96.858889	33.679167	145	I	1976		413		23		0.7	<	0.4
Grayson	1818406	-96.857222	33.690833	150	I	1976		436		30		0.5		3.2
Grayson	1818407	-96.873889	33.667222	160	I	1976		139		24		0.7	<	0.4
Grayson	1818302	-96.751111	33.742500	165	U	1969		26		8		0.8	<	0.4
Grayson	1818302	-96.751111	33.742500	165	U	1978		27		17		0.7	<	0.4
Grayson	1809901	-96.890833	33.780556	180	I	1957		27		18		0.2		0
Grayson	1810406	-96.873056	33.822500	180	I	1957		40		7.2		0.2		0
Grayson	1811701	-96.745278	33.777222	192	U	1957		3.8		9.5		0.2		0.2
Grayson	1813803	-96.438333	33.754167	200	H	1976		24		11		0.1		19
Grayson	1813803	-96.438333	33.754167	200	H	1989		27		12	<	0.1		10.41
Grayson	1809501	-96.942500	33.825000	205	H	1976		9		10		0.2	<	0.4
Grayson	1809501	-96.942500	33.825000	205	H	1983		9		10		0.2	<	0.04
Grayson	1833302	-96.913333	33.466944	215	U	1958		24		16		0.4		0
Grayson	1833602	-96.916389	33.441111	220	I	1976		129		36		0.3		5.8
Grayson	1810601	-96.780556	33.793889	234	H	1976		41		11		0.4		0.4
Grayson	1810601	-96.780556	33.793889	234	H	1983		41		14		0.4		0.04
Grayson	1810103	-96.844722	33.838333	235	H	1977		22		13		1.5		0.4
Grayson	1818405	-96.856111	33.690833	250	I	1976		201		21		0.4		1.2
Grayson	1833501	-96.923611	33.436389	279	I	1976		61		23		0.3	<	0.4
Grayson	1825301	-96.907222	33.587778	280	H	1976		13		25		0.3	<	0.4
Grayson	1811804	-96.682222	33.775278	281	P	1974		18		11		0.3	<	0.4
Grayson	1811804	-96.682222	33.775278	281	P	1984		10		10		0.5		0.04
Grayson	1810801	-96.807222	33.785556	285	H	1957				23				
Grayson	1810801	-96.807222	33.785556	285	H	1977		41		20		0.3		2.9
Grayson	1817601	-96.878333	33.680833	290	I	1976		112		36		0.3		0.9
Grayson	1819101	-96.749444	33.738333	300	H	1958		85		16		2.4		0
Grayson	1818418	-96.847222	33.680833	300	P	1975		152		24		0.5	<	0.4
Grayson	1825610	-96.891111	33.548056	300	I	1976		17		74		0.2		0.4
Grayson	1819101	-96.749444	33.738333	300	H	1978		77		77		2.2	<	0.4
Grayson	1819101	-96.749444	33.738333	300	H	1986		80		12		2.2	<	0.04
Grayson	1821901	-96.388611	33.653056	301	H	1976		87		17		0.3	<	0.4
Grayson	1821901	-96.388611	33.653056	301	H	1987		90		18		0.3		0.04
Grayson	1821901	-96.388611	33.653056	301	H	1993		98		18		0.22		0.8
Grayson	1810405	-96.834167	33.809722	308	P	1957				12				

County Name	State Well ID	Longitude	Latitude	Well Depth	Primary Water Uses	Year Collected	Sulfate Flag	Sulfate (Mg/L)	Chloride Flag	Chloride (Mg/L)	Fluoride Flag	Fluoride (Mg/L)	Nitrate Flag	Nitrate (Mg/L)
Grayson	1825608	-96.889444	33.559167	309	I	1976		17		21		0.3	<	0.4
Grayson	1825609	-96.904722	33.580833	310	I	1976		53		19		0.4	<	0.4
Grayson	1818420	-96.847222	33.682500	310	P	1977		114		33		0.3	<	0.4
Grayson	1833502	-96.925556	33.420556	317	I	1976		70		17		0.4	<	0.4
Grayson	1825302	-96.893333	33.584167	320	I	1976		40		23		0.3	<	0.4
Grayson	1825606	-96.884444	33.569444	320	I	1976		36		22		0.2	<	0.4
Grayson	1825611	-96.896944	33.571944	321	I	1976		34		23		0.2	<	0.4
Grayson	1825607	-96.878333	33.560000	330	I	1976		87		23		0.4	<	0.4
Grayson	1825607	-96.878333	33.560000	330	I	1983		100		29		0.3	<	0.04
Grayson	1810702	-96.848333	33.782778	338	U	1958		21		19		0.2		0
Grayson	1826404	-96.870833	33.546667	340	I	1976		72		22		0.4	<	0.4
Grayson	1811901	-96.659167	33.765556	341	P	1976		21		7		0.4	<	0.4
Grayson	1810802	-96.821944	33.783611	345	I	1958		43		22		0.4		0.2
Grayson	1825901	-96.905000	33.530278	352	I	1976		30		21		0.2	<	0.4
Grayson	1810902	-96.785833	33.777778	354	U	1958				14				
Grayson	1826401	-96.870556	33.554444	355	I	1976		45		22		0.3	<	0.4
Grayson	1818401	-96.864722	33.684722	356	I	1976		124		20		0.4	<	0.4
Grayson	1811801	-96.680000	33.763611	375	N	1976		17		7		0.3	<	0.4
Grayson	1811801	-96.680000	33.763611	375	N	1987		16		6		0.3	<	0.04
Grayson	1811801	-96.680000	33.763611	375	N	1993		17		6		0.24		1.46
Grayson	1820501	-96.542222	33.698611	380	P	1977		550		107		3.7		4.47
Grayson	1820501	-96.542222	33.698611	380	P	1983		539		113		3.8		4.4
Grayson	1834601	-96.777778	33.436944	387	U	1973		1300		285		2.5		11
Grayson	1818901	-96.770556	33.627500	390	H	1976		109		13		1		1.2
Grayson	1818901	-96.770556	33.627500	390	H	1987		114		14		1		0.4
Grayson	1834101	-96.847778	33.458611	400	S	1971		38		14		0.5	<	0.4
Grayson	1818902	-96.765833	33.630556	410	U	1958		50		20		1.2		1
Grayson	1818701	-96.855000	33.657778	420	I	1976		920		41		0.7		7
Grayson	1818903	-96.769167	33.629444	420	P	1976		42		6		0.9		
Grayson	1825605	-96.876944	33.573889	425	I	1976		111		12		0.6	<	0.4
Grayson	1811802	-96.668333	33.759722	443	I	1958		31		12		0.4		0.5
Grayson	1811802	-96.668333	33.759722	443	I	1968		24		10		0.4	<	0.4
Grayson	1826101	-96.863889	33.621667	446	P	1976		48		20		0.3		4.1
Grayson	1811803	-96.669722	33.758611	458	P	1967		24		10		0.4		5
Grayson	1811803	-96.669722	33.758611	458	P	1977		27		11		0.3	<	0.4
Grayson	1811806	-96.668889	33.758611	470	P	1997		27		6.73	<	0.3		2.13
Grayson	1811805	-96.680833	33.752778	496	N	1962		28		11				
Grayson	1811805	-96.680833	33.752778	496	N	1977		34		10		0.9	<	0.4
Grayson	1801902	-96.900000	33.877222	574	P	1987		84		224		1.2	<	0.04
Grayson	1827701	-96.708611	33.531667	613	H	1976	<	4		890		2.6		4.8
Grayson	1819303	-96.657778	33.714722	620	U	1957		104		18		0.6		0.2
Grayson	1820101	-96.621944	33.708611	630	H	1971		36		30		0.5	<	0.4
Grayson	1819801	-96.697500	33.650833	632	H	1977	<	4		910		2.5	<	0.4
Grayson	1819602	-96.663889	33.706389	642	U	1957		48		18		0.8		2
Grayson	1827201	-96.696111	33.623611	670	P	1979		56		28		1.9		3.2
Grayson	1819304	-96.657222	33.709444	688	U	1957		69		21		0.7		1.5
Grayson	1827204	-96.671389	33.607500	690	H	1979		196		30		2.6		2.9
Grayson	1829301	-96.408333	33.610278	709	P	1958		39		14		0.7		1.2
Grayson	1829301	-96.408333	33.610278	709	P	1964		37		14		0.9	<	0.4
Grayson	1829301	-96.408333	33.610278	709	P	1976		42		15		1	<	0.4
Grayson	1829301	-96.408333	33.610278	709	P	1987		222		55		1.7		0.04
Grayson	1829301	-96.408333	33.610278	709	P	1997		132		28.9		1.2	<	0.26
Grayson	1820721	-96.595000	33.642222	730	U	1956		72		25				
Grayson	1835402	-96.734167	33.454167	730	U	1958		42		19		0.4		0
Grayson	1835401	-96.747222	33.448889	734	U	1953		65		28		1.4		0.4
Grayson	1835401	-96.747222	33.448889	734	U	1956		1281		114		2		6
Grayson	1835401	-96.747222	33.448889	734	U	1967		46		19		0.5	<	0.4
Grayson	1835401	-96.747222	33.448889	734	U	1976		23		20		0.3	<	0.4
Grayson	1828301	-96.534722	33.612778	745	H	1966		20		4		0.8	<	0.4
Grayson	1819702	-96.718889	33.627778	770	N	1953		62		17				
Grayson	1819701	-96.712500	33.627222	772	N	1951		55		15				
Grayson	1819701	-96.712500	33.627222	772	N	1977		63		12		0.7	<	0.4
Grayson	1820707	-96.620556	33.646111	786	P	1958		72		66		0.6		0.5
Grayson	1820707	-96.620556	33.646111	786	P	1966		73		26		0.7	<	0.4
Grayson	1820707	-96.620556	33.646111	786	P	1977		84		52		0.6	<	0.4
Grayson	1820707	-96.620556	33.646111	786	P	1983		110		202		0.7		0.18
Grayson	1819301	-96.657500	33.710556	788	U	1976		146		14		0.6	<	0.4
Grayson	1819301	-96.657500	33.710556	788	U	1987		186		14		0.5		0.22
Grayson	1820710	-96.624167	33.648333	789	P	1958		24		8.5		0.5		0.8
Grayson	1820710	-96.624167	33.648333	789	P	1969		32		11		0.5	<	0.4
Grayson	1820710	-96.624167	33.648333	789	P	1977		35		40		0.7		0.4
Grayson	1819302	-96.657500	33.711667	790	P	1971		124		11		0.6	<	0.4
Grayson	1819302	-96.657500	33.711667	790	P	1993		103		11		0.62		0.09
Grayson	1819307	-96.657222	33.711111	801	U	1957		15		11		0.5		0.2
Grayson	1810503	-96.831389	33.826944	834	P	1987		91		113		1.7		0.58
Grayson	1828503	-96.549444	33.568056	856	U	1965		238		104		0.7	<	0.4
Grayson	1819501	-96.670833	33.676111	865	N	1977		19		7		0.8	<	0.4
Grayson	1819901	-96.657778	33.625556	872	N	1971		30		11		1	<	0.4
Grayson	1827203	-96.683333	33.621111	900	H	1979		32		882		2.2	<	0.04
Grayson	1827205	-96.700000	33.619722	945	H	1979		73		13		0.7		1.5
Grayson	1827801	-96.701667	33.532500	950	P	1973		72		12		0.8		1
Grayson	1820901	-96.503611	33.634167	950	P	1983		32		10		0.8		0
Grayson	1827801	-96.701667	33.532500	950	P	1983		64		11		0.8		0.66
Grayson	1827801	-96.701667	33.532500	950	P	1997		73.4		9.89		0.68	<	0.27
Grayson	1820711	-96.593611	33.657222	955	P	1958		32		10		0.5		0
Grayson	1820711	-96.593611	33.657222	955	P	1969		73		29		0.7	<	0.4
Grayson	1820711	-96.593611	33.657222	955	P	1977		30		11		0.5	<	0.4
Grayson	1829103	-96.465556	33.603889	970	P	1974		29		10		0.7		1.5
Grayson	1820401	-96.603889	33.670000	1012	P	1969		21		11		0.5	<	0.4
Grayson	1820401	-96.603889	33.670000	1012	P	1972		19		12		0.4	<	0.4

County Name	State Well ID	Longitude	Latitude	Well Depth	Primary Water Uses	Year Collected	Sulfate Flag	Sulfate (Mg/L)	Chloride Flag	Chloride (Mg/L)	Fluoride Flag	Fluoride (Mg/L)	Nitrate Flag	Nitrate (Mg/L)
Grayson	1820401	-96.603889	33.670000	1012	P	1983		23		10		0.3	<	0.04
Grayson	1820805	-96.560000	33.641667	1022	P	1994		17.5		13.4		0.3		0
Grayson	1828103	-96.604722	33.583889	1023	P	1959		62		18				
Grayson	1835601	-96.644722	33.453333	1023	P	1967		74		29		1.7	<	0.4
Grayson	1828103	-96.604722	33.583889	1023	P	1969		56		14		0.9		0.5
Grayson	1828103	-96.604722	33.583889	1023	P	1977		57		14		0.8	<	0.4
Grayson	1820801	-96.577222	33.638889	1025	P	1966		26		9		1.2		0.3
Grayson	1820801	-96.577222	33.638889	1025	P	1977		61		158		0.8	<	0.4
Grayson	1820801	-96.577222	33.638889	1025	P	1997		18.2		8.76		0.34	<	0.27
Grayson	1820804	-96.563889	33.635833	1044	P	1977		40		11		0.9	<	0.4
Grayson	1828402	-96.612222	33.572778	1050	P	1977		80		17		0.9	<	0.4
Grayson	1827804	-96.672222	33.525000	1061	P	1979		122		14		0.9	<	0.04
Grayson	1827804	-96.672222	33.525000	1061	P	1987		106		14		0.9	<	0.04
Grayson	1828702	-96.611667	33.503611	1069	P	1958		118		33		1.4		3
Grayson	1828702	-96.611667	33.503611	1069	P	1970		94		28		1.7		3.5
Grayson	1828403	-96.602778	33.547222	1090	P	1977		100		57		1.8	<	0.4
Grayson	1828403	-96.602778	33.547222	1090	P	1987		93		44		2	<	0.04
Grayson	1828403	-96.602778	33.547222	1090	P	1997		92.8		30		1.64	<	0.27
Grayson	1828104	-96.611111	33.604722	1112	U	1962		149		63				
Grayson	1828705	-96.619444	33.529444	1134	P	1977		53		16		0.8	<	0.4
Grayson	1829901	-96.389444	33.513056	1160	P	1950		109		138		1.8		
Grayson	1829901	-96.389444	33.513056	1160	P	1962		100		87		2	<	0.4
Grayson	1829901	-96.389444	33.513056	1160	P	1972		106		75		3	<	0.4
Grayson	1829701	-96.484722	33.520833	1180	P	1958		99		104		1.6		1
Grayson	1829701	-96.484722	33.520833	1180	P	1964		97		102		2.1	<	0.4
Grayson	1829701	-96.484722	33.520833	1180	P	1976		141		55		1.6		0.5
Grayson	1829701	-96.484722	33.520833	1180	P	1987		106		104		1.8		0.13
Grayson	1829902	-96.390000	33.513056	1189	P	1958		108		56		1.4		2
Grayson	1829902	-96.390000	33.513056	1189	P	1962		110		45		1.3	<	0.4
Grayson	1829902	-96.390000	33.513056	1189	P	1972		109		45		1.9	<	0.4
Grayson	1829104	-96.490278	33.591111	1196	P	1986		23		14		0.8		0
Grayson	1828504	-96.551389	33.557222	1202	P	1987		294		75		0.6		0.04
Grayson	1828802	-96.566667	33.536389	1207	P	1982		86		22		1.7	<	0.1
Grayson	1829703	-96.482222	33.504444	1224	P	1977		324		142		1.5		0
Grayson	1828603	-96.540556	33.572778	1250	P	1976		70		20		0.9	<	0.4
Grayson	1829903	-96.398333	33.508611	1257	P	1972		133		34		0.9	<	0.4
Grayson	1828502	-96.579167	33.555278	1260	P	1967		99		29		1		1.4
Grayson	1828502	-96.579167	33.555278	1260	P	1977		96		24		1.2	<	0.4
Grayson	1828605	-96.532222	33.575000	1265	P	1983		33		22		0.8		1.3
Grayson	1828703	-96.608056	33.510556	1298	P	1968		96		28		1.4		4
Grayson	1828703	-96.608056	33.510556	1298	P	1970		60		16		0.9	<	0.4
Grayson	1829801	-96.441389	33.526111	1331	P	1975		103		26		1		2.2
Grayson	1828604	-96.524167	33.568889	1339	P	1986		90		14		1	<	0.4
Grayson	1829904	-96.390556	33.508611	1388	P	1976		136		30		1	<	0.4
Grayson	1829904	-96.390556	33.508611	1388	P	1987		136		31		1	<	0.04
Grayson	1836502	-96.576111	33.423333	1401	P	1958		74		19		0.8		0
Grayson	1836502	-96.576111	33.423333	1401	P	1962		75		24		0.8		2.8
Grayson	1836502	-96.576111	33.423333	1401	P	1971		75		19		1.2		1
Grayson	1836506	-96.575833	33.422500	1411	U	1951		85		28		0.9		
Grayson	1836504	-96.571667	33.435833	1425	P	1983		69		17		0.9	<	0.04
Grayson	1829702	-96.485000	33.520556	1475	P	1976		142		39		1.5	<	0.4
Grayson	1829702	-96.485000	33.520556	1475	P	1997		138		29.8		1.16	<	0.27
Grayson	1828902	-96.518333	33.515000	1502	P	1991		89.2		20		0.9		0
Grayson	1817909	-96.901944	33.663611	1507	P	1989		48		64		0.4		0.13
Grayson	1817909	-96.901944	33.663611	1507	P	1997		40		83		0.32	<	0.27
Grayson	1828901	-96.509444	33.516389	1520	P	1989		95		20		0.9	<	0.04
Grayson	1817908	-96.913333	33.652500	1522	P	1987		49		60		0.4		0.09
Grayson	1817908	-96.913333	33.652500	1522	P	1993		47		69		0.38		0.22
Grayson	1836602	-96.503056	33.431389	1527	P	1991		105		26.6		1.3		0
Grayson	1837602	-96.401667	33.427778	1598	P	1978		176.7		44.2		1.3		0
Grayson	1837601	-96.401944	33.422778	1638	P	1977		179		42		1.2		1
Grayson	1837603	-96.401944	33.423333	1800	P	1986		180.6		47.5		0.9		0
Hill	3254501	-97.301111	32.202222	40	U	1960		47		28				9
Hill	3255701	-97.226111	32.126389	166	H	1971		251		60		0.6	<	0.4
Hill	3255701	-97.226111	32.126389	166	H	1986		300		67		0.3		0.31
Hill	4007501	-97.181111	31.921111	185	S	1968		600		114		2.3		2.5
Hill	4007501	-97.181111	31.921111	185	S	1986		411		93		1.4		2.92
Hill	4007501	-97.181111	31.921111	185	S	1993		553		104		0.83		0.04
Hill	3263904	-97.143611	32.011111	200	U	1955		173		67		1.1	<	0.4
Hill	3263905	-97.141111	32.011111	200	U	1955		127		39		0.9		3.5
Hill	3263906	-97.144722	32.013056	200	U	1955		158		43		0.8		4.9
Hill	3263901	-97.143056	32.008889	200	U	1957		180		52		1.2		1.8
Hill	3255304	-97.151111	32.230000	273	U	1968		472		96		0.9	<	0.4
Hill	3255907	-97.150278	32.160833	290	P	1997		61.7		15		0.46	<	0.27
Hill	3255901	-97.150556	32.161111	293	U	1953		132		32		0.4	<	0.4
Hill	3255905	-97.140000	32.149722	300	U	1960		466		56				0.2
Hill	3255903	-97.140556	32.162500	312	P	1955		74		28		0.4	<	0.4
Hill	3255903	-97.140556	32.162500	312	P	1974		82		64		1.1		0.8
Hill	3255903	-97.140556	32.162500	312	P	1986		174		27		0.5		0.13
Hill	3264704	-97.115278	32.032222	315	H	1970		101		20		0.8		1.5
Hill	3255602	-97.132500	32.169167	340	P	1993		61		16		0.62		0.04
Hill	4008101	-97.084444	31.983889	480	H	1968		494		131		2.9	<	0.4
Hill	3256101	-97.083889	32.208611	488	U	1960		201		25		0.8		0.2
Hill	3264307	-97.006944	32.095833	520	S	1970		750		199		2.8	<	0.4
Hill	3264309	-97.025556	32.085278	575	P	1998		93.6		24.1		0.85	<	0.22
Hill	3264801	-97.071667	32.017500	595	H	1968		454		89		4.5		0.5
Hill	3264801	-97.071667	32.017500	595	H	1974		341		85		4.2		3.5
Hill	3264801	-97.071667	32.017500	595	H	1986		88		68		1.2		0.22
Hill	3264203	-97.058889	32.084167	640	P	1998		95.9		29.4		0.79		0.36
Hill	3264605	-97.041111	32.077500	670	P	1984		692		281		4.5		2.04

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Hill	3264604	-97.018889	32.058889	700	H	1970		187		52		2.6		3.5
Hill	4008301	-97.005278	31.967778	726	P	1959		600		340		5	<	0.4
Hill	4008301	-97.005278	31.967778	726	P	1968		620		335		4.2	<	0.4
Hill	4008301	-97.005278	31.967778	726	P	1986		625		293		4.9	<	0.04
Hill	4008301	-97.005278	31.967778	726	P	1993		618		289		1.37		0.09
Hill	3357103	-96.998889	32.086944	727	N	1965		245		64		2.2	<	0.4
Hill	3357601	-96.896389	32.056389	832	P	1969		470		157		3.4	<	0.4
Hill	3357601	-96.896389	32.056389	832	P	1978		487		172		3	<	0.09
Hill	3357601	-96.896389	32.056389	832	P	1984		502		171		3		0.09
Hill	3901102	-96.989722	31.994444	870	S	1968		670		550		4.1	<	0.4
Hill	3902101	-96.873333	31.991111	915	U	1962		474		481		4.3	<	0.4
Hill	3357602	-96.896389	32.056111	934	P	1998		207		61.5		1.82	<	0.22
Johnson	3254201	-97.312500	32.234444	18	S	1966		164		78		0.2		0
Johnson	3238501	-97.300833	32.452778	33	H	1970		116		31		0.3		56
Johnson	3231806	-97.191944	32.533611	93	H	1983		190		61		0.4		0.04
Johnson	3238810	-97.320000	32.381944	115	H	1983		356		138		0.5	<	0.04
Johnson	3230910	-97.260000	32.518333	125	I	1983		511		105		0.3	<	0.04
Johnson	3248403	-97.086944	32.293056	135	H	1976		391		71		1.7		3.6
Johnson	3246902	-97.260000	32.272500	137	S	1966		261		85				
Johnson	3247403	-97.233333	32.297222	152	S	1966		500		74		0.5		2
Johnson	3247807	-97.207500	32.271944	160	H	1970		420		67		2.8	<	0.4
Johnson	3246209	-97.320000	32.351111	160	I	1975		294		139		0.9		6
Johnson	3247504	-97.205556	32.320556	187	H	1966		62		25		0.7		1.2
Johnson	3239502	-97.172500	32.455278	197	H	1966		656		129				
Johnson	3239502	-97.172500	32.455278	197	H	1970		180		57		0.7		3
Johnson	3247801	-97.181111	32.268333	210	P	1952		183		43		0.7		0.4
Johnson	3247901	-97.136389	32.286944	210	S	1966		916		78				
Johnson	3247801	-97.181111	32.268333	210	P	1973		192		44		0.7		9
Johnson	3239505	-97.181667	32.453611	210	H	1989		193		57		0.5		
Johnson	3231902	-97.153333	32.515556	212	N	1975		102		22		0.7		6
Johnson	3231902	-97.153333	32.515556	212	N	1983		98		21		0.6		2.22
Johnson	3239102	-97.236111	32.467222	215	H	1966		256		31		1		0.2
Johnson	3247202	-97.169444	32.339722	216	H	1966		147		25		0.4		0.2
Johnson	3247202	-97.169444	32.339722	216	H	1989		132		46		0.7		
Johnson	3247202	-97.169444	32.339722	216	H	1997		113		40.3		0.53	<	0.27
Johnson	3231801	-97.188056	32.504167	217	H	1961		152		90		0.5		0.5
Johnson	3231901	-97.144167	32.505556	220	H	1966		104		20		0.6		0
Johnson	3247102	-97.231389	32.364722	220	H	1966		374		105		0.4		0
Johnson	3239901	-97.157222	32.385278	220	H	1970		158		29		0.5		7
Johnson	3247810	-97.179444	32.288333	220	N	1975		117		32		1.4		8
Johnson	3239901	-97.157222	32.385278	220	H	1987		160		30		0.4	<	0.04
Johnson	3247806	-97.181111	32.271944	224	P	1964		120		36		0.7	<	0.4
Johnson	3247806	-97.181111	32.271944	224	P	1989		251		60		0.3		
Johnson	3239801	-97.186667	32.392222	225	H	1966		108		19				
Johnson	3248101	-97.111944	32.370833	225	H	1970		231		23		0.8	<	0.4
Johnson	3255101	-97.217778	32.241667	235	H	1966		194		38				
Johnson	3247804	-97.166944	32.271944	237	H	1966		415		71		3		0.5
Johnson	3231802	-97.189167	32.504722	240	H	1966		181		24		1		0
Johnson	3231802	-97.189167	32.504722	240	H	1976		183		28		0.9		1.5
Johnson	3232701	-97.114167	32.524722	240	H	1976		126		43		0.4		0.4
Johnson	3231802	-97.189167	32.504722	240	H	1987		173		72		0.6	<	0.04
Johnson	3232701	-97.114167	32.524722	240	H	1989		126		39		0.4		1.24
Johnson	3239103	-97.235833	32.465833	244	H	1966		214		27				
Johnson	3239602	-97.155000	32.421111	250	H	1975		183		22		0.3		8
Johnson	3239705	-97.213889	32.386944	251	H	1983		102		27		1.4		0.71
Johnson	3247809	-97.175278	32.262778	255	I	1975		118		64		0.5		0.9
Johnson	3247302	-97.125000	32.365833	256	H	1966		58		20		0.9		0.2
Johnson	3247304	-97.145833	32.347778	260	H	1976		60		22		1	<	0.4
Johnson	3247304	-97.145833	32.347778	260	H	1987		78		52		1		1.15
Johnson	3239802	-97.199167	32.415833	263	H	1966		298		58				
Johnson	3239106	-97.220556	32.467500	264	P	1985		167		53		0.5		2.48
Johnson	3248702	-97.118333	32.272778	265	H	1961		70		20		1.1		2.2
Johnson	3239201	-97.203056	32.483889	270	S	1966		137		22				
Johnson	3239201	-97.203056	32.483889	270	S	1976		126		24		0.6		7
Johnson	3239201	-97.203056	32.483889	270	S	1987		126		23		0.6		0.04
Johnson	3239201	-97.203056	32.483889	270	S	1997		116		19.8		0.45	<	0.27
Johnson	3247805	-97.181111	32.269167	273	P	1952		345		75		0.4		0.4
Johnson	3247805	-97.181111	32.269167	273	P	1966		192		42		0.5		0.2
Johnson	3247805	-97.181111	32.269167	273	P	1975		580		80		0.8		14
Johnson	3247805	-97.181111	32.269167	273	P	1987		240		49		0.5		7.53
Johnson	3247805	-97.181111	32.269167	273	P	1997		1263		134		0.38	<	0.27
Johnson	3239302	-97.145000	32.476944	276	H	1975		102		21		0.6		9
Johnson	3239309	-97.134722	32.472222	296	P	1983		157		23		0.5		1.33
Johnson	3232704	-97.108611	32.536111	300	H	1976		462		19		0.3	<	0.4
Johnson	3240101	-97.113333	32.460000	305	H	1994		309		33		0.4	<	0.04
Johnson	3239107	-97.209167	32.481944	309	P	1984		136		43		0.5		1.37
Johnson	3239205	-97.180000	32.498333	309	P	1984		164		32		0.9		0.62
Johnson	3239107	-97.209167	32.481944	309	P	1993		141		42		0.46		0.04
Johnson	3247601	-97.154722	32.321667	310	H	1966		109		31		1.4		0.5
Johnson	3239605	-97.125278	32.423889	310	H	1966		207		15				
Johnson	3240401	-97.102500	32.431944	380	U	1951		259		28		0.4		0.9
Johnson	3240402	-97.102500	32.431944	380	P	1959		199		19		0.5	<	0.4
Johnson	3240402	-97.102500	32.431944	380	P	1961		223		21		0.7		0
Johnson	3240402	-97.102500	32.431944	380	P	1976		188		18		0.5	<	0.4
Johnson	3240408	-97.103056	32.432500	390	P	1993		206		17		0.58		0.04
Johnson	3240410	-97.095833	32.417778	395	P	1984		198		18		0.4		0.3
Johnson	3238701	-97.370556	32.388333	700	H	1970		47		17		0.6	<	0.4
Johnson	3239101	-97.242222	32.497778		H	1966		242		120		0.4		0
Tarrant	3224114	-97.121389	32.744444	14	Z	1993		1300		41		1.1	<	0.22
Tarrant	3207501	-97.204444	32.933889	17	H	1953		179		85		0.8		0

County Name	State Well ID	Longitude	Latitude	Well Depth	Primary Water Uses	Year Collected	Sulfate Flag	Sulfate (Mg/L)	Chloride Flag	Chloride (Mg/L)	Fluoride Flag	Fluoride (Mg/L)	Nitrate Flag	Nitrate (Mg/L)
Tarrant	3224112	-97.091944	32.734722	17	Z	1995		390		76		1.5		31.43
Tarrant	3216207	-97.074722	32.855833	18	Z	1993		810		57		0.7		0.62
Tarrant	3223315	-97.150000	32.722500	21	Z	1993		27		11		0.5	<	0.22
Tarrant	3224115	-97.121389	32.744444	23	Z	1993		1900		73		0.2		2.21
Tarrant	3216206	-97.083056	32.873611	25	Z	1993		2100		120		5		2.04
Tarrant	3216208	-97.067222	32.862222	25	Z	1993		340		150		0.3		0.25
Tarrant	3223206	-97.180556	32.711944	25	Z	1993		2000		1000		0.5	<	0.22
Tarrant	3223316	-97.139722	32.709444	25	Z	1993		910		410		0.4	<	0.22
Tarrant	3223508	-97.192778	32.677778	25	Z	1993		2000		3100		0.5	<	0.22
Tarrant	3223509	-97.183889	32.668611	25	Z	1995		800		110		0.8	<	0.22
Tarrant	3215608	-97.127778	32.831111	26	Z	1993		81		110		0.3	<	0.22
Tarrant	3215208	-97.179167	32.860278	27	Z	1993		440		460		0.3	<	0.22
Tarrant	3216109	-97.087778	32.845278	27	Z	1993		55		67		1		0.38
Tarrant	3215310	-97.154722	32.853611	28	Z	1995		240		120		0.3		43.8
Tarrant	3216106	-97.097500	32.833611	29	Z	1993		400		85		2		0.4
Tarrant	3224111	-97.109722	32.734444	29	Z	1993		360		390		1.7		102
Tarrant	3224113	-97.091944	32.734722	29	Z	1995		2000		250		1		0.9
Tarrant	3215309	-97.158611	32.853056	30	Z	1995		3300		1700		0.7	<	0.2
Tarrant	3223317	-97.135000	32.724444	31	Z	1993		470		150		0.4		43.38
Tarrant	3216209	-97.067222	32.862222	34	Z	1993		230		100		0.4	<	0.22
Tarrant	3223510	-97.183889	32.668611	37	Z	1995		260		70		0.2		0.22
Tarrant	3216205	-97.082500	32.845278	38	Z	1993		74		37		0.6	<	0.22
Tarrant	3215609	-97.127778	32.831111	42	Z	1993		19		56		0.2	<	0.22
Tarrant	3216110	-97.087778	32.845278	43	Z	1993		65		120		0.7	<	0.22
Tarrant	3215311	-97.154722	32.853611	47	Z	1993		360		190		0.4	<	0.22
Tarrant	3215801	-97.190000	32.766111	48	U	1953		52		31		0.2		1.8
Tarrant	3216107	-97.097500	32.833611	49	Z	1993		470		220		1.3		2.26
Tarrant	3215302	-97.135000	32.857222	50	H	1970		42		151		0.3		27
Tarrant	3231203	-97.179722	32.608056	50	N	1975		34		82		0.3		7
Tarrant	3215312	-97.154722	32.853611	58	Z	1993		420		190		0.5	<	0.22
Tarrant	3224118	-97.121111	32.726944	68	I	1993		180		92		1.2		38.07
Tarrant	3208108	-97.121944	32.981944	70	P	1974		48		35		0.4		1.7
Tarrant	3231311	-97.155833	32.619167	70	I	1978		10		72		0.3		2.4
Tarrant	3224116	-97.104722	32.732778	85	I	1993		1400		550		0.3	<	0.22
Tarrant	3207907	-97.143889	32.895833	87	I	1976		25		67		0.7		2.7
Tarrant	3207907	-97.143889	32.895833	87	I	1989		49		40		1.1		0.97
Tarrant	3223308	-97.155556	32.719722	98	I	1975		70		44		0.4		38
Tarrant	3223511	-97.175000	32.672500	100	I	1993		650		300		0.4	<	0.22
Tarrant	3224203	-97.083333	32.727778	100	I	1993		470		62		1.6		0.24
Tarrant	3207903	-97.142778	32.891111	103	P	1975		37		34		0.3		17
Tarrant	3207903	-97.142778	32.891111	103	P	1997		82.4		97.4	<	0.3		0.8
Tarrant	3208703	-97.122778	32.897500	105	I	1975		3.8		7		0.6	<	0.4
Tarrant	3208704	-97.118611	32.892500	110	I	1976		47		115		0.1		44
Tarrant	3208705	-97.123333	32.894167	110	I	1976		40		21		0.1		2.3
Tarrant	3216112	-97.085833	32.859444	120	I	1993		55		38		0.3	<	0.22
Tarrant	3224601	-97.037500	32.705556	125	H	1953		315		50		0.4		5.9
Tarrant	3207102	-97.225278	32.959722	125	P	1974		5		13		0.2		10
Tarrant	3216111	-97.087778	32.863333	129	I	1993		42		39		0.2	<	0.22
Tarrant	3223601	-97.131389	32.686667	135	U	1970		256		154		0.9	<	0.4
Tarrant	3223601	-97.131389	32.686667	135	U	1986		211		91		0.7		0.84
Tarrant	3208106	-97.101111	32.978056	145	P	1973		131		71		0.4	<	0.4
Tarrant	3208106	-97.101111	32.978056	145	P	1983		48		27		0.2	<	0.93
Tarrant	3216706	-97.105833	32.777500	150	U	1953		91		37				2.5
Tarrant	3215313	-97.143333	32.857500	150	I	1993		55		31		0.5		0.3
Tarrant	3216210	-97.082778	32.859722	158	I	1993		52		42		0.2	<	0.22
Tarrant	3223310	-97.143333	32.713889	160	I	1975		30		16		0.4	<	0.4
Tarrant	3223906	-97.148611	32.626111	160	I	1978		92		46		0.4		1.1
Tarrant	3232101	-97.092778	32.586111	165	H	1953		81		17		1.2		2.5
Tarrant	3208105	-97.102500	32.965278	170	P	1974		55		56		0.4		2.1
Tarrant	3231109	-97.223333	32.588611	170	P	1979		41		46		0.2	<	0.1
Tarrant	3231301	-97.162222	32.590000	171	H	1970		9		13		0.5	<	0.4
Tarrant	3231301	-97.162222	32.590000	171	H	1997		5.42		10.8	<	0.3	<	0.27
Tarrant	3208104	-97.084722	32.959167	177	P	1973		56		56		0.3	<	0.4
Tarrant	3223607	-97.143611	32.666944	180	I	1975		219		87		0.7	<	0.4
Tarrant	3223607	-97.143611	32.666944	180	I	1993		205		81		0.41		0.09
Tarrant	3215314	-97.146667	32.856944	180	I	1993		61		49		0.4	<	0.22
Tarrant	3207911	-97.130000	32.891667	185	I	1975		76		132		0.2		22
Tarrant	3208504	-97.075000	32.955556	187	P	1974		33		42		0.3	<	0.4
Tarrant	3208107	-97.093056	32.964722	195	P	1974		56		63		0.3	<	0.4
Tarrant	3208505	-97.079722	32.955278	197	P	1968		33		63				
Tarrant	3208505	-97.079722	32.955278	197	P	1974		65		58		0.3	<	0.4
Tarrant	3231602	-97.141944	32.565556	200	U	1950		181		40				3.5
Tarrant	3231601	-97.141389	32.563056	200	U	1956		40		32		0.3		1.6
Tarrant	3231602	-97.141944	32.565556	200	U	1963		150		32		0.5	<	0.4
Tarrant	3231604	-97.142500	32.564722	200	U	1965		167		29		0.6		1.5
Tarrant	3208202	-97.065556	32.982222	200	P	1974		50		28		0.8		2.3
Tarrant	3223608	-97.141111	32.666944	200	I	1976		228		117		0.3	<	0.4
Tarrant	3223608	-97.141111	32.666944	200	I	1987		214		87		0.4	<	0.04
Tarrant	3231310	-97.156667	32.618611	210	I	1978		16		18		0.7	<	0.4
Tarrant	3231313	-97.153889	32.616667	210	H	1978		49		35		0.4	<	0.4
Tarrant	3216801	-97.073056	32.778056	217	H	1970		179		35		0.8		4.5
Tarrant	3216801	-97.073056	32.778056	217	H	1989		187		35		0.5		0.53
Tarrant	3216801	-97.073056	32.778056	217	H	1993		183		34		0.51		2.04
Tarrant	3224117	-97.112222	32.709167	225	I	1997		101		37.9	<	0.3		6.42
Tarrant	3231609	-97.132778	32.552222	230	H	1983		341		33		0.5		2.6
Tarrant	3208201	-97.066944	32.958333	238	P	1972		40		56		0.3		1.5
Tarrant	3232404	-97.113611	32.553611	270	H	1975		95		18		0.6	<	0.4
Tarrant	3232404	-97.113611	32.553611	270	H	1983		106		18		0.5		0.09
Tarrant	3224804	-97.080278	32.628056	271	H	1983		325		38		0.3		0.89
Tarrant	3216802	-97.072778	32.776111	285	H	1975		168		32		1	<	0.4

County Name	State Well ID	Longitude	Latitude	Well Depth	Primary Water Uses	Year Collected	Sulfate Flag	Sulfate (Mg/L)	Chloride Flag	Chloride (Mg/L)	Fluoride Flag	Fluoride (Mg/L)	Nitrate Flag	Nitrate (Mg/L)
Tarrant	3232202	-97.068056	32.606111	289	P	1975		67		12		1.2		2.2
Tarrant	3231312	-97.138611	32.616389	295	I	1978								
Tarrant	3223905	-97.137500	32.636111	310	S	1977		560		47		2.5	<	0.4
Tarrant	3232205	-97.066944	32.614722	320	H	1983		47		29		0.6	<	0.04
Tarrant	3224803	-97.077778	32.648056	336	H	1989		39		19		1		0.31
Tarrant	3223901	-97.130000	32.645833	338	N	1975		28		28		0.6		4.7
Tarrant	3224404	-97.115833	32.676944	344	P	1975		54		25		0.8	<	0.4
Tarrant	3224502	-97.049722	32.703889	350	N	1972		190		18				
Tarrant	3224505	-97.050556	32.694722	395	I	1975		144		22		1	<	0.4
Tarrant	3207806	-97.203333	32.908611	700	P	1994		54		10		0.67		0.04
Tarrant	3215503	-97.185556	32.808611		H	1951		195		258				6.5

NOTE: Codes For Primary Well Uses

Code	Primary Well Use Types
H	Domestics
I	Irrigation
N	Industrial
P	Public Supply
S	Stock
U	Unused
Z	Other (refers to miscellaneous uses not included in the listed categories)

APPENDIX D

KRUSKAL-WALLIS TEST

BETWEEN CONTAMINANTS AND COUNTY

IN THE WOODBINE AQUIFER

BY DECADE

Woodbine Aquifer
Kruskal-Wallis
Between contaminants and county

Code no	County Name
1	Collin
2	Cooke
3	Dallas
4	Denton
5	Ellis
6	Grayson
7	Hill
8	Johnson
9	Tarrant

1950s

Sulfate

```
MTB > read 'e:\kruskal\county\1950\sulfate.txt' c1-c2
    100 ROWS READ
 ROW       C1   C2
   1     57.0    1
   2    322.0    1
   3    100.0    1
   4     47.0    1
  .  .  .

MTB > kruskal-wallis c1 c2

   94 CASES WERE USED
    6 CASES CONTAINED MISSING VALUES

LEVEL    NOBS    MEDIAN     AVE. RANK  Z VALUE
    1      10    164.50       48.0      0.07
    3      28    375.50       68.0      4.75
    5      10    479.50       70.2      2.78
    6      31     62.00       22.4     -6.26
    7       7    158.00       52.2      0.48
    9       8    135.00       39.8     -0.83
OVERALL    94                 47.5

H = 49.88  d.f. = 5  p = 0.000
H = 49.89  d.f. = 5  p = 0.000 (adj. for ties)
```

Chloride

```
MTB > read 'e:\kruskal\county\1950\chloride.txt' c1-c2
    100 ROWS READ

 ROW       C1   C2

   1     36.0    1
   2    302.0    1
   3     37.0    1
   4    147.0    1
  .  .  .

MTB > kruskal-wallis c1 c2

LEVEL    NOBS    MEDIAN    AVE. RANK   Z VALUE
    1      10    143.00       68.8      2.10
    3      28    163.00       71.6      4.54
    5      10    176.50       75.2      2.84
    6      37     19.00       23.9     -7.01
    7       7     43.00       50.6      0.01
    9       8     38.50       45.6     -0.50
OVERALL   100                 50.5

H = 57.28  d.f. = 5  p = 0.000
H = 57.29  d.f. = 5  p = 0.000 (adj. for ties)
```

Fluoride

```
MTB > read 'e:\kruskal\county\1950\fluoride.txt' c1-c2
    100 ROWS READ
 ROW     C1   C2
   1    1.2    1
   2    2.8    1
   3    2.8    1
   4    1.3    1
  .  .  .

MTB > kruskal-wallis c1 c2

   84 CASES WERE USED
   16 CASES CONTAINED MISSING VALUES

LEVEL    NOBS    MEDIAN    AVE. RANK   Z VALUE
    1      10    1.7000       47.1      0.64
    3      27    2.4000       59.4      4.36
    5       9    2.4000       64.6      2.88
    6      26    0.6500       23.8     -4.71
    7       7    0.9000       31.3     -1.27
    9       5    0.4000       15.4     -2.56
OVERALL    84                 42.5

H = 43.62  d.f. = 5  p = 0.000
H = 43.75  d.f. = 5  p = 0.000 (adj. for ties)
```

Nitrate

```
MTB > read 'e:\kruskal\county\1950\nitrate.txt' c1-c2
    100 ROWS READ
 ROW     C1   C2
   1    0.0    1
   2    0.0    1
   3    3.0    1
   4    0.0    1
  .  .  .

MTB > kruskal-wallis c1 c2

   86 CASES WERE USED
   14 CASES CONTAINED MISSING VALUES

LEVEL    NOBS    MEDIAN    AVE. RANK   Z VALUE
    1      10   0.00E+00       41.6     -0.26
    3      27   0.00E+00       39.9     -0.90
    5      10   0.00E+00       39.8     -0.50
    6      24   2.00E-01       41.8     -0.39
    7       7   0.00E+00       45.0      0.17
    9       8   2.50E+00       66.3      2.71
OVERALL    86                  43.5

H = 7.60  d.f. = 5  p = 0.181
H = 8.98  d.f. = 5  p = 0.111 (adj. for ties)
```

1960s

Sulfate

```
MTB > read 'e:\kruskal\county\1960\sulfate.txt' c1-c2
    187 ROWS READ
 ROW     C1   C2
   1    153    1
   2    438    1
   3    348    1
   4    348    1
  .  .  .

MTB > kruskal-wallis c1 c2

  185 CASES WERE USED
    2 CASES CONTAINED MISSING VALUES

LEVEL    NOBS    MEDIAN    AVE. RANK   Z VALUE
    1      10    204.50       68.1     -1.51
    3      26    361.50      116.2      2.38
    4      11    164.00       54.1     -2.48
    5      78    403.00      115.8      4.95
    6      22     64.50       21.2     -6.70
    7      12    471.00      131.6      2.58
    8      26    193.00       70.3     -2.33
OVERALL   185                 93.0

H = 77.48  d.f. = 6  p = 0.000
H = 77.49  d.f. = 6  p = 0.000 (adj. for ties)
```

Chloride

```
MTB > read 'e:\kruskal\county\1960\chloride.txt' c1-c2
    187 ROWS READ

 ROW     C1   C2

   1     78    1
   2    616    1
   3     92    1
   4     92    1
  .  .  .

MTB > kruskal-wallis c1 c2

LEVEL    NOBS    MEDIAN    AVE. RANK   Z VALUE
    1      10     73.50       92.3     -0.10
    3      28    132.00      121.0      2.86
    4      11     75.00       91.0     -0.19
    5      78    115.50      112.4      3.94
    6      22     21.50       33.4     -5.59
     7      12    105.00      110.8      1.11
    8      26     33.50       55.0     -3.96
OVERALL   187                 94.0

H = 58.29  d.f. = 6  p = 0.000
H = 58.30  d.f. = 6  p = 0.000 (adj. for ties)
```

Fluoride

```
MTB > read 'e:\kruskal\county\1960\fluoride.txt' c1-c2
    187 ROWS READ
 ROW     C1   C2
   1    0.7    1
   2    3.0    1
   3    2.7    1
   4    2.7    1
  .  .  .

MTB > kruskal-wallis c1 c2

  135 CASES WERE USED
   52 CASES CONTAINED MISSING VALUES

LEVEL    NOBS    MEDIAN    AVE. RANK   Z VALUE
    1      10    2.1500       67.7     -0.02
    3      26    2.8500       83.7      2.28
    4      11    1.5000       51.5     -1.46
    5      41    3.2000       91.8      4.67
    6      20    0.8000       33.0     -4.33
    7      10    3.1500       88.7      1.74
    8      17    0.7000       26.3     -4.70
OVERALL   135                 68.0

H = 59.45  d.f. = 6  p = 0.000
H = 59.50  d.f. = 6  p = 0.000 (adj. for ties)
```

Nitrate

```
MTB > read 'e:\kruskal\county\1960\nitrate.txt' c1-c2
    187 ROWS READ
 ROW     C1   C2
   1    0.0    1
   2    0.6    1
   3    0.4    1
   4    0.0    1
  .  .  .

MTB > kruskal-wallis c1 c2

  141 CASES WERE USED
   46 CASES CONTAINED MISSING VALUES

LEVEL    NOBS     MEDIAN    AVE. RANK   Z VALUE
    1      10   0.00E+00       72.9      0.15
    3      26   0.00E+00       74.5      0.49
    4      11   0.00E+00       60.3     -0.91
    5      45   0.00E+00       75.7      0.94
    6      20   0.00E+00       67.2     -0.45
    7      12   0.00E+00       64.8     -0.55
    8      17   0.00E+00       67.7     -0.35
OVERALL   141                 71.0

H = 2.13  d.f. = 6  p = 0.907
H = 2.98  d.f. = 6  p = 0.811 (adj. for ties)
```

1970s

Sulfate

```
MTB > read 'e:\kruskal\county\1970\sulfate.txt' c1-c2
    348 ROWS READ
 ROW       C1   C2
   1    203.0    1
   2    105.0    1
   3    241.0    1
   4    109.0    1
  .  .  .
MTB > kruskal-wallis c1 c2

  347 CASES WERE USED
    1 CASES CONTAINED MISSING VALUES

LEVEL    NOBS    MEDIAN    AVE. RANK   Z VALUE
    1      24    153.50      189.3      0.78
    2       5     29.00       95.0     -1.77
    3      53    405.00      256.4      6.50
    4      64     88.50      149.3     -2.18
    5      45    344.00      266.2      6.61
    6      90     66.50      114.8     -6.50
    7       7    251.00      238.6      1.72
    8      21    180.00      206.8      1.55
    9      38     52.00      102.3     -4.67
OVERALL   347                174.0

H = 137.19  d.f. = 8  p = 0.000
H = 137.20  d.f. = 8  p = 0.000 (adj. for ties)
```

Chloride

```
MTB > read 'e:\kruskal\county\1970\chloride.txt' c1-c2
    348 ROWS READ
 ROW      C1   C2
   1    59.0    1
   2   115.0    1
   3   152.0    1
   4    30.0    1
  .  .  .

MTB > kruskal-wallis c1 c2

  347 CASES WERE USED
    1 CASES CONTAINED MISSING VALUES

LEVEL    NOBS    MEDIAN    AVE. RANK   Z VALUE
    1      24     65.00      217.5      2.20
    2       5     39.00      215.9      0.94
    3      53     92.00      225.5      4.06
    4      64     37.00      170.3     -0.33
    5      45     77.00      234.0      4.30
    6      90     21.00      107.2     -7.34
    7       7     64.00      228.6      1.46
    8      21     29.00      149.0     -1.18
    9      38     43.00      166.3     -0.50
OVERALL   347                174.0

H = 79.00  d.f. = 8  p = 0.000
H = 79.02  d.f. = 8  p = 0.000 (adj. for ties)
```

Fluoride

```
MTB > read 'e:\kruskal\county\1970\fluoride.txt' c1-c2
    348 ROWS READ
 ROW     C1   C2
   1    3.7    1
   2    2.6    1
   3    2.7    1
   4    1.3    1
  .  .  .

MTB > kruskal-wallis c1 c2

  345 CASES WERE USED
    3 CASES CONTAINED MISSING VALUES

LEVEL    NOBS    MEDIAN    AVE. RANK   Z VALUE
    1      24    1.9000      238.7      3.34
    2       5    0.2000       45.8     -2.87
    3      52    2.2000      247.4      5.84
    4      64    1.0000      171.4     -0.14
    5      45    1.9000      250.2      5.57
    6      90    0.7000      125.0     -5.31
    7       7    2.6000      234.5      1.65
    8      21    0.7000      126.2     -2.22
    9      37    0.4000       83.6     -5.77
OVERALL   345                173.0

H = 132.34  d.f. = 8  p = 0.000
H = 132.71  d.f. = 8  p = 0.000 (adj. for ties)
```

Nitrate

```
MTB > read 'e:\kruskal\county\1970\nitrate.txt' c1-c2
    348 ROWS READ
 ROW       C1   C2
   1     3.20    1
   2     0.00    1
   3     0.00    1
   4     0.50    1
  .  .  .

MTB > kruskal-wallis c1 c2

  345 CASES WERE USED
    3 CASES CONTAINED MISSING VALUES

LEVEL    NOBS    MEDIAN    AVE. RANK   Z VALUE
    1      24   0.00E+00      148.3     -1.26
    2       5   4.00E-01      158.3     -0.33
    3      53   1.30E+00      188.7      1.24
    4      64   5.00E-01      176.9      0.34
    5      45   1.09E+00      197.6      1.78
    6      89   0.00E+00      137.9     -3.85
    7       7   8.00E-01      175.0      0.05
    8      21   3.60E+00      235.2      2.95
    9      37   0.00E+00      180.6      0.49
OVERALL   345                 173.0

H = 25.11  d.f. = 8  p = 0.002
H = 28.59  d.f. = 8  p = 0.000 (adj. for ties)
```

1980s

Sulfate

```
MTB > read 'e:\kruskal\county\1980\sulfate.txt' c1-c2
    156 ROWS READ
 ROW      C1   C2
   1   123.0    1
   2   111.0    1
   3    98.0    1
   4    55.0    1
  .  .  .

MTB > kruskal-wallis c1 c2

  152 CASES WERE USED
    4 CASES CONTAINED MISSING VALUES

LEVEL    NOBS    MEDIAN    AVE. RANK   Z VALUE
    1      22    138.50       60.0     -1.90
    3      14    419.50      113.7      3.32
    4      12     86.00       44.2     -2.64
    5      35    362.00      114.4      5.81
    6      33     90.00       40.2     -5.36
    7       7    411.00      112.5      2.22
    8      19    164.00       76.9      0.05
    9      10    146.50       60.5     -1.19
OVERALL   152                 76.5

H = 73.98  d.f. = 7  p = 0.000
H = 73.98  d.f. = 7  p = 0.000 (adj. for ties)
```

Chloride

```
MTB > read 'e:\kruskal\county\1980\chloride.txt' c1-c2
    156 ROWS READ
 ROW       C1   C2
   1     70.0    1
   2     31.0    1
   3    155.0    1
   4     17.0    1
  .  .  .

MTB > kruskal-wallis c1 c2

  152 CASES WERE USED
    4 CASES CONTAINED MISSING VALUES

LEVEL    NOBS    MEDIAN    AVE. RANK   Z VALUE
    1      22     60.00       81.8      0.61
    3      14    114.50       99.7      2.07
    4      12     33.50       56.9     -1.61
    5      35     92.00      101.7      3.85
    6      33     18.00       46.2     -4.47
    7       7     93.00      109.9      2.06
    8      19     46.00       68.4     -0.86
    9      10     34.00       59.7     -1.25
OVERALL   152                 76.5

H = 39.76  d.f. = 7  p = 0.000
H = 39.77  d.f. = 7  p = 0.000 (adj. for ties)
```

Fluoride

```
MTB > read 'e:\kruskal\county\1980\fluoride.txt' c1-c2
    156 ROWS READ
 ROW     C1   C2
   1    1.3    1
   2    1.2    1
   3    1.5    1
   4    0.8    1
  .  .  .

MTB > kruskal-wallis c1 c2

  152 CASES WERE USED
    4 CASES CONTAINED MISSING VALUES

LEVEL    NOBS    MEDIAN    AVE. RANK   Z VALUE
    1      22    1.4500       86.8      1.19
    3      14    2.2000      106.1      2.64
    4      12    1.5000       85.2      0.72
    5      35    2.3000      109.3      5.02
    6      33    0.8000       54.5     -3.24
    7       7    1.4000       88.3      0.73
    8      19    0.5000       33.2     -4.59
    9      10    0.5000       33.7     -3.18
OVERALL   152                 76.5

H = 64.01  d.f. = 7  p = 0.000
H = 64.14  d.f. = 7  p = 0.000 (adj. for ties)
```

Nitrate

```
MTB > read 'e:\kruskal\county\1980\nitrate.txt' c1-c2
    156 ROWS READ
 ROW      C1   C2
   1    2.61    1
   2    1.82    1
   3    0.53    1
   4    0.93    1
  .  .  .

MTB > kruskal-wallis c1 c2

  144 CASES WERE USED
   12 CASES CONTAINED MISSING VALUES

LEVEL    NOBS     MEDIAN    AVE. RANK   Z VALUE
    1      22   0.00E+00       76.1      0.44
    3      14   0.00E+00       53.5     -1.79
    4      12   0.00E+00       63.8     -0.76
    5      30   0.00E+00       69.1     -0.50
    6      33   0.00E+00       66.3     -0.97
    7       7   0.00E+00       76.9      0.29
    8      16   6.65E-01       94.8      2.26
    9      10   6.85E-01       93.5      1.65
OVERALL   144                  72.5

H = 11.69  d.f. = 7  p = 0.113
H = 19.45  d.f. = 7  p = 0.007 (adj. for ties)
```

1990s

Sulfate

```
MTB > read 'e:\kruskal\county\1990\sulfate.txt' c1-c2
    107 ROWS READ
 ROW        C1   C2
   1    147.00    1
   2    113.00    1
   3    130.00    1
   4    106.00    1
  .  .  .

MTB > kruskal-wallis c1 c2

LEVEL    NOBS    MEDIAN     AVE. RANK  Z VALUE
    1       9    113.00       41.3     -1.29
    3       8    339.50       60.2      0.59
    4       9     59.00       37.1     -1.71
    5      10    357.50       76.2      2.38
    6      15     73.40       25.0     -3.90
    7       7     95.90       53.8     -0.02
    8       6    173.50       61.5      0.61
    9      43    340.00       63.0      2.45
OVERALL   107                 54.0

H = 26.65  d.f. = 7  p = 0.000
H = 26.65  d.f. = 7  p = 0.000 (adj. for ties)
```

Chloride

```
MTB > read 'e:\kruskal\county\1990\chloride.txt' c1-c2
    107 ROWS READ
 ROW        C1   C2
   1     37.40    1
   2     30.00    1
   3     37.00    1
   4     65.00    1
  .  .  .

MTB > kruskal-wallis c1 c2

LEVEL    NOBS    MEDIAN    AVE. RANK   Z VALUE
    1       9     37.40       44.4     -0.97
    3       8     74.60       54.4      0.04
    4       9     28.00       44.7     -0.94
    5      10    105.35       72.7      2.00
    6      15     18.00       22.0     -4.31
    7       7     29.40       44.3     -0.86
    8       6     36.65       41.7     -1.00
    9      43     92.00       68.0      3.83
OVERALL   107                 54.0

H = 31.68  d.f. = 7  p = 0.000
H = 31.68  d.f. = 7  p = 0.000 (adj. for ties)
```

Fluoride

```
MTB > read 'e:\kruskal\county\1990\fluoride.txt' c1-c2
    107 ROWS READ
 ROW     C1   C2
   1   1.62    1
   2   1.18    1
   3   1.30    1
   4   0.80    1
  .  .  .

MTB > kruskal-wallis c1 c2

LEVEL    NOBS    MEDIAN    AVE. RANK   Z VALUE
    1       9    1.3000       78.9      2.52
    3       8    1.1200       75.6      2.05
    4       9    1.0000       62.3      0.84
    5      10    1.9450       88.1      3.64
    6      15    0.3800       39.9     -1.90
    7       7    0.8300       63.3      0.82
    8       6    0.4550       35.8     -1.48
    9      43    0.5000       41.1     -3.54
OVERALL   107                 54.0

H = 35.66  d.f. = 7  p = 0.000
H = 35.75  d.f. = 7  p = 0.000 (adj. for ties)
```

Nitrate

```
MTB > read 'e:\kruskal\county\1990\nitrate.txt' c1-c2
    107 ROWS READ
 ROW       C1   C2
   1     0.00    1
   2     1.78    1
   3     0.00    1
   4     0.00    1
  .  .  .

MTB > kruskal-wallis c1 c2

  106 CASES WERE USED
    1 CASES CONTAINED MISSING VALUES

LEVEL    NOBS    MEDIAN     AVE. RANK   Z VALUE
    1       9   0.00E+00       47.8     -0.58
    3       8   0.00E+00       42.0     -1.10
    4       8   0.00E+00       48.6     -0.47
    5      10   0.00E+00       47.1     -0.69
    6      15   0.00E+00       52.2     -0.17
    7       7   0.00E+00       48.1     -0.48
    8       6   0.00E+00       42.0     -0.94
    9      43   0.00E+00       62.2      2.39
OVERALL   106                  53.5

H =  6.55  d.f. = 7  p = 0.478
H = 12.59  d.f. = 7  p = 0.084 (adj. for ties)

MTB > stop
*** Minitab Release 8.3 Extended *** Minitab, Inc. ***
Storage available 100000
```

APPENDIX E

KRUSKAL-WALLIS TEST

BETWEEN CONTAMINANTS AND LAND USE TYPES

IN THE WOODBINE AQUIFER

IN 1990s

Woodbine Aquifer
Kruskal-Wallis
Between contaminants and land use types in 1990s

Land use #	Land use type
1	Water
2	Forest
3	Urban
4	Grassland
5	Cropland
6	Wetland
7	Shrub land
8	Bare soil

This study did not have # 1, 6, and 8

Sulfate

```
MTB > read 'e:\kruskal\landuse\sulfate.txt' c1-c2
    108 ROWS READ

 ROW       C1   C2

   1     50.0    5
   2     46.0    5
   3    339.0    5
   4    490.0    5
  .  .  .

MTB > kruskal-wallis c1 c2

LEVEL    NOBS    MEDIAN    AVE. RANK   Z VALUE
    2      11     113.0       51.3     -0.36
    3      43     138.0       55.2      0.20
    4      34     124.5       51.2     -0.75
    5      20     290.0       60.3      0.92
OVERALL   108                 54.5

H = 1.21  d.f. = 3  p = 0.751
H = 1.21  d.f. = 3  p = 0.751 (adj. for ties)
```

Chloride

```
MTB > read 'e:\kruskal\landuse\chloride.txt' c1 c2
    108 ROWS READ

 ROW        C1    C2

   1     26.90    5
   2     69.60    4
   3     37.40    4
   4     37.00    3
  .  .  .

MTB > kruskal-wallis c1 c2

LEVEL    NOBS    MEDIAN    AVE. RANK   Z VALUE
    2      11     69.00       63.6      1.02
    3      43     76.00       61.1      1.79
    4      34     37.65       44.4     -2.27
    5      20     63.70       52.3     -0.34
OVERALL   108                 54.5

H = 6.47  d.f. = 3  p = 0.091
H = 6.47  d.f. = 3  p = 0.091 (adj. for ties)
```

Fluoride

```
MTB > read 'e:\kruskal\landuse\fluoride.txt' c1-c2
    108 ROWS READ

 ROW     C1   C2

   1   1.00    5
   2   3.10    4
   3   1.62    4
   4   1.30    3
  .  .  .

MTB > kruskal-wallis c1 c2

LEVEL    NOBS    MEDIAN    AVE. RANK   Z VALUE
    2      11    0.4000       45.3     -1.03
    3      43    0.7000       53.1     -0.38
    4      34    0.5000       51.1     -0.77
    5      20    1.0000       68.4      2.20
OVERALL   108                 54.5

H = 5.40  d.f. = 3  p = 0.145
H = 5.42  d.f. = 3  p = 0.145 (adj. for ties)
```

Nitrate

```
MTB > read 'e:\kruskal\landuse\nitrate.txt' c1-c2
    108 ROWS READ

 ROW       C1   C2

   1     0.00    5
   2     0.00    4
   3     0.00    4
   4     0.00    3
  .  .  .

MTB > kruskal-wallis c1 c2

  107 CASES WERE USED
    1 CASES CONTAINED MISSING VALUES

LEVEL    NOBS    MEDIAN     AVE. RANK   Z VALUE
    2      11    0.00E+00       60.2      0.70
    3      43    0.00E+00       59.2      1.41
    4      33    0.00E+00       50.1     -0.86
    5      20    0.00E+00       45.8     -1.30
OVERALL   107                   54.0

H = 3.52  d.f. = 3  p = 0.318
H = 6.05  d.f. = 3  p = 0.110 (adj. for ties)

MTB > stop
*** Minitab Release 8.3 Extended *** Minitab, Inc. ***
Storage available 100000
```

APPENDIX F

KRUSKAL-WALLIS TEST

BETWEEN CONTAMINANTS AND PRIMARY WELL USES

IN THE WOODBINE AQUIFER

BY DECADE

Woodbine Aquifer
Kruskal-Wallis
Between contaminants and Primary Well Uses

Code no.	PWU
1	Domestic
2	Irrigation
3	Industrial
4	Public Supply
5	Stock
6	Unused
7	Other (Miscellaneous Uses)

1950s

Sulfate

```
MTB > read 'e:\kruskal\pwu\1950\sulfate.txt' c1-c2
     97 ROWS READ
 ROW       C1   C2
   1     57.0    4
   2    322.0    4
   3    100.0    4
   4     47.0    4
  .  .  .

MTB > kruskal-wallis c1 c2

   90 CASES WERE USED
    7 CASES CONTAINED MISSING VALUES

LEVEL    NOBS    MEDIAN    AVE. RANK   Z VALUE
    1       6     147.5       39.6     -0.57
    4      33     183.0       47.6      0.58
    6      51     173.0       44.8     -0.27
OVERALL    90                 45.5

H = 0.55  d.f. = 2  p = 0.759
H = 0.55  d.f. = 2  p = 0.759 (adj. for ties)
```

Chloride

```
MTB > read 'e:\kruskal\pwu\1950\chloride.txt' c1-c2
     97 ROWS READ
 ROW       C1   C2
   1     36.0    4
   2    302.0    4
   3     37.0    4
   4    147.0    4
  .  .  .

MTB > kruskal-wallis c1 c2

   96 CASES WERE USED
    1 CASES CONTAINED MISSING VALUES

LEVEL    NOBS    MEDIAN    AVE. RANK   Z VALUE
    1       7     26.00       35.1     -1.32
    4      35     75.00       46.8     -0.45
    6      54     69.00       51.3      1.13
OVERALL    96                 48.5

H = 2.31  d.f. = 2  p = 0.315
H = 2.31  d.f. = 2  p = 0.315 (adj. for ties)
```

Fluoride

```
MTB > read 'e:\kruskal\pwu\1950\fluoride.txt' c1-c2
     93 ROWS READ

ROW      C1   C2
   1    1.2    4
   2    2.8    4
   3    2.8    4
   4    1.3    4
  .  .  .

MTB > kruskal-wallis c1 c2

   79 CASES WERE USED
   14 CASES CONTAINED MISSING VALUES

LEVEL    NOBS    MEDIAN    AVE. RANK   Z VALUE
    4      31     1.800       41.4      0.42
    6      48     1.400       39.1     -0.42
OVERALL    79                 40.0

H = 0.18  d.f. = 1  p = 0.673
H = 0.18  d.f. = 1  p = 0.673 (adj. for ties)
```

Nitrate

```
MTB > read 'e:\kruskal\pwu\1950\nitrate.txt' c1-c2
     99 ROWS READ

 ROW      C1   C2

   1    0.0    4
   2    0.0    4
   3    3.0    4
   4    0.0    4
  .  .  .

MTB > kruskal-wallis c1 c2

   84 CASES WERE USED
   15 CASES CONTAINED MISSING VALUES

LEVEL    NOBS     MEDIAN      AVE. RANK   Z VALUE
    1       5    2.50E+00       55.1      1.19
    4      30    0.00E+00       36.9     -1.58
    6      49    4.00E-01       44.7      0.96
OVERALL    84                   42.5

H = 3.32  d.f. = 2  p = 0.191
H = 3.84  d.f. = 2  p = 0.147 (adj. for ties)
```

1960s

Sulfate

```
MTB > read 'e:\kruskal\pwu\1960\sulfate.txt' c1-c2
    184 ROWS READ

 ROW      C1   C2

   1     153    6
   2     438    4
   3     348    6
   4     348    4
  .  .  .

MTB > kruskal-wallis c1 c2

  182 CASES WERE USED
    2 CASES CONTAINED MISSING VALUES

LEVEL    NOBS    MEDIAN    AVE. RANK   Z VALUE
    1      63     340.0       98.0      1.21
    4      69     268.0       77.1     -2.88
    5      15     374.0      118.5      2.07
    6      35     348.0       96.6      0.64
OVERALL   182                 91.5

H = 10.39  d.f. = 3  p = 0.016
H = 10.39  d.f. = 3  p = 0.016 (adj. for ties)
```

Chloride

```
MTB > read 'e:\kruskal\pwu\1960\chloride.txt' c1-c2
    184 ROWS READ

 ROW      C1   C2

   1      78    6
   2     616    4
   3      92    6
   4      92    4
  .  .  .

MTB > kruskal-wallis c1 c2

LEVEL    NOBS    MEDIAN    AVE. RANK   Z VALUE
    1      64     84.50       88.3     -0.78
    4      69     75.00       85.4     -1.39
    5      15     82.00      103.4      0.82
    6      36    118.00      109.0      2.07
OVERALL   184                 92.5

H = 5.70  d.f. = 3  p = 0.128
H = 5.70  d.f. = 3  p = 0.128 (adj. for ties)
```

Fluoride

```
MTB > read 'e:\kruskal\pwu\1960\fluoride.txt' c1-c2
    184 ROWS READ

 ROW     C1   C2

   1    0.7    6
   2    3.0    4
   3    2.7    6
   4    2.7    4
  .  .  .

MTB > kruskal-wallis c1 c2

  132 CASES WERE USED
   52 CASES CONTAINED MISSING VALUES

LEVEL    NOBS    MEDIAN    AVE. RANK   Z VALUE
    1      29     1.300       56.0     -1.67
    4      68     1.950       66.0     -0.16
    5       7     2.300       59.4     -0.51
    6      28     2.850       80.4      2.17
OVERALL   132                 66.5

H = 6.15  d.f. = 3  p = 0.105
H = 6.15  d.f. = 3  p = 0.105 (adj. for ties)
```

Nitrate

```
MTB > read 'e:\kruskal\pwu\1960\nitrate.txt' c1-c2
    184 ROWS READ

 ROW     C1   C2

   1    0.0    6
   2    0.6    4
   3    0.4    6
   4    0.0    4
  .  .  .

MTB > kruskal-wallis c1 c2

  138 CASES WERE USED
   46 CASES CONTAINED MISSING VALUES

LEVEL    NOBS     MEDIAN      AVE. RANK   Z VALUE
    1      32    0.00E+00       71.3       0.29
    4      67    0.00E+00       67.9      -0.46
    5       7    2.00E+00       97.4       1.89
    6      32    0.00E+00       65.0      -0.73
OVERALL   138                   69.5

H = 3.98  d.f. = 3  p = 0.264
H = 5.51  d.f. = 3  p = 0.139 (adj. for ties)
```

1970s

Sulfate

```
MTB > read 'e:\kruskal\pwu\1970\sulfate.txt' c1-c2
    348 ROWS READ
 ROW       C1   C2
   1    203.0    1
   2    105.0    1
   3    241.0    1
   4    109.0    3
  .  .  .

MTB > kruskal-wallis c1 c2

  347 CASES WERE USED
    1 CASES CONTAINED MISSING VALUES

LEVEL    NOBS    MEDIAN    AVE. RANK   Z VALUE
    1      86     92.50      145.0     -3.09
    2      57     84.00      145.4     -2.35
    3      31    190.00      203.5      1.72
    4     141    141.00      187.6      2.09
    5      10    337.50      227.4      1.71
    6      22    215.50      208.7      1.68
OVERALL   347                174.0

H = 22.58  d.f. = 5  p = 0.000
H = 22.58  d.f. = 5  p = 0.000 (adj. for ties)
```

Chloride

```
MTB > read 'e:\kruskal\pwu\1970\chloride.txt' c1-c2
    348 ROWS READ
 ROW      C1   C2
   1    59.0    1
   2   115.0    1
   3   152.0    1
   4    30.0    3
  .  .  .

MTB > kruskal-wallis c1 c2


  347 CASES WERE USED
    1 CASES CONTAINED MISSING VALUES

LEVEL    NOBS    MEDIAN    AVE. RANK   Z VALUE
    1      86     31.00      148.6     -2.71
    2      57     31.00      153.4     -1.70
    3      31     56.00      181.0      0.41
     4     141     55.00      188.3      2.19
    5      10     57.50      202.4      0.91
    6      22    113.50      212.7      1.87
OVERALL   347                174.0

H = 15.02  d.f. = 5  p = 0.011
H = 15.02  d.f. = 5  p = 0.011 (adj. for ties)
```

Fluoride

```
MTB > read 'e:\kruskal\pwu\1970\fluoride.txt' c1-c2
    348 ROWS READ
 ROW     C1   C2
   1    3.7    1
   2    2.6    1
   3    2.7    1
   4    1.3    3
  .  .  .

MTB > kruskal-wallis c1 c2

  345 CASES WERE USED
    3 CASES CONTAINED MISSING VALUES

LEVEL    NOBS    MEDIAN    AVE. RANK   Z VALUE
    1      86    1.0000      172.1     -0.09
    2      57    0.4000      102.3     -5.86
    3      29    1.4000      211.9      2.20
    4     141    1.3000      190.3      2.68
    5      10    0.8500      167.1     -0.19
    6      22    1.0000      200.1      1.32
OVERALL   345                173.0

H = 39.00  d.f. = 5  p = 0.000
H = 39.11  d.f. = 5  p = 0.000 (adj. for ties)
```

Nitrate

```
MTB > read 'e:\kruskal\pwu\1970\nitrate.txt' c1-c2
    348 ROWS READ

 ROW       C1   C2

   1     3.20    1
   2     0.00    1
   3     0.00    1
   4     0.50    3
  .  .  .

MTB > kruskal-wallis c1 c2

  345 CASES WERE USED
    3 CASES CONTAINED MISSING VALUES

LEVEL    NOBS    MEDIAN     AVE. RANK   Z VALUE
    1      86   2.00E-01      173.6      0.06
    2      57   0.00E+00      168.6     -0.36
    3      30   2.20E+00      209.4      2.09
    4     140   1.10E-01      168.1     -0.75
    5      10   0.00E+00      173.2      0.01
    6      22   0.00E+00      163.1     -0.48
OVERALL   345                173.0

H = 4.67  d.f. = 5  p = 0.458
H = 5.32  d.f. = 5  p = 0.379 (adj. for ties)
```

1980s

Sulfate

```
MTB > read 'e:\kruskal\pwu\1980\sulfate.txt' c1-c2
    156 ROWS READ

 ROW      C1   C2

   1   123.0    4
   2   111.0    3
   3    98.0    4
   4    55.0    3
  .  .  .

MTB > kruskal-wallis c1 c2

  152 CASES WERE USED
    4 CASES CONTAINED MISSING VALUES

LEVEL    NOBS    MEDIAN    AVE. RANK   Z VALUE
    1      40     129.0       63.5     -2.17
    2       9     214.0       91.5      1.05
    3      12     149.0       78.4      0.15
    4      82     170.0       79.0      0.74
    6       9     333.5       94.3      1.25
OVERALL   152                 76.5

H = 6.26  d.f. = 4  p = 0.182
H = 6.26  d.f. = 4  p = 0.182 (adj. for ties)
```

Chloride

```
MTB > read 'e:\kruskal\pwu\1980\chloride.txt' c1-c2
    156 ROWS READ
 ROW       C1   C2

   1     70.0    4
   2     31.0    3
   3    155.0    4
   4     17.0    3
  .  .  .

MTB > kruskal-wallis c1 c2

  152 CASES WERE USED
    4 CASES CONTAINED MISSING VALUES

LEVEL    NOBS    MEDIAN    AVE. RANK   Z VALUE
    1      40     34.50       61.0     -2.60
    2       9     87.00      103.2      1.87
    3      12     33.00       70.5     -0.49
    4      82     59.50       79.3      0.84
    6       9    125.00      101.6      1.76
OVERALL   152                 76.5

H = 11.76  d.f. = 4  p = 0.020
H = 11.77  d.f. = 4  p = 0.020 (adj. for ties)
```

Fluoride

```
MTB > read 'e:\kruskal\pwu\1980\fluoride.txt' c1-c2
    156 ROWS READ
 ROW     C1   C2

   1    1.3    4
   2    1.2    3
   3    1.5    4
   4    0.8    3
  .  .  .

MTB > kruskal-wallis c1 c2

  152 CASES WERE USED
    4 CASES CONTAINED MISSING VALUES

LEVEL    NOBS    MEDIAN    AVE. RANK   Z VALUE
    1      40    0.7000       58.0     -3.10
    2       9    1.1000       72.2     -0.30
    3      12    1.2000       82.3      0.48
    4      82    1.3000       82.7      1.89
    6       9    2.2000       98.4      1.54
OVERALL   152                 76.5

H = 11.26  d.f. = 4  p = 0.024
H = 11.28  d.f. = 4  p = 0.024 (adj. for ties)
```

Nitrate

```
MTB > read 'e:\kruskal\pwu\1980\nitrate.txt' c1-c2
    156 ROWS READ

 ROW      C1   C2

   1    2.61    4
   2    1.82    3
   3    0.53    4
   4    0.93    3
  .  .  .

MTB > kruskal-wallis c1 c2

  144 CASES WERE USED
   12 CASES CONTAINED MISSING VALUES

LEVEL    NOBS    MEDIAN     AVE. RANK   Z VALUE
    1      38   0.00E+00       79.2      1.16
    2       9   0.00E+00       61.0     -0.85
    3      12   0.00E+00       72.3     -0.02
    4      76   0.00E+00       70.9     -0.48
    6       9   0.00E+00       69.2     -0.25
OVERALL   144                  72.5

H = 1.84  d.f. = 4  p = 0.766
H = 3.05  d.f. = 4  p = 0.549 (adj. for ties)
```

1990s

Sulfate

```
MTB > read 'e:\kruskal\pwu\1990\sulfate.txt' c1-c2
    102 ROWS READ

 ROW        C1   C2
   1    147.00    1
   2    130.00    4
   3    106.00    4
   4     47.70    4
  .  .  .

MTB > kruskal-wallis c1 c2

LEVEL    NOBS    MEDIAN     AVE. RANK   Z VALUE
    1       9    113.00       39.4     -1.29
    2      15     61.00       43.8     -1.09
    4      50    118.00       45.6     -1.98
    7      28    410.00       70.1      3.90
OVERALL   102                 51.5

H = 15.55  d.f. = 3  p = 0.001
H = 15.55  d.f. = 3  p = 0.001 (adj. for ties)
```

Chloride

```
MTB > read 'e:\kruskal\pwu\1990\chloride.txt' c1-c2
    102 ROWS READ

 ROW        C1   C2

   1     37.40    1
   2     37.00    4
   3     65.00    4
   4     40.00    4
  .  .  .

MTB > kruskal-wallis c1 c2

LEVEL    NOBS    MEDIAN    AVE. RANK   Z VALUE
    1       9     34.00       33.2     -1.94
    2      15     42.00       51.6      0.01
    4      50     37.80       42.5     -3.00
    7      28    120.00       73.3      4.59
OVERALL   102                 51.5

H = 23.27  d.f. = 3  p = 0.000
H = 23.27  d.f. = 3  p = 0.000 (adj. for ties)
```

Fluoride

```
MTB > read 'e:\kruskal\pwu\1990\fluoride.txt' c1-c2
    102 ROWS READ

 ROW     C1   C2

   1   1.62    1
   2   1.30    4
   3   0.80    4
   4   1.74    4
  .  .  .

MTB > kruskal-wallis c1 c2

LEVEL    NOBS    MEDIAN    AVE. RANK   Z VALUE
    1       9    0.5100       38.9     -1.34
    2      15    0.4000       32.3     -2.73
    4      50    1.0800       63.2      3.90
    7      28    0.5000       45.1     -1.35
OVERALL   102                 51.5

H = 17.05  d.f. = 3  p = 0.001
H = 17.10  d.f. = 3  p = 0.001 (adj. for ties)
```

Nitrate

```
MTB > read 'e:\kruskal\pwu\1990\nitrate.txt' c1-c2
    102 ROWS READ

 ROW       C1   C2

   1     0.00    1
   2     0.00    4
   3     0.00    4
   4     0.00    4
  .  .  .

MTB > kruskal-wallis c1 c2

  101 CASES WERE USED
    1 CASES CONTAINED MISSING VALUES

LEVEL    NOBS    MEDIAN     AVE. RANK   Z VALUE
    1       9   0.00E+00       60.9      1.07
    2      14   0.00E+00       54.5      0.48
    4      50   0.00E+00       43.2     -2.64
    7      28   0.00E+00       59.9      1.90
OVERALL   101                  51.0

H =  7.35  d.f. = 3  p = 0.062
H = 13.63  d.f. = 3  p = 0.004 (adj. for ties)

MTB > stop
*** Minitab Release 8.3 Extended *** Minitab, Inc. ***
Storage available 100000
```

APPENDIX G

SPEARMAN'S RANK CORRELATION COEFFICIENT BETWEEN WELL DEPTH AND EACH CONTAMINAT IN THE WOODBINE AQUIFER BY DECADE

Woodbine Aquifer
Spearman's Rank Correlation Coefficient

Code #	Variable
C1	Well Depth
C2	Sulfate Concentrations
C3	Chloride Concentrations
C4	Fluoride Concentrations
C5	Nitrate Concentrations

1950s

```
MTB > read 'f:\spearman\1950.txt' c1-c5
    104 ROWS READ

 ROW     C1       C2       C3      C4      C5

   1    460    116.0     28.0    1.6    0.0
   2    300     85.0     16.0    2.4    0.0
   3      *    195.0    258.0      *    6.5
   4    165     81.0     17.0    1.2    2.5
  .  .  .

MTB > rank c1 c6
MTB > rank c2 c7
MTB > rank c3 c8
MTB > rank c4 c9
MTB > rank c5 c10
MTB > correlation c6-c10

             C6       C7       C8       C9
C7        0.313
C8        0.508    0.747
C9        0.577    0.656    0.746
C10      -0.092    0.034    0.068    0.008
```

1960s

```
MTB > read 'f:\spearman\1960.txt' c1-c5
    190 ROWS READ

 ROW     C1     C2     C3     C4     C5

   1   1853    153     78    0.7    0.0
   2    806    438    616    3.0    0.6
   3    714    348     92    2.7    0.4
   4   1216    348     92    2.7    0.0
  .  .  .

MTB > rank c1 c6
MTB > rank c2 c7
MTB > rank c3 c8
MTB > rank c4 c9
MTB > rank c5 c10
MTB > correlation c6-c10

             C6       C7       C8       C9
C7        0.211
C8        0.414    0.674
C9        0.551    0.653    0.769
C10       0.114    0.049    0.152    0.053
```

1970s

```
MTB > read 'f:\spearman\1970.txt' c1-c5
    348 ROWS READ

 ROW     C1       C2      C3     C4       C5

   1   1415    203.0    59.0    3.7     3.20
   2    771    105.0   115.0    2.6     0.00
   3   1104    241.0   152.0    2.7     0.00
   4   1136    109.0    30.0    1.3     0.50
  .  .  .

MTB > rank c1 c6
MTB > rank c2 c7
MTB > rank c3 c8
MTB > rank c4 c9
MTB > rank c5 c10
MTB > correlation c6-c10

             C6       C7       C8       C9
C7        0.337
C8        0.212    0.645
C9        0.544    0.601    0.507
C10      -0.146    0.189    0.228    0.098
```

1980s

```
MTB > read 'f:\spearman\1980.txt' c1-c5
    159 ROWS READ

 ROW     C1      C2        C3     C4      C5

   1   1559   123.0     70.0    1.3    2.61
   2   1136   111.0     31.0    1.2    1.82
   3   1563    98.0    155.0    1.5    0.53
   4   1753    55.0     17.0    0.8    0.93
  .  .  .

MTB > rank c1 c6
MTB > rank c2 c7
MTB > rank c3 c8
MTB > rank c4 c9
MTB > rank c5 c10
MTB > correlation c6-c10

             C6       C7       C8       C9
C7        0.180
C8        0.308    0.701
C9        0.507    0.539    0.595
C10      -0.213   -0.048    0.001   -0.084
```

1990s

```
MTB > read 'f:\spearman\1990.txt' c1-c5
    110 ROWS READ

 ROW     C1        C2         C3     C4        C5

   1   1415    147.00     37.40   1.62     0.00
   2   1136    113.00     30.00   1.18     1.78
   3   1470    130.00     37.00   1.30     0.00
   4   1900    106.00     65.00   0.80     0.00
  .  .  .

MTB > rank c1 c6
MTB > rank c2 c7
MTB > rank c3 c8
MTB > rank c4 c9
MTB > rank c5 c10
MTB > correlation c6-c10

             C6       C7       C8       C9
C7       -0.240
C8       -0.261    0.757
C9        0.388    0.371    0.214
C10      -0.338    0.123    0.108   -0.076

MTB > stop
*** Minitab Release 8.3 Extended *** Minitab, Inc. ***
Storage available 100000
```

APPENDIX H

SPREADSHEET

OF CONTAMINANTS AND LAND USE TYPES

IN THE WOODBINE AQUIFER

IN 1990s

Table of the 1990s Woodbine data including Landuse Data in 1993

State Well ID	Longitude	Latitude	WELL TYPE	WELL DEPTH	YEAR	Sulfate Flag	Sulfate (Mg/L)	Chloride Flag	Chloride (Mg/L)	Fluoride Flag	Fluoride (Mg/L)	Nitrate Flag	Nitrate (Mg/L)	County Name	Land Use
1845803	-96.4317	33.2769	W	1890	1991		50.0		26.90		1.00		0.00	**Collin**	**Cropland**
1844201	-96.5478	33.3481	W	1470	1993		130.0		37.00		1.30		0.09	**Collin**	**Urban**
1844702	-96.6206	33.2603	W	1136	1993		113.0		30.00		1.18		1.78	**Collin**	**Urban**
1845604	-96.4019	33.2983	W	1900	1993		106.0		65.00		0.80		0.04	**Collin**	**Urban**
1842602	-96.7842	33.3214	W	700	1997		47.7		40.00		1.74	<	0.27	**Collin**	**Urban**
1843204	-96.6669	33.3478	W	1216	1997		374.0		69.60		3.10	<	0.27	**Collin**	**Grassland**
1844803	-96.5728	33.2839	W	1512	1997		136.0		139.00		1.57	<	0.27	**Collin**	**Urban**
1850301	-96.7831	33.2444	W	958	1997		52.8		14.00		0.78	<	0.27	**Collin**	**Urban**
1851902	-96.6578	33.1519	W	1415	1997		147.0		37.40		1.62	<	0.27	**Collin**	**Grassland**
1817401	-96.9783	33.6872	W	235	1993		31.0		30.00		0.38		0.13	**Cooke**	**Forest**
1932304	-97.0131	33.6100	W	45	1997		522.0		369.00		1.34		7.39	**Cooke**	**Forest**
1940301	-97.0039	33.4864	W	105	1997		61.2		37.40	<	0.30		1.06	**Cooke**	**Forest**
3224911	-97.0178	32.6436	W	350	1993		46.0		12.00		1.00		0.04	**Dallas**	**Cropland**
3302902	-96.7822	32.9122	W	1047	1993		368.0		235.00		1.04		0.04	**Dallas**	**Urban**
3326408	-96.8439	32.5594	W	1100	1993		339.0		63.00		1.20	<	0.04	**Dallas**	**Cropland**
3224909	-97.0242	32.6428	W	381	1998		36.8		18.40		0.97		0.24	**Dallas**	**Urban**
3319704	-96.7250	32.6400	W	1353	1998		490.0		102.00		2.09	<	0.22	**Dallas**	**Cropland**
3325203	-96.9564	32.5881	W	895	1998		271.0		21.40		0.52	<	0.22	**Dallas**	**Cropland**
3326505	-96.8175	32.5744	W	988	1998		428.0		86.20		1.31	<	0.22	**Dallas**	**Cropland**
3327602	-96.6644	32.5469	W	1390	1998		340.0		180.00		2.90	<	0.22	**Dallas**	**Cropland**
1833804	-96.9336	33.3769	W	400	1993		59.0		28.00		0.49		0.04	**Denton**	**Grassland**
1849801	-96.9172	33.1419	W	420	1993		237.0		169.00		1.00		1.86	**Denton**	**Cropland**
1857603	-96.9111	33.0642	W	530	1993		196.0		107.00		0.99		0.04	**Denton**	**Cropland**
1849708	-96.9697	33.1606	W	377	1994		58.2		20.90		1.40		0.00	**Denton**	**Grassland**
1956602	-97.0375	33.1831	W	60	1994		45.0		11.80		0.29			**Denton**	**Grassland**
1849802	-96.9414	33.1625	W	317	1997		43.0		14.00		1.16	<	0.27	**Denton**	**Grassland**
1858701	-96.8558	33.0244	W	858	1997		347.0		371.00		3.74	<	0.27	**Denton**	**Forest**
1964306	-97.0044	33.1064	W	308	1997		102.0		38.60		2.33	<	0.27	**Denton**	**Grassland**
1841207	-96.9417	33.3711	W	220	1998		55.3		23.00		0.35	<	0.22	**Denton**	**Grassland**
3248605	-97.0111	32.3114	W	462	1993		729.0		128.00		1.90		0.09	**Ellis**	**Grassland**
3326903	-96.7814	32.5314	W	1195	1993		315.0		306.00		0.66		0.04	**Ellis**	**Urban**
3334209	-96.8292	32.4664	W	1110	1993		335.0		76.00		0.58		1.64	**Ellis**	**Cropland**
3248602	-97.0125	32.3072	W	410	1997		144.0		34.40		1.99	<	0.27	**Ellis**	**Grassland**
3334211	-96.8239	32.4650	W	1180	1997		326.0		64.40		2.34	<	0.27	**Ellis**	**Cropland**
3335504	-96.6856	32.4331	W	1440	1997		309.0		122.00		4.01	<	0.27	**Ellis**	**Cropland**
3336201	-96.5694	32.4617	W	1982	1997		459.0		364.00		5.11	<	0.27	**Ellis**	**Urban**
3343802	-96.6950	32.2636	W	1450	1997		380.0		188.00		6.27	<	0.27	**Ellis**	**Grassland**
3349602	-96.8928	32.1797	W	935	1997		480.0		88.70		3.25	<	0.27	**Ellis**	**Grassland**
3357202	-96.9450	32.1250	W	900	1997		521.0		52.70		1.73	<	0.27	**Ellis**	**Grassland**
1810605	-96.7828	33.8108	W	130	1994		39.0		17.00		0.20		0.18	**Grayson**	**Urban**
1811801	-96.6800	33.7636	W	375	1993		17.0		6.00		0.24		1.46	**Grayson**	**Grassland**
1811806	-96.6689	33.7586	W	470	1997		27.0		6.73	<	0.30		2.13	**Grayson**	**Urban**
1817908	-96.9133	33.6525	W	1522	1993		47.0		69.00		0.38		0.22	**Grayson**	**Forest**
1817909	-96.9019	33.6636	W	1507	1997		40.0		83.00		0.32	<	0.27	**Grayson**	**Urban**
1819302	-96.6575	33.7117	W	790	1993		103.0		11.00		0.62		0.09	**Grayson**	**Urban**
1820801	-96.5772	33.6389	W	1025	1997		18.2		8.76		0.34	<	0.27	**Grayson**	**Grassland**
1820805	-96.5600	33.6417	W	1022	1994		17.5		13.40		0.30		0.00	**Grayson**	**Grassland**
1821901	-96.3886	33.6531	W	301	1993		98.0		18.00		0.22		0.80	**Grayson**	**Urban**
1827801	-96.7017	33.5325	W	950	1997		73.4		9.89		0.68	<	0.27	**Grayson**	**Shrubland**
1828403	-96.6028	33.5472	W	1090	1997		92.8		30.00		1.64	<	0.27	**Grayson**	**Forest**
1828902	-96.5183	33.5150	W	1502	1991		89.2		20.00		0.90		0.00	**Grayson**	**Shrubland**
1829301	-96.4083	33.6103	W	709	1997		132.0		28.90		1.20	<	0.26	**Grayson**	**Cropland**
1829702	-96.4850	33.5206	W	1475	1997		138.0		29.80		1.16	<	0.27	**Grayson**	**Urban**
1836602	-96.5031	33.4314	W	1527	1991		105.0		26.60		1.30		0.00	**Grayson**	**Grassland**
3255602	-97.1325	32.1692	W	340	1993		61.0		16.00		0.62		0.04	**Hill**	**Cropland**
4007501	-97.1811	31.9211	W	185	1993		553.0		104.00		0.83		0.04	**Hill**	**Cropland**
4008301	-97.0053	31.9678	W	726	1993		618.0		289.00		1.37		0.09	**Hill**	**Cropland**
3255907	-97.1503	32.1608	W	290	1997		61.7		15.00		0.46	<	0.27	**Hill**	**Grassland**
3264203	-97.0589	32.0842	W	640	1998		95.9		29.40		0.79		0.36	**Hill**	**Grassland**
3264309	-97.0256	32.0853	W	575	1998		93.6		24.10		0.85	<	0.22	**Hill**	**Cropland**
3357602	-96.8964	32.0561	W	934	1998		207.0		61.50		1.82	<	0.22	**Hill**	**Grassland**
3239107	-97.2092	32.4819	W	309	1993		141.0		42.00		0.46		0.04	**Johnson**	**Cropland**
3240408	-97.1031	32.4325	W	390	1993		206.0		17.00		0.58		0.04	**Johnson**	**Grassland**
3240101	-97.1133	32.4600	W	305	1994		309.0		33.00		0.40	<	0.04	**Johnson**	**Cropland**
3239201	-97.2031	32.4839	W	270	1997		116.0		19.80		0.45	<	0.27	**Johnson**	**Cropland**
3247202	-97.1694	32.3397	W	216	1997		113.0		40.30		0.53	<	0.27	**Johnson**	**Forest**
3247805	-97.1811	32.2692	W	273	1997		1263.0		134.00		0.38	<	0.27	**Johnson**	**Grassland**
3207806	-97.2033	32.9086	W	700	1994		54.0		10.00		0.67		0.04	**Tarrant**	**Urban**
3207903	-97.1428	32.8911	W	103	1997		82.4		97.40	<	0.30		0.80	**Tarrant**	**Grassland**
3215208	-97.1792	32.8603	O	27	1993		440.0		460.00		0.30	<	0.22	**Tarrant**	**Grassland**
3215309	-97.1586	32.8531	O	30	1995		3300.0		1700.00		0.70	<	0.20	**Tarrant**	**Urban**
3215310	-97.1547	32.8536	O	28	1995		240.0		120.00		0.30		43.80	**Tarrant**	**Urban**
3215311	-97.1547	32.8536	O	47	1993		360.0		190.00		0.40	<	0.22	**Tarrant**	**Urban**
3215312	-97.1547	32.8536	O	58	1993		420.0		190.00		0.50	<	0.22	**Tarrant**	**Urban**
3215313	-97.1433	32.8575	W	150	1993		55.0		31.00		0.50		0.30	**Tarrant**	**Urban**
3215314	-97.1467	32.8569	W	180	1993		61.0		49.00		0.40	<	0.22	**Tarrant**	**Grassland**
3215608	-97.1278	32.8311	O	26	1993		81.0		110.00		0.30	<	0.22	**Tarrant**	**Urban**
3215609	-97.1278	32.8311	O	42	1993		19.0		56.00		0.20	<	0.22	**Tarrant**	**Urban**
3216106	-97.0975	32.8336	O	29	1993		400.0		85.00		2.00		0.40	**Tarrant**	**Urban**
3216107	-97.0975	32.8336	O	49	1993		470.0		220.00		1.30		2.26	**Tarrant**	**Urban**
3216109	-97.0878	32.8453	O	27	1993		55.0		67.00		1.00		0.38	**Tarrant**	**Urban**
3216110	-97.0878	32.8453	O	43	1993		65.0		120.00		0.70	<	0.22	**Tarrant**	**Urban**
3216111	-97.0878	32.8633	W	129	1993		42.0		39.00		0.20	<	0.22	**Tarrant**	**Urban**
3216112	-97.0858	32.8594	W	120	1993		55.0		38.00		0.30	<	0.22	**Tarrant**	**Forest**
3216205	-97.0825	32.8453	O	38	1993		74.0		37.00		0.60	<	0.22	**Tarrant**	**Grassland**
3216206	-97.0831	32.8736	O	25	1993		2100.0		120.00		5.00		2.04	**Tarrant**	**Urban**
3216207	-97.0747	32.8558	O	18	1993		810.0		57.00		0.70		0.62	**Tarrant**	**Urban**
3216208	-97.0672	32.8622	O	25	1993		340.0		150.00		0.30		0.25	**Tarrant**	**Grassland**
3216209	-97.0672	32.8622	O	34	1993		230.0		100.00		0.40	<	0.22	**Tarrant**	**Grassland**
3216210	-97.0828	32.8597	W	158	1993		52.0		42.00		0.20	<	0.22	**Tarrant**	**Urban**
3216801	-97.0731	32.7781	W	217	1993		183.0		34.00		0.51		2.04	**Tarrant**	**Grassland**
3223206	-97.1806	32.7119	O	25	1993		2000.0		1000.00		0.50	<	0.22	**Tarrant**	**Urban**
3223315	-97.1500	32.7225	O	21	1993		27.0		11.00		0.50	<	0.22	**Tarrant**	**Urban**
3223316	-97.1397	32.7094	O	25	1993		910.0		410.00		0.40	<	0.22	**Tarrant**	**Grassland**

State Well ID	Longitude	Latitude	WELL TYPE	WELL DEPTH	YEAR	Sulfate Flag	Sulfate (Mg/L)	Chloride Flag	Chloride (Mg/L)	Fluoride Flag	Fluoride (Mg/L)	Nitrate Flag	Nitrate (Mg/L)	County Name	Land Use
3223317	-97.1350	32.7244	O	31	1993		470.0		150.00		0.40		43.38	**Tarrant**	**Forest**
3223508	-97.1928	32.6778	O	25	1993		2000.0		3100.00		0.50	<	0.22	**Tarrant**	**Urban**
3223509	-97.1839	32.6686	O	25	1995		800.0		110.00		0.80	<	0.22	**Tarrant**	**Urban**
3223510	-97.1839	32.6686	O	37	1995		260.0		70.00		0.20		0.22	**Tarrant**	**Urban**
3223511	-97.1750	32.6725	W	100	1993		650.0		300.00		0.40	<	0.22	**Tarrant**	**Forest**
3223607	-97.1436	32.6669	W	180	1993		205.0		81.00		0.41		0.09	**Tarrant**	**Forest**
3224111	-97.1097	32.7344	O	29	1993		360.0		390.00		1.70		102.00	**Tarrant**	**Urban**
3224112	-97.0919	32.7347	O	17	1995		390.0		76.00		1.50		31.43	**Tarrant**	**Urban**
3224113	-97.0919	32.7347	O	29	1995		2000.0		250.00		1.00		0.90	**Tarrant**	**Urban**
3224114	-97.1214	32.7444	O	14	1993		1300.0		41.00		1.10	<	0.22	**Tarrant**	**Grassland**
3224115	-97.1214	32.7444	O	23	1993		1900.0		73.00		0.20		2.21	**Tarrant**	**Grassland**
3224116	-97.1047	32.7328	W	85	1993		1400.0		550.00		0.30	<	0.22	**Tarrant**	**Urban**
3224117	-97.1122	32.7092	W	225	1997		101.0		37.90	<	0.30		6.42	**Tarrant**	**Grassland**
3224118	-97.1211	32.7269	W	68	1993		180.0		92.00		1.20		38.07	**Tarrant**	**Urban**
3224203	-97.0833	32.7278	W	100	1993		470.0		62.00		1.60		0.24	**Tarrant**	**Urban**
3231301	-97.1622	32.5900	W	171	1997		5.4		10.80	<	0.30	<	0.27	**Tarrant**	**Grassland**

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