Pesticides, Water Quality and Geochemical Evolution of Ground Water in the Alluvial Aquifer, Bayou Bartholomew Watershed, Arkansas

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WATER DIVISION, PLANNING SECTION

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Table of Contents

Water Quality

List of Figures

List of Tables

List of Appendices

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Introduction

This study is part of a larger non-point source investigation evaluating potential impacts to both surface water and ground water within the Bayou Bartholomew watershed from 1999-2000 under an EPA 319 non-point source program grant. Ground-water quality was assessed by sampling 119 alluvial wells and one spring within the watershed. The wells were chosen in a random order to reflect the best distribution of the planned number of monitoring sites (originally 100 wells). The alluvial aquifer was targeted for monitoring as the shallow-most aquifer reflecting potential impacts from non-point sources of pollution. Two deeper aquifers, the Cockfield and Sparta aquifers, are important aquifers within the watershed, but do not have surface exposures or recharge areas within the watershed. The Jackson Formation is exposed at the surface throughout the northwestern portion of the watershed, predominately in Drew and Lincoln counties. This formation, where present, is more strictly defined as a confining unit between the alluvial and Cockfield aquifers. However, the Jackson does contain thin sand lenses and historically supplied water to numerous households in the watershed in its outcrop area; most of these wells haven been drilled at the turn of the century through the early 1950s. With the growth of community water systems, together with the small yields and poor water quality associated with the Jackson deposits, operational wells in the Jackson are currently scarce within the watershed. Where present and operational, these wells are mainly used for purposes other than drinking water; such as watering gardens, stock animals and other uses. One well sampled for the present study, LINC19, is believed to be receiving water from the Jackson Formation, and is discussed in further detail in the sections below.

Although every effort was made to evenly distribute the ground-water sampling sites across the watershed, this task was made difficult by the well locations. Alluvial wells dominantly are used for irrigation purposes, and the majority of these are located in the productive Delta ecoregion, which occurs along the eastern portion of the watershed. Approximately 2/3 of the western portion of the watershed, mainly in Ashley and Drew counties, is characterized by upland terrace deposits and is dominated by silviculture. Because silviculture does not rely on irrigation, there are significantly fewer alluvial wells in these areas. Through an extensive search of well logs and meetings with personnel of local Conservation District offices in Lincoln, Drew and Ashley counties, both irrigation and domestic wells were located in the terrace deposits, of which 25 were sampled for the present study. Because agriculture is the dominant land-use on managed land in the watershed and can impact the alluvial aquifer through the extensive use of pesticides in row-crop areas, decisions were made to have the greatest number of sampling sites in the Delta.

Geology

The Bayou Bartholomew watershed lies along the western boundary of the Mississippi Embayment province and is bounded to the west within its watershed by topographically higher Quaternary terraces and Tertiary sediments that delimit the eastern extent of the Gulf Coastal Plain province (Haley et al., 1993). The Bayou Bartholomew meander belt lies within the Boeuf Basin, just east of the terraces, along an abandoned course of the Arkansas River. Tertiary and Quaternary deposits are exposed at the surface throughout the watershed (Figure 1), and are underlain by Tertiary deposits. Tertiary strata dominantly are represented by unconsolidated deposits of Paleocene and Eocene age, although minor exposures of probable Pliocene age exist in Lincoln and Drew counties.

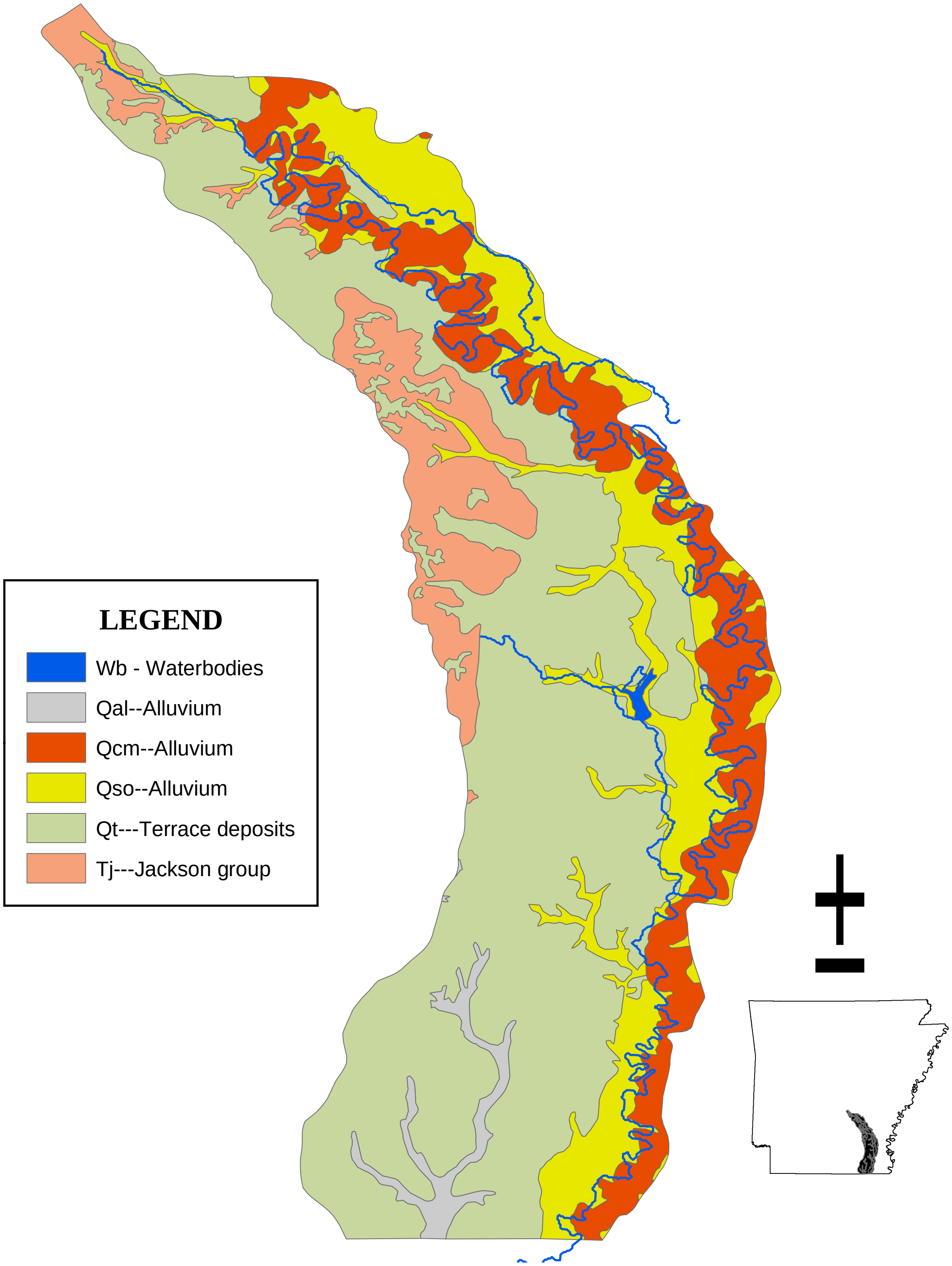

Figure 1. Geologic Map of Bayou Bartholomew Watershed

Quaternary deposits are of both Pleistocene and Holocene age and represent a variety of depositional environments and sub-environments. Jackson Group deposits of Late Eocene age are unconformable with the overlying younger sediments and occur in the subsurface throughout the study area (Bedinger and Reed 1961; Saucier 1994).

The Mississippi Embayment owes its existence to Late Cretaceous rifting and structural downwarping of faulted and folded Paleozoic rocks producing a southward plunging syncline. The axis of the syncline is approximately along the present course of the Mississippi River (Figure 2). Based on the distribution of Lower Cretaceous sediments, the embayment was not formed until the beginning of Late Cretaceous, during which subsidence occurred contemperaneously with Upper Cretaceous deposition. Related to the upwarping of the adjacent Monroe Uplift near the Arkansas-Louisiana boundary, a partially enclosed structural depression, separated from the remainder of the Gulf Plain, was formed and is referred to as the Desha Basin. This basin trends southeastward through Lincoln and Desha counties and acted as a structural depocenter within the Mississippi Embayment until late Eocene time (Bedinger and Reed 1961).

Although continental sediments are more plentiful than marine sediments in the Mississippi Embayment, marine sediments provide the best stratigraphic markers and are important for dating sediments and establishing correlations in the Gulf Plain. There were three major marine transgressions in the Mississippi Embayment. The first marine transgression occurred during Late Cretaceous time when Upper Cretaceous sediments were deposited toward the head of the embayment. In the Paleocene, complete marine inundation of the central Gulf Plain occurred with widespread deposition of the Midway Group sediments (Wilbert 1953). Eocene sediments of the non-marine Wilcox Group overly the Midway, and are overlain by the chiefly non-marine sediments of the Claiborne Group (Bedinger and Reed 1961). The final transgression occurred with deposition of the marine section of Jackson sediments in the late Eocene. Within the embayment west of the Mississippi River, all known marine Jackson outcrops within the Bayou Bartholomew watershed are inliers, completely surrounded by younger beds (Wilbert 1953). Gravels and sands of possible Pliocene age cap the older Tertiary deposits in topographically higher areas (Bedinger and Reed 1961). During the transgression-regression cycles of the Tertiary, there was a progressive filling of the embayment and a net gulfward shift with the migration of the shoreline. Most of the embayment had been filled by the end of the Tertiary and the ancestral Mississippi River was probably established in a well-defined but rather narrow and shallow valley (Saucier, 1994).

Within the Bayou Bartholomew watershed, late Eocene Jackson Group deposits are unconformably overlain by pre-Wisconsin to late Wisconsin (Pleistocene) Prairie Complex terrace deposits west of the Bayou Bartholomew meander belt. Holocene tributaries drain eastward from the terrace into or along the bayou. Flood basin deposits of Bayou Bartholomew and the former Arkansas River are exposed in a band on each side of and roughly parallel to the meander belt deposits. Subcropping the Quaternary meander belt and Prairie Complex are early Pleistocene valley train deposits and sediments of the Jackson Group (Saucier 1994).

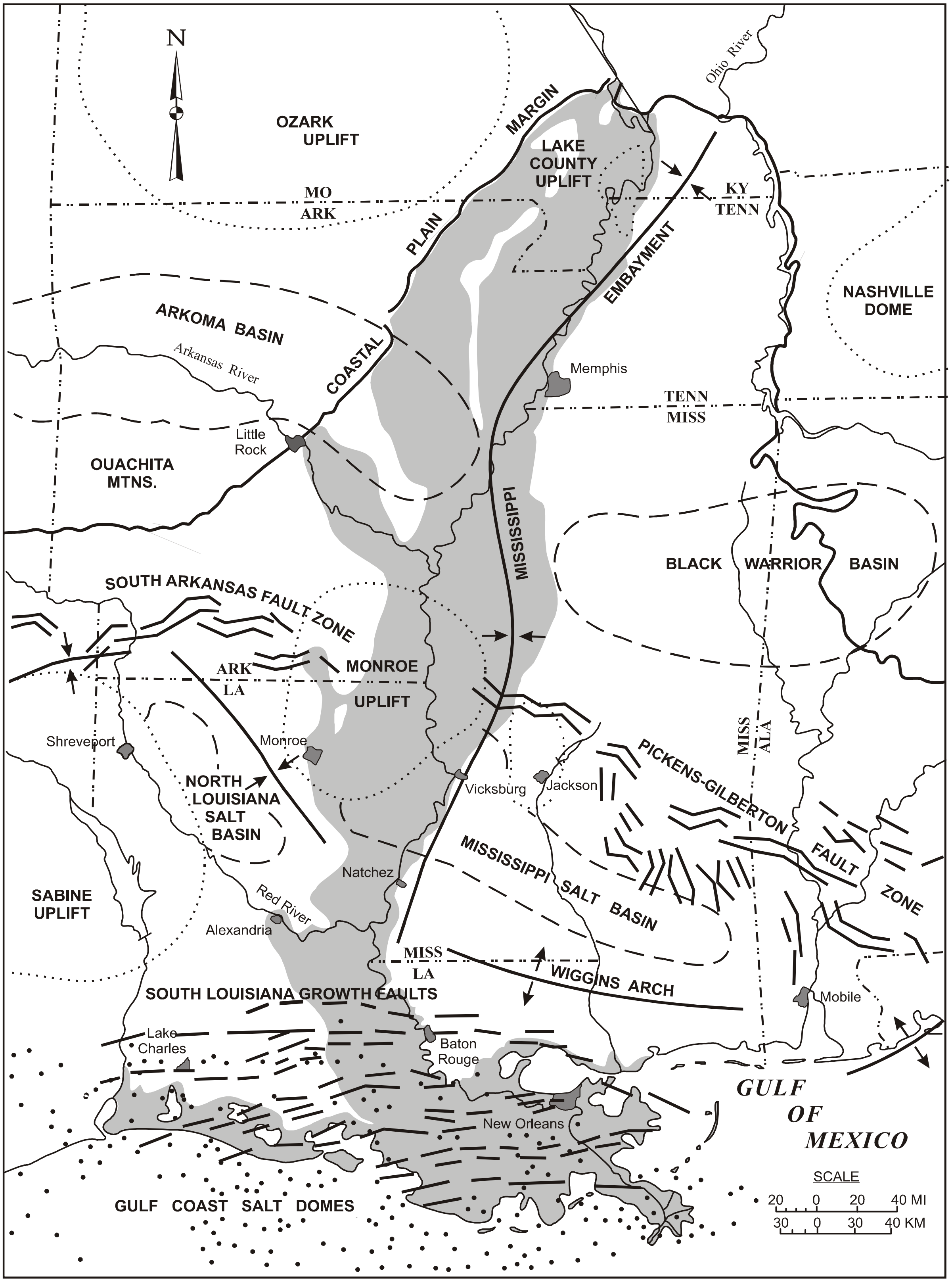

Figure 2. Map showing the major structural features of the Lower Mississippi Valley

In the study area, the Jackson Group consists of the marine White Bluff Formation and the overlying non-marine Redfield Formation. These are the stratigraphic equivalents of the regionally-named Moodys Branch and Yazoo Clay Formations listed in Table 1. The White Bluff Formation is thicker and more laterally persistent than the Redfield Formation over most of the outcrop area. Within the northern extent of Jackson Group deposition, the Redfield Formation is best developed, and farther south into Drew and Cleveland counties, lower parts of the Redfield Formation are likely time equivalents of the upper parts of the White Bluff Formation. Three marine facies are recognized in the off-white to blue-gray White Bluff Formation; each deposited under distinct sets of environmental conditions and designated as separate members. The Caney Point Marl Member is a calcareous glauconitic clay or argillaceous greensand, containing abundant and diverse invertebrate fauna including molluscs, ostracods, bryozoans, echinoids and foraminifers. It is overlain by the Pastoria Sand Member; a dark-gray argillaceous sand with abundant molluscan fauna. The Rison Clay Member exhibits a variable lithology predominated by thinly-bedded silty clays and blocky clays. It is characterized by a sparse fauna consisting of arenaceous foraminifers and small molluscs, but locally may contain mollusca concentrated in thin discontinuous beds. Lignitic fragments and fossil leaves are locally present in the Rison Clay Member; indicative of its transitional boundary with the overlying terrigenous Redfield Formation. The light-gray Redfield Formation exhibits variable non-marine lithology characterized by thinly-bedded lignitic silts commonly containing well preserved fossil leaves, cross-bedded sands, and discontinuous thinly-bedded lignite (Wilbert 1953).

The Caney Point and Pastoria Members of the White Bluff Formation are regarded as products of transgressive and inundative phases of a Jacksonian depositional cycle, whereas the Caney Point Member and the Redfield Formation are interpreted as products of a regressive phase of the sedimentary cycle. Following deposition of the marine portion of the Jackson Group, the Desha Basin ceased to exist as a depositional center. Quaternary fluvial activity produced alluvium and other deposits which mask older sediments over large parts of the embayment adjacent to the Mississippi River and its tributaries (Wilbert 1953). The Jackson Group approaches 500 ft in thickness on the Monticello ridge in Lincoln County. Elsewhere, where outcropping at the surface or underlying younger alluvial sediments, erosion has reduced thicknesses to between 100 and 300 ft. Coarse sands and gravels interbedded with clay up to 80 ft thick occur as erosional remnants and unconformably overly Jackson deposits (Bedinger and Reed 1961). These sediments are of probable Pliocene age and may represent the remains of a nonglacial alluvial apron that blanketed the area prior to the onset of Pleistocene glaciations (Saucier 1994).

The following discussion of the Quaternary geology of eastern Arkansas was adapted from Saucier (1994). When discussing the Quaternary geology of Arkansas, it is helpful to define the physiographic nomenclature applicable to the area. The Lower Mississippi Valley is defined as the greater Quaternary valley and deposits of the Mississippi River and its principal tributaries within the limits of the Coastal Plain (excluding the Red River in Texas). Within this area is the Mississippi alluvial valley, which is defined as that segment of the Lower Mississippi Valley characterized by landforms and deposits that are primarily of Wisconsin and Holocene age. Finally, the Mississippi alluvial plain is defined as those areas (Holocene), such as the Mississippi River meander belts, that are (or were) subject to the flooding by the rivers in their present regime (Figure 3).

Table 1. Generalized, composite stratigraphic column for the Lower Mississippi Valley (after Saucier, 1994).

ERA	SYSTEM	SERIES	GROUP	FORMATION OR UNIT	THICKNESS RANGE (ft)	LITHOLOGY
Cenozoic	Quaternary	Holocene		Alluvium	0-400	Unconsolidated clays, silts, and sands deposited in fluvial, deltaic, lacustrine, and marine environments.
		Pleistocene		Valley Trains	50-300	Two sequences (Early & Late Wisconsin) of braided-stream deposits consisting of massive sands and gravels.
				Loess	0-75	Five sheets of tan to light-brown, lightly calcareous, massive, eolian silts of Late to Middle Pleistocene age.
				Deweyville Complex	40-80	Fluvial terrace with thin, fine-grained topstratum and thick, coarse-grained substratum.
				Prairie Complex	60-200	Diverse time-transgressive depositional sequence representing fluvial to marine environments.
				Intermediate Complex	50-150	Fluvial terrace deposits of well-oxidized clays, silts, sands and gravels. Includes Montgomery terrace.
	Tertiary	Miocene		Upland Complex	20-100	Well-dissected deposits of highly-oxidized, fluvial (braided-stream) sands and gravels. Includes Bentley and Williana terraces and Citronelle and Layfayette
				Pascagoula	0-200	Gray fluvial to estuarine clays and sandy clays with layers of sand and sandstone. Occasionally fossiliferous.
				Hattiesburg	0-450	Hard, gray clays with claystone and thin, greenish sandstone and cemented sand layers. Includes Fleming formation of Louisiana.
		Oligocene		Catahoula	0-350	Gray to white, tuffaceous siltstones and sandstones with layers of loose, fine sands and thin clay layers.
			Vicksburg	Bucatunna	30-40	Dark-brown, lignitic clays of marine or estuarine origin. Few thin siltstone layers.
				Byram	40-50	Highly fossiliferous marine clays and sandy marls with zones of nodular or lenticular limestone.
				Glendon Limestone	30-40	Alternating thick layers of hard, sandy limestones and clayey, sandy marls.
				Mint Springs	20	Fossiliferous, sandy and clayey marls with occasional phosphatic and lignitic pebbles.
				Forest Hill	0-150	Clayey, lignitic silts irregularly interbedded with fine, cross-bedded sands and thin layers of clayey lignite.
		Eocene	Jackson	Yazoo Clay	0-500	Dark-gray massive clays with widely scattered, irregular zones of silty clays. Occasionally fossiliferous.
				Moodys Branch	0-40	Fossiliferous, sandy and clayey marls with occasional layers and nodular zones.
			Claiborne	Cockfield	200-400	Lenticular, alternating, thin strata of gray to gray-brown clays and light-gray silts or silty sands. Scattered lignite fragments and layers.
				Cook Mountain	130-160	Thick, brown, hard clays and reddish, clayey limonite alternating with thin beds of glauconitic sands.
				Sparta Sand	400-500	Massive, light-gray, fine to medium sands interbedded with thin layers of brown, lignitic sandy clays. Includes Memphis sand.
				Cane River	0-200	Green and brown, calcareous, glauconitic and fossiliferous clays, marls, and sands. Includes Kosciusko formation.
				Carrizo Sand	0-190	Light-gray to brownish-gray, fine to coarse, micaceous sands.
			Wilcox	Undiff.	100-920	Fine to medium, lignitic sands and sandy clays and lignite. Massive sands, some coarse and graveliferous, in upper and basal portions.
		Paleocene	Midway	Porters Creek Clay	200-670	Massive, gray, fissile shales, clay shales, and clays with sandy clay beds.
				Clayton	0-60	Gray, calcareous, glauconitic, fossiliferous shales with scattered lenses of white limestone near base.

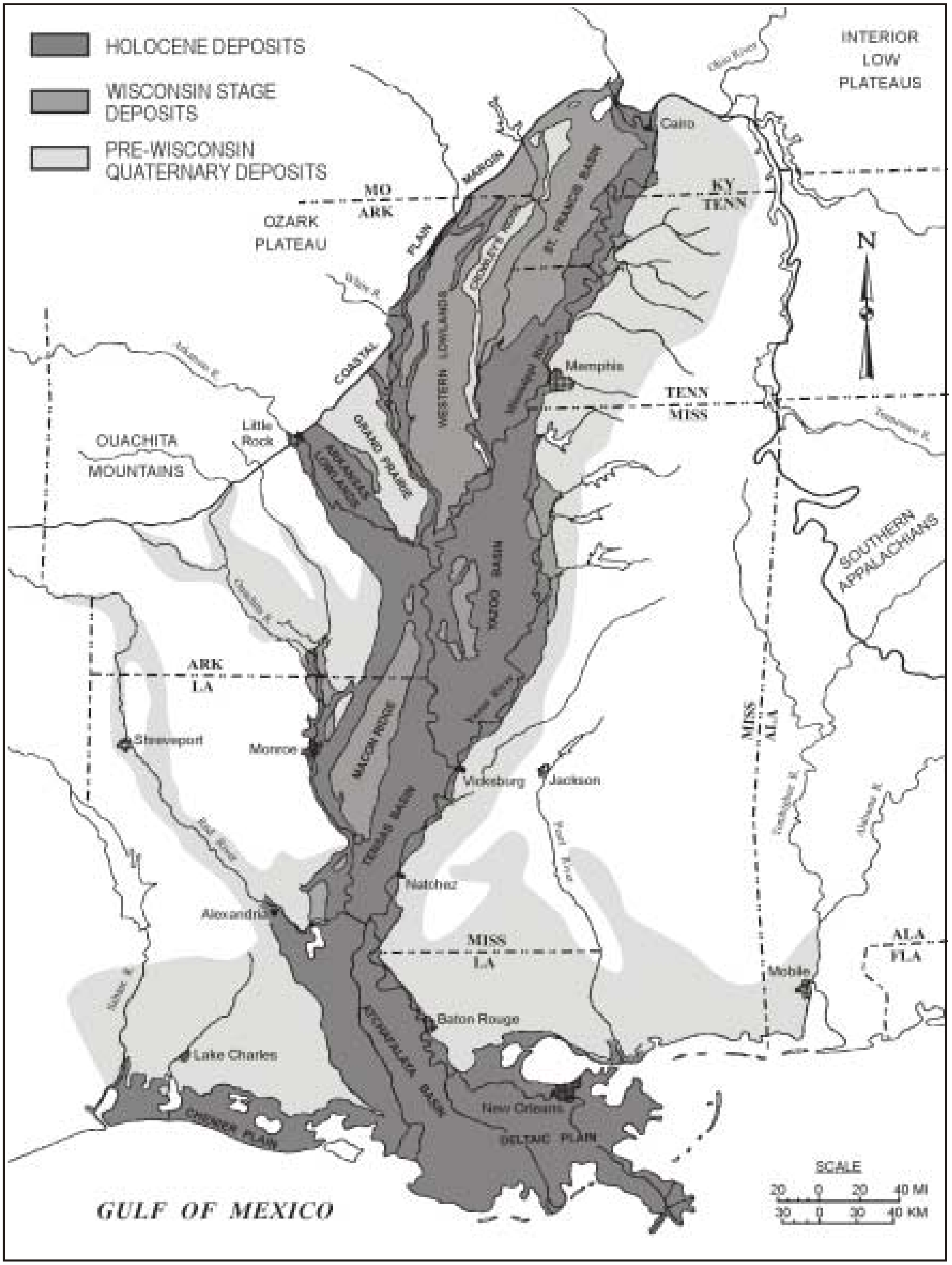

Figure 3. Map showing the Mississippi alluvial valley, deltaic plain, and chenier plain, and the total distribution of Quaternary deposits in the Lower Mississippi Valley portion of the Gulf Coastal Plain (from Saucier, 1994).

The Pleistocene was dominated by several major glacial periods. Although glaciers never advanced into Arkansas, outwash produced by periodic recession of glacial lobes provided massive amounts of coarse sediments that were channeled through and deposited in the Lower Mississippi Valley. Wisconsin stage (late Pleistocene) valley trains, braided stream surfaces underlain by glacial outwash, and Holocene meander belts and floodplains dominate the Mississippi alluvial valley area landscape today. All valley trains exhibit multiple terrace levels that are interpreted as evidence of cyclic downcutting during waning glaciation. Within the Lower Mississippi Valley are several Pleistocene terrace complexes (Table 1) mapped as separate geologic units based on both temporal relationships and depositional environments.

With the culmination of glaciation came a change in fluvial flow regimes. The onset of the Holocene revealed an evolutionary change in the ancestral Mississippi River from a bedload-dominated braided stream to a suspended load-dominated meandering stream. Six Mississippi River and eight Arkansas River meander belts have been delineated within the alluvial valley. Modern rivers flow along the former courses of these rivers. The Bayou Bartholomew flows along the most recent former Arkansas River meander belt within the Boeuf Basin.

The Prairie Complex is distributed in several areas of the Lower Mississippi Valley, spans multiple glacial stages and has as many as three stratigraphic units separated by erosional unconformities. Seven depositional environments have been identified, which are differentiated vertically and laterally by distinct sedimentary facies. A several foot thick veneer of loess and colluvial deposits from the adjacent uplands covers the surface of the complex. In the Bayou Bartholomew watershed, the Prairie Complex is characterized by backswamp deposits. All areas of Prairie Complex backswamp deposits are underlain by tens of feet of massive sands or sands and gravels that extend down to Tertiary-age formations that constitute the subsurface. The bulk of this material represents glacial outwash laid down by braided streams, before the Mississippi River evolved to a meandering stream, during an earlier glacial cycle.

The Prairie Complex backswamp deposits include natural levee deposits and consist of 60 to 80 ft of stiff to hard, well-oxidized, mottled dark-gray to brown, massive clays and silty clays. The clays incorporate scattered organic fragments and woody debris; show evidence of extensive biogenic reworking; often exhibit slickensided surfaces caused by dessication and consolidation; and contain calcareous nodules. The sediments originated primarily from ancestral Mississippi River backwater flooding, but are mixed near the upland margin with siltier and sandier deposits eroded from the uplands and carried into the flood basins by local creeks. The creeks occasionally extended their courses from the upland into and across the backswamp areas, leaving narrow entrenched channels that are evidenced in the backswamp sedimentary sequences by interrupting, narrow bands of muddy sands up to several tens of feet thick. Additionally, during the several interruptions in backswamp deposition when the alluvial valley experienced degradation, dendritic gully systems analogous to those of the present extended themselves inland from the edge of the valley and are evidenced by sandy valley-fill sequences.

The Holocene fluvial sediments of the Bayou Bartholomew and the former Arkansas River may be divided into several types of deposits based on environment of deposition, lithologic character, and topographic expression. These deposits include natural-levee, backswamp, point-bar, swale, and channel-fill deposits. Point-bar and natural-levee deposits are the most permeable of the surface sediments in the watershed and are important as areas of recharge in their outcrop areas. The finer grained backswamp, swale, and channel-fill deposits are relatively impermeable and therefore are not important as areas of recharge (Bedinger and Reed 1961).

The alluvial aquifer of the Lower Mississippi Valley is one of the largest and most exploited sources of shallow, fresh water in the United States. The alluvial aquifer is the largely uninterrupted mass of Quaternary coarse-grained sediments that overlies the eroded Tertiary suballuvial surface and extends from valley wall to valley wall. It has a nominal thickness of approximately 125 ft and includes the lower, coarse-grained portions of the Holocene point-bar environment, the Early- and Late Wisconsin-stage valley trains and underlying glacial outwash, the substratum deposits underlying the Prairie Complex, and probable remnants of earlier Quaternary valley-fill sequences. Longitudinally, the aquifer extends from the head of the alluvial valley downstream to and beyond the deltaic plain where it includes the deposits that fill the entrenched valley. The upper part consists of fine to medium sands while the remainder consists of coarse sands and gravels. Almost everywhere the sequence fines upward, but not in a uniform manner. The aquifer is confined where the alluvial topstratum is thick and continuous, such as in the backswamp or flood basin areas, but it is otherwise an open hydrologic system with relatively rapid recharge and discharge, both natural and artificial. Recharge occurs primarily through infiltration in point bars of meander belts and valley train areas where the top-stratum is thin, and along major streams during high stages. Recharge occurs secondarily from underflow from suballuvial aquifers of Tertiary and Cretaceous age. Discharge occurs mainly as a result of contributions to stream base flow during low stages, and withdrawal by excessive pumpage.

Tertiary formations are generally devoid of gravel-sized materials since sources of such coarse clastics were not present in the region. In the deltaic, estuarine, and shallow marine environments in which the sediments were deposited, energy levels were insufficient to transport sediments coarser than sand. Therefore, when drilling in the Lower Mississippi Valley, the occurrence of the base of a graveliferous (or coarser) sedimentary sequence, either in the uplands or beneath the alluvial plain, often marks the unconformity separating Quaternary from underlying Tertiary units (Saucier 1994).

Subsurface Hydrology

Ground water stored in the sands and gravels of the alluvial deposits within the watershed provide the most important source of water to all of the counties through which flows the Bayou Bartholomew River. In Jefferson, Lincoln, Drew, and Ashley counties, which occupy the dominant land mass in the watershed (only small portions of Chicot and Desha contribute to the watershed), ground water accounts for over 80% of the total water use. In all counties except Jefferson, which uses the Sparta extensively for municipal and industrial use, the Quaternary deposits account for over 97% of the total ground water used; nearly 90% of this exclusively used for irrigations purposes (Terry Holland, written communication,2001; Holland, 1995).

There are two main reasons for the extensive use of the alluvial aquifer for irrigation and other uses: (1) the alluvial deposits provide a shallow, productive aquifer, and the depths and the costs associated with well drilling are less than that for deeper wells drilled into the Claiborne group, and (2) the high yield associated with the alluvial deposits provide the quantities necessary for irrigating large tracts of land. Although the average yield for alluvial wells is approximately 1,600 gpm, yields of up to 2,000 gpm are common throughout the watershed, and are greater than 3,000 gpm in some portions of the watershed (Klein et al., 1950; Onellion, 1956; Bedinger and Reed, 1961; Boswell et al., 1968). The type of sediments overlying the surface of the alluvial deposits vary in their permeability, and, as such, the aquifer can be partially confined in many areas. The lower permeability materials also affect recharge to the aquifer through reduced infiltration of rainfall and irrigation water through the land surface. Krinitzsky and Wire (1964) listed direct penetration by percolating rainfall as the most important source of recharge to the aquifer followed secondly by stream capture and irrigation return, and thirdly by underflow from lower aquifers. Their report estimated approximately 5% of precipitation percolates into the earth as ground-water recharge. However, Broom and Reed (1973) provided model calculations which estimated that up to 70% of recharge was from stream capture as a result of intense pumping, which lowered the water table resulting in a losing stream scenario.

The direction of ground-water flow in the alluvial aquifer is dominantly southward with the slope of the land within the watershed. This flow pattern is affected both by streams acting as either drains and/or sources of recharge, and, during the irrigation season, by pumping wells which can induce large local cones of depression. Broom and Reed (1973) state that Bayou Bartholomew serves as a drain for the ground water in the northwestern part of the watershed (Jefferson and Lincoln counties), and serves as a drain to the west and a recharge source to the east of the bayou in the lower sections of the bayou. Their assessment of the bayou as both losing and gaining in the lower section is based on the fact that flow lines perpendicular to the potentiometric surface in much of Drew and Ashley counties cross directly from the west to the east across the bayou. Another explanation is that the bayou has little effect either as a drain or a recharge source and does not affect the ground water flow in the lower section of the watershed. In either case, current potentiometric maps (Stanton et al., 1998; Joseph, 1999) depict similar directions of flow for both the upper part of the watershed, where the bayou acts dominantly as a drain, and the lower part of the watershed, where the dominant flow is to the south/southeast and is not affected by the bayou according to the scale dictated by the number of sampling sites.

The upland terrace deposits, similar to the delta alluvial deposits, are capable of large yields in areas of channel fills and depressions. Hewitt et al. (1949) stated that the terrace deposits were the most important source of water for Ashley County in the late 1940s. Wells in some of the ancient Pleistocene channels can yield as much as 2,500 gpm. Their report also speculated that recharge was probably limited as the upper part of the deposits are composed dominantly of fine-grained, silty to sandy clay. In unison with the observation that many of the channel fills and depression are not interconnected, they attributed varying water quality to aquifer thinning, isolated basins and channel fills, and poor recharge. Bedinger and Reed (1963) listed yields of only a few hundred gallons/minute for wells completed in the terrace deposits in Desha and Lincoln counties. However, many of these wells were <100 feet and probably do not penetrate the full thickness of the aquifer, where better yields might be obtained.

A review of well logs for this report revealed well depths consistently between 120 - 170 feet with a maximum depth of 172 feet in Ashley County. Although many wells were less than 100 feet in depth, primarily in Lincoln County and parts of Drew County, these wells were mostly domestic and most probably do not extend to the base of the aquifer. The deeper wells undoubtedly reflect the thickness of the terrace deposits as compared to the recent alluvial deposits in the delta, and are in agreement with formation thicknesses provided by Onellion (1956) of 175 feet one mile east of the Monticello ridge, where the old channel is deepest, to approximately 95 feet near the border in Drew County.

The Jackson Formation and overlying Pliocene deposits have sufficient yield for use as a domestic water supply, based on the extensive history of both deposits as domestic and farm supply sources. A review of the various reports referenced for this study revealed no fewer than 90 Jackson and 35 Pliocene wells (pre-1960) in Drew and Lincoln counties, and six wells in the Jackson Formation in Jefferson County. The combined effects of poor yields, little movement, and resulting high mineralization makes the Jackson a poor choice as a dependable water supply, where other supplies are available. With the advent and large growth of community water systems, operational wells in the Jackson and/or Pliocene deposits are difficult to locate. Only one homeowner interviewed for this report had an operational well (used for watering the garden), which was completed in the Jackson Formation, based on water quality and state geologic maps.

Most wells in the Jackson investigated in this study were less than 50 feet deep and many less than 30 feet; however, four wells were greater than 150 feet. All of the wells noted as being completed in the Pliocene deposits were less than 50 feet deep. Water quality in the Pliocene deposits is much less mineralized than that in the Jackson; however, the deposits are thin, averaging 10 - 15 feet thick and upwards to 50 feet or so, the saturated portion is very thin, and yields are typically low (Onellion, 1956). Flow is radially outward and discharges at the contact with the Jackson Formation in the forms of seeps and springs (Bedinger and Reed, 1961).

Methodology

The intended goal of the ground-water sampling phase of the investigation was two-fold: first, to assess potential non-point source impacts to ground water, primarily from extensive pesticide use, and, second, to report on the overall ground-water quality of the Quaternary alluvium in the delta versus the terrace deposits in the upland region. Figure 4 shows the location of the sampling sites for the present study. Appendix I lists information concerning the location of all ground-water sampling sites. Out of 118 alluvial wells sampled for the present study, 25 of these were in terrace deposits in Ashley and Drew counties, and all of the remaining wells were agricultural wells in the delta. Although most of the agricultural wells were associated with row-crop operations, some of these wells were located at fish-production farms.

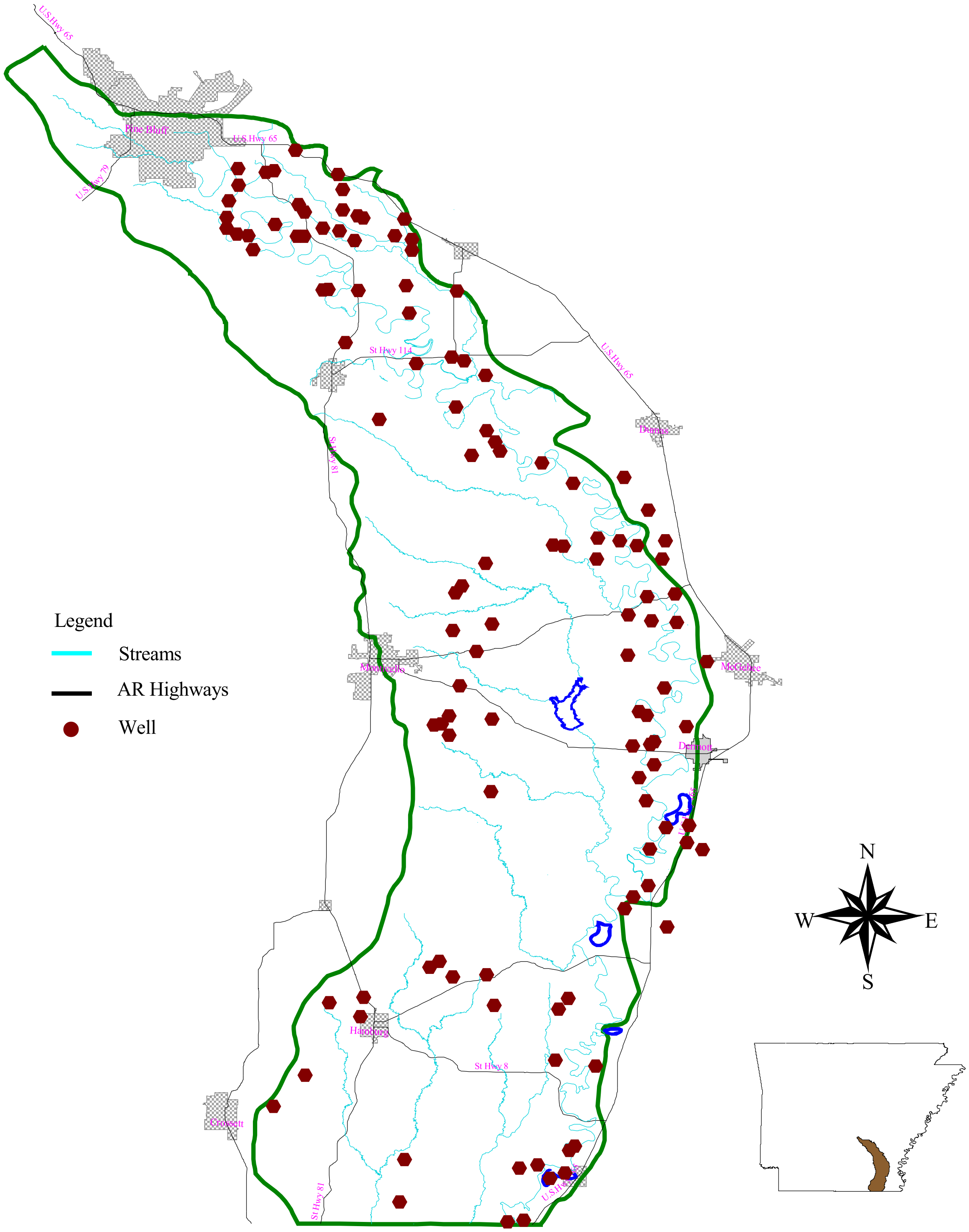

Figure 4. Location of Wells Within Bayou Bartholomew Watershed

The wells were sampled during the summer season in 1999 (33 wells) and 2000 (86 wells). All wells were sampled as near to the wellhead as possible through available faucets and other outlets. Most wells were in use at the time; however, where wells were turned on for sampling purposes, the well was allowed to run for a minimum of ten minutes until field-measured parameters had stabilized prior to sampling. All samples were collected in approved containers for the selected parameters. Samples were filtered through disposable 0.45 µm pore-sized membrane in the field for analysis of dissolved metals and preserved with nitric acid to a pH of 2.0. All other samples were unfiltered samples, stored on ice, and delivered to the Arkansas Department of Environmental Quality (ADEQ) laboratory under chain-of-custody requirements by the sampling team. All samples were analyzed for major and minor cations and anions, nutrients, trace metals, selected pesticides and total dissolved solids. Analysis for pH, conductance and temperature were performed in the field at the time of sampling with an Orion^{tm} multifunction portable meter.

Water Quality

Inorganic and General Water Quality

In general, the water quality in the alluvial aquifer throughout the watershed is very good with respect to national drinking water quality criteria. The problems encountered when using the water for either domestic or industrial uses (and to a certain extent, irrigation purposes) are the high concentrations of Fe, Mn and hardness. Elevated concentrations of these constituents are associated with problems ranging from staining and scale formation to objectionable taste. Secondary maximum contaminant levels (SMCLs) apply to these inorganic substances, none of which is a hazard to human health. Violations of the SMCLs were noted for total dissolved solids (TDS), Fe, Mn and Al.

It is not practical to list all references to the high Fe and Mn content in the alluvial aquifer. It is sufficient to state that elevated concentrations of both are ubiquitous throughout the aquifer, and have been referenced by nearly every author reporting on water quality in the alluvial aquifer in Arkansas. Iron concentrations were greater than the SMCL of 300 µg/L in all but 24 of the 119 wells, and 23 of the 24 wells with concentrations <300 µg/L are located in the upland terrace deposits (see next section). Manganese was greater than the SMCL of 50 µg/L in all but 18 of the wells. Most wells sampled for the study were below the SMCL of 500 mg/L TDS, except for 9 wells, which ranged upwards to 746 mg/L. Five wells exceeded the SMCL of 200 µg/L for Al.

Hardness historically has been associated with the effects observed in the use of soap and encrustations left by heated water (Hem, 1989), and additionally is used to calculate the toxicity of certain metals in water sources (USEPA, 1992). This present study uses the classification of hardness by Doll et al. (1963), which states that soft water is that less than or equal to 60 mg/L; moderately hard between 61 and 120 mg/L; hard between 121 and 180 mg/L; and very hard water all those greater than 180 mg/L. Accordingly, 15 wells (13%) in the present study would be classified as soft; 31 wells (26%) classified as moderately hard; 34 wells (29%) classified as hard; and 38 wells (32%) classified as very hard. The large numbers of wells (61%) classified as hard to very hard in combination with the high Fe and Mn reveal some of the undesirable qualities associated with domestic and industrial uses of the alluvial aquifer.

Table 2 lists selected statistical analyses for all wells with full chemical analyses, with the exception of LIN19, which was completed in the Jackson Formation and does not reflect the typical chemistry associated with the alluvial aquifer (for a complete listing of inorganic chemical analyses, see Appendix II). In general, there is a high variability of water quality within the alluvial aquifer, and no unique characteristics can be used to unequivocally identify ground water as originating solely from the alluvial aquifer. The ground water is typically a Ca-HCO_3 to a Ca(Mg)-HCO_3 water type, and, with the exception of eight wells in the terrace deposits, the water type was similar to that of the alluvial aquifer throughout the delta. Because alkalinity was not measured on some of the sample runs, a complete analysis of all major cations and anions were performed on only 98 of the 118 alluvial wells. Calcium was the dominant cation in 84 of the 98 samples (85%) and was greater than 50% of the total cations in 57 of the 98 samples (58%). Bicarbonate was greater than 50% of the total anions in all but one of the samples, ASH027, in which Cl dominated with 66% of the total anion molar concentration.

Chloride concentrations range from approximately 4 mg/L to 137 mg/L, with a median concentration of 17 mg/L and a mean concentration of 25 mg/L. Four wells have concentrations exceeding 100 mg/L and are located in Jefferson and Lincoln counties (Figure 5). Isolated areas of Cl concentrations >100 mg/L and ranging upwards to >300 mg/L are located in parts of Jefferson, Lincoln and Desha counties and have been documented in other publications, including Fitzpatrick (1985), Klein et al. (1950), Bedinger and Reed (1961) and Kresse et al. (1997). In many cases, these areas of >100 mg/L chloride are less than 5 miles in diameter, and there is no clear explanation as to their origin. Possible causes include the Arkansas River, which has maximum annual concentrations exceeding 200 mg/L (unpublished ADEQ data); older contamination from an ancestral channel of the Arkansas River, when concentrations exceeded 1,000 mg/L, which were never flushed from less permeable zones within the aquifer; poor surface recharge leading to minimal flushing and increased residence time for the ground-water underflow from other parts of the aquifer; downward percolation by irrigation water, which has been enriched in salts by evaporation at the surface; and up-welling of poor quality water from underlying Tertiary sediments through thinning portions of the confining layer. Problems associated with bypass through the annulus of poorly-constructed wells would have to be discounted largely by the absence of nitrate and other surface contaminants.

Although Cl concentrations are below the SMCL of 250 mg/L for all wells, the importance of addressing salinity is related to the various problems imposed by the use of high salinity waters for irrigation purposes. High Cl concentrations can pose immediate problems, including the burning of crop foliage, to long-term effects, including the reduction in a plant's ability to take up water as a result of an increase in the osmotic pressure of soils (McFarland et al., 1998). Additionally, high Na levels commonly encountered in high salinity waters can cause soil structure deterioration and water infiltration problems (Cardon and Mortvedt, 2001).

Table 2. Statistical analysis of major ions in alluvial aquifer well-water samples.

Parameter	Minimum	Maximum	Mean	Median	Standard Deviation
Calcium, mg/L	3.6	143	47	42	29.5
Magnesium, mg/L	1.4	33.5	11.1	9.3	6.8
Potassium, mg/L	<0.46 (1)	4.9	1.9	1.9	0.8
Sodium, mg/L	4.2	75.9	25.7	21	14.0
Chloride, mg/L	4.2	137	24.6	17.3	23.7
Sulfate, mg/L	0.8	93.4	11.4	5.4	17.1
Bicarbonate, mg/L (2)	32	442	202	196	102.7
Silica, mg/L	15.5	56.2	35.7	33.9	8.1
TDS, mg/L	92	746	276	244	127.8
Iron, mg/L	<0.015 (1)	41.4	8.8	8.5	8.5

(1) Less than parameter detection limit; statistical analyses performed using half of detection limit concentration.
(2) Bicarbonate analyses calculated on 98 of 118 alluvial samples with complete alkalinity; all other analyses based on 118 samples.

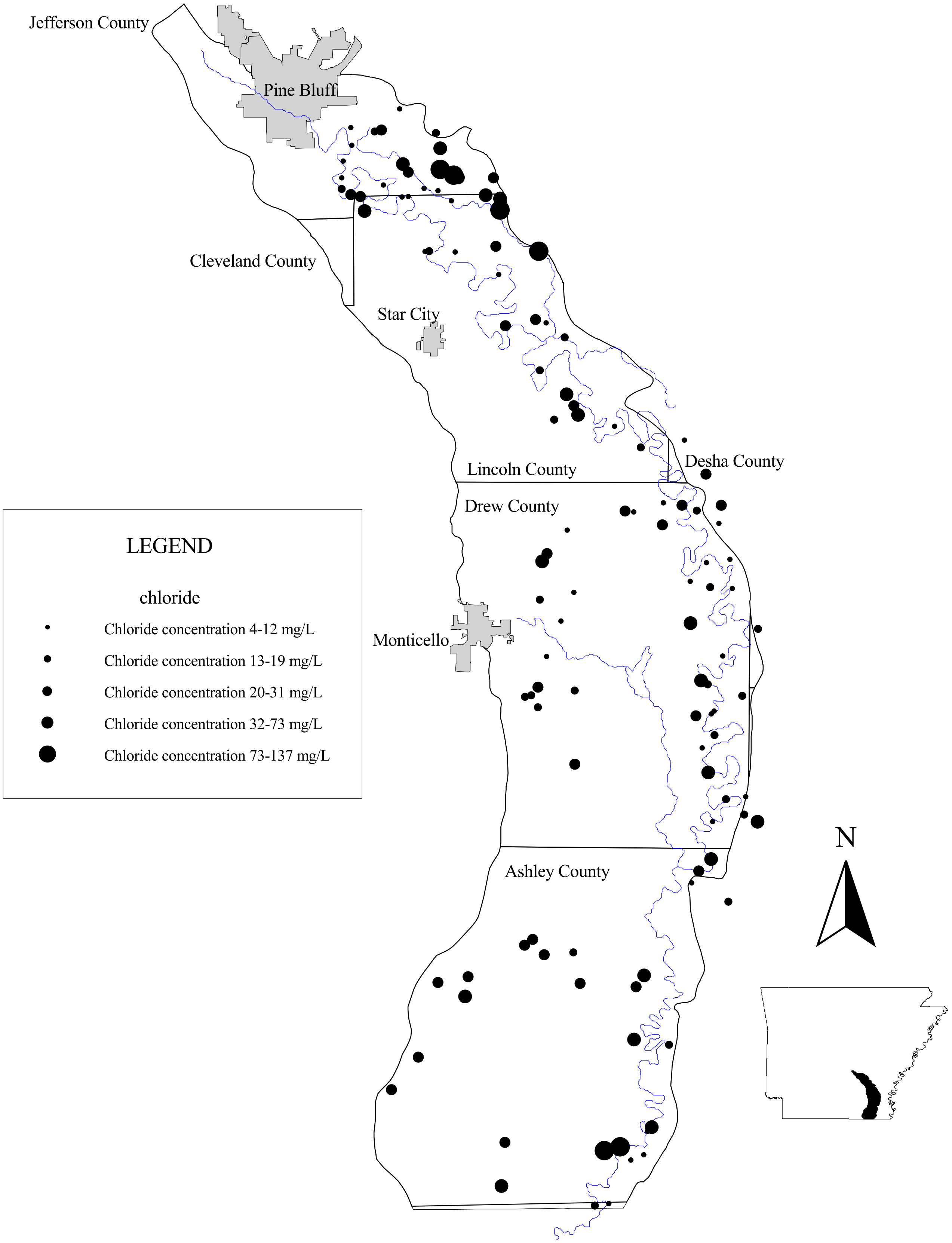

Figure 5. Ranges for chloride concentrations in the alluvial aquifer

Agronomists commonly use the specific conductance of irrigation waters to determine suitability from a salinity standpoint. The USDA (1969) and the University of Arkansas Cooperative Extension Service (CES, unpublished data) both list irrigation waters with conductance values exceeding 750 µS/cm as waters of concern as related to salinity. The CES also lists 70 mg/L Cl as posing potential problems for crops, especially to rice. These values are site-specific and are affected by soil type and chemistry and amount of annual flushing. Seven water samples had Cl concentrations exceeding 70 mg/L, and ten samples had conductance values exceeding 750 µS/cm. All seven samples with high Cl concentrations (>70 mg/L) had conductance values exceeding 750 µS/cm, and reveal a very good correlation between Cl and conductance at this range, making the less-expensive field conductance reading an excellent screening tool for assessing potential problems with irrigation waters.

Concentrations for NO_3-N ranged from non-detect at 0.01 mg/L to 0.94 mg/L, with a mean concentration of 0.06 mg/L and a median concentration of 0.02 mg/L. There were 25 wells with non-detect concentrations out of 119 wells. These results are similar to those of Kresse (1997), which noted NO_3-N concentrations ranging upwards to 0.26 mg/L in 77 wells in parts of Jefferson, Desha and Phillips counties. The low concentrations of NO_3-N in the alluvial aquifer, especially with regard to the high detection rate for pesticides (see pesticide section below), may be the result of several processes, including potential de-nitrification in the subsurface, mixing and dilution at the deeper point of withdrawal for most wells, and maintenance of recommended rates of fertilizer and uptake by crops. Steele et al. (1994) noted that shallow alluvial wells (<50 feet) in Woodruff County had median NO_3-N concentrations of 2.94 mg/L, whereas deep wells (>50 feet) had median concentrations of 0.13 mg/L, and suggested de-nitrification with depth as a possible reason for the difference. These findings, while limited in extent, show differences in NO_3-N concentrations for shallow versus deep wells and would suggest de-nitrification or mixing and dilution with depth as dominant causes for lack of NO_3-N with depth. However, nearly all of the shallow wells were domestic wells and the impact of on-site septic systems cannot be negated, whereas most of the deeper wells were irrigation wells and would not have this input. As such, the differences between the shallow and deep wells may be directly attributable to the well type and source inputs, and further sampling is necessary to substantiate these findings.

Concentrations for dissolved As in the ground-water samples range from non-detect at <1 µg/L to 50.67 µg/L. The U.S. Environmental Protection Agency recently revised the MCL for As from 50 µg/L to 10 µg/L. The final proposed rule was published in the Federal Register on January 22, 2001 (USEPA, 2001). Community water systems and non-community, non-transient water systems with As exceeding 10 µg/L in their drinking water will be required to reduce the As concentrations. Compliance with the 10 µg/L MCL is required 5 years after the publication of the final rule, which will be in January, 2006. Only one well sampled for the present study had an As concentration exceeding 50 µg/L; however, 21 of 118 alluvial wells had concentrations exceeding 10 µg/L. As such, there may be potential problems with As concentrations in the alluvial aquifer from a health consideration that have not been previously documented in the literature. A review of data within the ADEQ files revealed that this problem is not observed in the deeper Tertiary aquifers, including the Cockfield and Sparta aquifers. In addition, there were no elevated As concentrations in water samples from wells located in the terrace deposits. A more detailed discussion on the difference in As concentrations between the two geologic provinces is presented in the next section.

Comparison of Water Quality in Alluvial Delta versus Upland Terrace Deposits

During the planning phase for the present investigation, every effort was made to sample a uniform distribution of alluvial wells in the Quaternary terrace deposits. Ultimately, 25 terrace wells were selected in Ashley and Drew counties and included both irrigation and domestic wells. Because of the high Fe content associated with the alluvial aquifer, non-acidified samples exhibit a strong yellow to orange color within hours of sampling, whereas the same samples are clear and transparent at the time of sampling. By the next morning there is often a noticeable and appreciable quantity of Fe oxide on the bottom of the container. It was noted that the samples from the terrace deposits remained clear the next day and, together with conversations with area farmers, indicated possible chemical differences between the ground water in the delta versus that in the terrace deposits.

A cursory inspection of the data from both areas revealed marked differences in the Fe and Mn concentrations. Iron concentrations in the alluvial wells in the delta ranged from 291 to 41,390 µg/L, with a mean and median concentrations of 12,548 µg/L and 11,600 µg/L, respectively. However, 16 of the 25 terrace wells were below the detection limit of 15 µg/L, with a mean Fe concentration (using 7.5 µg/L for non-detect samples) of 340 µg/L. Similarly, 8 of the 25 terrace wells revealed Mn concentrations less than the detection limit of 0.5 µg/L, and had a mean concentration of 192 µg/L versus 620 µg/L for the delta wells. Because there also were large apparent differences in the mean concentrations for dissolved As, Ba, B, and possibly other constituents, a *z*-test was performed to investigate the statistical significance of the perceived differences. A *z*-test is a statistical test that evaluates the differences between the means of two sample populations using calculated variances for each set, and was chosen because of the distribution of the sample concentrations. The results of the *z*-test are provided in Appendix III. Large, statically significant differences were noted between the two sets of data for Fe ($p = 0$) and Mn ($p = 2.5E-4$), as expected, and additionally for As ($p = 2.2E-10$) and Ba ($p = 1.1 E-19$).

The most likely controlling factor influencing the concentration of Ba in the alluvial ground water is its absorption by metal oxides. Hem (1989) noted that Ba is commonly found in deep-sea manganese nodules and also in freshwater manganese-oxide deposits. The fact that the delta wells have significant increases in Ba, in addition to Fe and Mn, appears to support co-precipitation as the source for the increased Ba. The source of increased As in the delta wells is complicated by its widespread use in pesticide formulations over the years. However, when applied as a pesticide, As competes with phosphorus in the soil and forms insoluble salts with various metals (USDA, 1996), and is listed as having a "low" leaching potential (Wauchope, 1988). A major inorganic factor acting to maintain concentrations of As at low levels is adsorption by hydrous Fe oxide (Hem, 1989). Because the As, similar to Ba, is elevated along with Fe and Mn in the delta deposits and appears relatively immobile in soils, it appears more likely that the As is associated with an inorganic source rather than through pesticide application. Additionally, the fact that the As concentrations are typically 2-5 orders of magnitude higher than documented pesticide concentrations in Arkansas would support an inorganic source for the arsenic. Hinkle (1997), investigating water quality in alluvial ground water in the Willamette Basin in Oregon, also supports the probability of natural (geologic) sources and geochemical controls to explain the occurrence of As in Oregon's alluvial ground water.

Broom and Reed (1973), reporting on the aquifer-stream relationship in Bayou Bartholomew, list differences between the terrace and delta deposits, and state that the water from the terrace deposits is a Na-HCO_3 water type, which is lower in TDS, hardness and Fe and has a lower pH than water from the delta alluvial deposits. However, results from this present investigation revealed that the mean, median and range of concentrations for TDS are very similar for both aquifer systems. Furthermore, although 7 of the 25 wells in the terrace deposits had waters of a Na-HCO_3 chemistry, which were all located within Drew County, the remaining water samples were Ca-dominated water types. Values for pH ranged from 6.0 to 7.4 for both areas, with similar mean and median values. As such, there does not appear to be consistent differences in water type or general chemistry based on data for this report by which to differentiate the two aquifer systems, except for the significant differences in Fe, Mn, Ba and As. Several areas within the alluvial aquifer as a whole have water types trending from a Ca-HCO_3 to a Na-HCO_3 water type, which is a result of cation exchange, mixing with other water sources, or a combination of both, and is controlled by multiple processes including amount of flushing, surface recharge, residence time, aquifer transmissivity, and other physical processes and site characteristics.

Water Quality in the Jackson Formation

There are few known existing domestic wells in the Jackson Formation for Drew and Lincoln counties. Coupled with the listed objectives for the investigation, efforts were focused on water quality in the quaternary deposits, with little attention to the saturated portions of the exposed Tertiary and Pliocene deposits. One sample, LINC19, was taken from domestic well in Star City, which was originally thought to be completed in the terrace deposits. However, the Na concentration of 243 mg/L was greater than three times the maximum concentration in the other wells (75 mg/L) and an order of magnitude larger than the mean concentration of 25.7 mg/L for all other wells. The SO_4 concentration of 211 mg/L was similarly elevated over the maximum and mean concentrations of 93 mg/L and 11.7 mg/L, respectively, for all other well-water samples. Boron and Zn were also elevated with respect to the other samples, and the B concentration of 1,356 µg/L exceeded the EPA health advisory limit of 600 µg/L. Onellion (1956) cited high concentrations of SO_4 (maximum concentration of 3080 mg/L), some elevated concentrations of Cl, and appreciable quantities of cations in the waters from the Jackson Formation in Drew County, and attributed this to the low permeability and restricted movement of ground water. Bedinger and Reed (1961) cited variation in the water quality (poor to fair) in the Jackson Formation in Lincoln County and stated that the water is high in SO_4, although less mineralized than that in Drew County. Their data reveal a wide range in SO_4 concentrations, with a maximum concentration of 2,360 mg/L. A close inspection of the geologic map revealed that LINC19, previously thought to be in the terrace deposits, is close to the mapped contact of the Jackson Formation and terrace deposits, and is either completed in Jackson Formation or receiving significant water from this source.

One spring (LINC20) that was previously used to water a poultry house was sampled in Lincoln County. The location of the spring and household is very near the contact of the Pliocene deposits and Jackson Formation, according to the state geologic map. The house is situated at the top of a dissected plateau and the spring is approximately 35 feet below the elevation of the homestead and the poultry house. The possibility that the spring resurges from the Pliocene deposits at the contact of the Jackson clay is consistent with the observation that the flow in the Pliocene deposits is radially outward from the central portion of the outcrop to exposed formational contacts as seeps and springs on top of the Jackson (Onellion, 1956). The low pH (4.86) and TDS concentration (76 mg/L) indicate a water of short residence time with little buffering. The spring also contained the only detected Be concentration (0.2 µg/L) and the highest Cu concentration (5.2 µg/L), which is possibly a result of the low pH combined with the near surface input and short residence time for the ground water. LINC20 also had the highest NO_3-N concentration (6.5 mg/L) and the only NO_3-N concentration >1.0 mg/L; a probable result of the near proximity to and the drainage alignment with the poultry house.

Results of Pesticide Investigation

All ground-water samples were analyzed for 61 pesticides and pesticide byproducts. Appendix IV lists the results of all pesticide analyses, including the percent recovery for the surrogate compounds. Pesticides were detected in 28 of the 119 well-water samples (no detections for LIN20, the spring sample), resulting in a 24% detection rate for the wells (Figure 6). A similar nonpoint source investigation by the ADEQ in 1996, which documented water quality in 77 wells in parts of Jefferson, Desha and Phillips counties for the same suite of pesticides, listed 24 wells with pesticide detections for a detection rate of 31% (Kresse et al., 1997). Table 3 lists the wells with positive pesticide detections and the corresponding pesticide concentrations. Pesticide concentrations range from 0.002 µg/L to 0.519 µg/L. Bentazon was the most frequently detected pesticide, accounting for 56% of the total detections and occurring in 19 of the 28 wells with positive pesticide detections. This result is similar to that of Kresse et al. (1977), who noted that bentazon accounted for 37% of the total detections, and Nichols et al. (1996), who revealed that bentazon accounted for 43% of the total detections of wells sampled throughout the Mississippi alluvial plain of Arkansas over an approximate 5-year period. Figure 7 shows the detection percentage for all pesticide detections for the present study.

The movement of pesticides through the subsurface to the ground-water table is dependent on several factors, including site characteristics, management practices, weather conditions and pesticide chemical characteristics. Important site characteristics include the depth to the water table, permeability of surface soil and subsurface material, and the fraction organic carbon in the soils. Rainfall amount and intensity are critical for generation of percolating recharge waters acting as a transport mechanism. Additionally, management practices regarding irrigation timing and rates together with flooding of certain crops can influence the downward movement of water. Other practices including pesticide storage, handling, mixing and application methods can influence the amount of pesticide applied or spilled onto the land, increasing the potential for pesticide transfer to the subsurface. Temperature can be a critical factor in the stability of certain pesticides in surficial soils; accelerating or slowing processes destructive to the pesticide. Lastly, but perhaps most importantly, chemical characteristics which affect the stability and mobility of pesticides in the environment (including adsorption, solubility, photo- and microbial degradation, and hydrolysis, among others) appear to be a critical factor in controlling the types of pesticides detected in ground water in Arkansas.

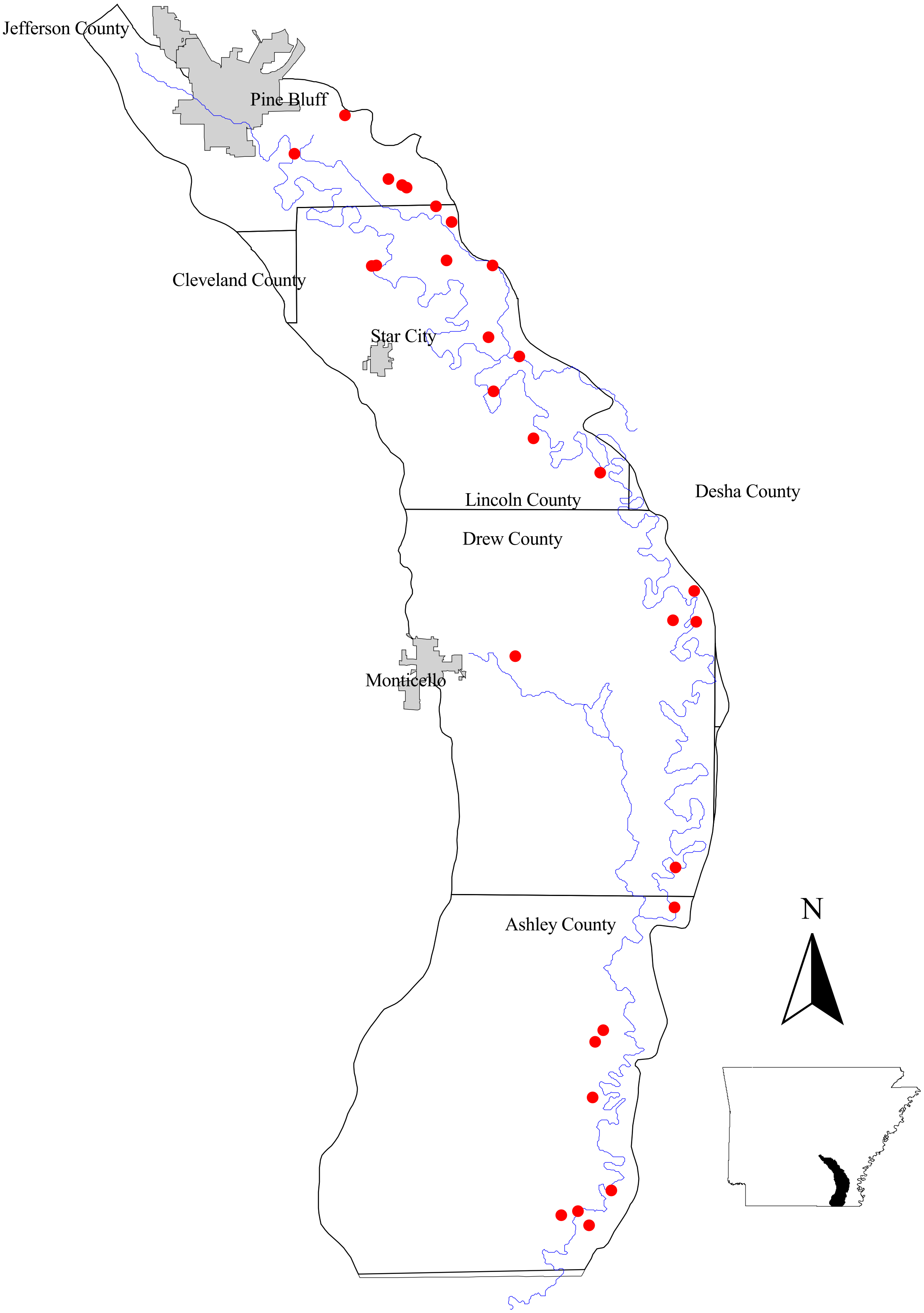

Figure 6. Location of wells with pesticide detections

Table 3. List of wells with positive pesticide detections (all detections in µg/L).

Station	2,4 -D	Bentazon	Acifuorfenn	Molinate	Simazine	Prometryn	Terbutryn	Metolachlor	Cyanazine	Pendimethalin	p-p-DDE	Methoxychlor
DREW03										0.013		
LINC01		0.025										
ASH04		0.024										
DREW05		0.025										
ASH07		0.023										
ASH09						0.440						
ASH10						0.050						
ASH11						0.011						
ASH15											0.009	
ASH17		0.094										
ASH18		0.014										
LINC05	0.025						0.127					
JEF01		0.058										
JEF02		0.017							0.010			0.002
JEF09		0.033						0.007				
JEF13		0.519										
LINC08		0.018										
LINC10		0.069		0.048								
LINC11		0.014										
LINC14				0.486								
LINC16		0.043										
LINC17		0.006										
DREW16		0.035										
JEF022		0.040										
LINC21			0.265									
DREW31					0.015							
LINC22		0.007										
LINC23		0.009										

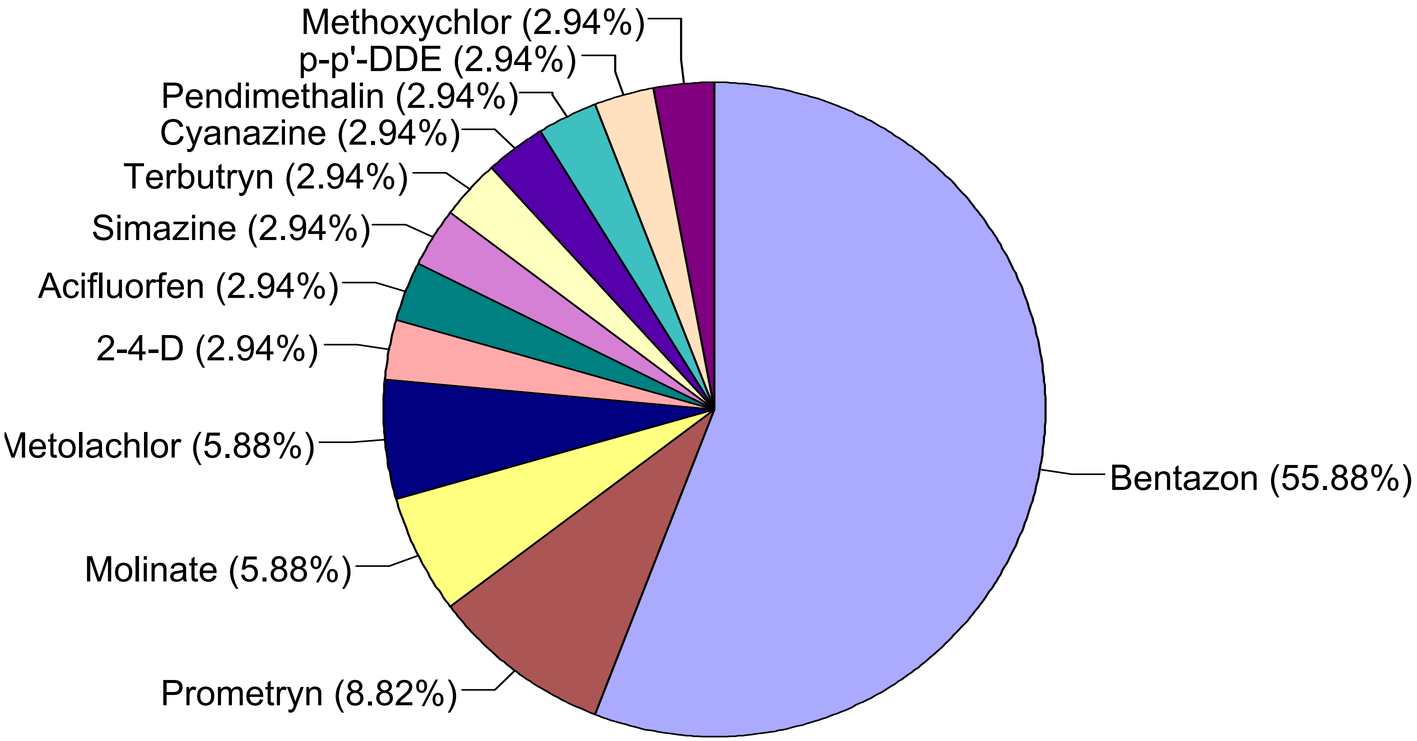

Figure 7. Percent of pesticide detections in ground water in Bayou Bartholomew watershed.

Given these factors, it is reasonable to assume that the greatest potential for pesticide leaching is through the use of highly soluble pesticides onto permeable soils overlying shallow ground water, followed by intense and heavy rainfall. Furthermore, it should be easy to predict the occurrence of pesticides according to their type, and model these occurrences according to important site characteristics retarding their transport. However, Barbash and Resek (1996), who conducted an excellent review of studies throughout North America concerning the occurrence, distribution and trends of pesticides in ground water, noted that pesticides from every chemical class have been detected in ground water around the nation. They attributed the widespread detection of a number of hydrophobic pesticides in ground water to preferential transport along macropore regions in the soil profile. Their also cited preferential transport as a dominant cause in the poor performance of most mathematic models and vulnerability assessments in predicting the occurrence and distribution of pesticides. In addition to preferential transport, secondary causes for the poor performance of prediction tools were (1) variations in listed adsorption and field half-life values, and (2) variations in the detection limits.

A problem in assessing and interpreting pesticide data on any level, especially on a nationwide basis, is the large differences between investigators in every phase of a pesticide investigation from planning to laboratory analysis. In Arkansas, there are three major agencies investigating the occurrence of pesticides in ground water in the delta: the ADEQ, the Arkansas Water Resource Center (AWRC) and, to a lesser extent, the USGS. Kresse (1997) noted differences in the data sets between all three agencies in the detection limits and types of pesticides. For example, the USGS did not have bentazon, molinate, aciflurofen and fluometuron in their set of analyses, although these pesticides were in the top five most frequently detected pesticides in the state. Conversely, the AWRC did not include prometryn, ametryn or silvex in their analyses, although ADEQ and USGS included all three of the pesticides, and all three were detected more than once. The percentage of wells with positive pesticide detections ranged from 31% to 33% for the ADEQ and the USGS, respectively; whereas, the AWRC only showed a 6% detection rate. The differences in the detection rates are thought to be the result of the higher detection limits for the AWRC. In addition, many of the wells sampled by the AWRC were domestic wells, whereas most all the wells sampled by the ADEQ were irrigation wells.

Unfortunately, because farmers are not required to report pesticide use, there is no accurate means to assess the most frequently used pesticides in the state. Pesticide sales data are available, but not of desirable quality for many reasons including sales across state and county lines. Kresse (1997) used soybean, corn and rice pesticide survey reports by the CES in conjunction with crop-production figures to estimate the most frequently used pesticides. Although the table provides an accurate representation of pesticide use in 1996, major changes in seed formulations have led to changes in current pesticide use. For example, Roundup Ready® soybeans have greatly diminished the use of bentazon, trifluralin and aciflurofen, and increased the use of gyphosate. Similar changes have resulted in the increased the use of bromoxynil in cotton (Ford Baldwin, CES, personal communication, 2001). Many other pesticides are used only with exemptions from restricted-use requirements by the federal government and may be used only within a limited time frame (one or two seasons). However, because many of the pesticides are very persistent in the ground-water environment, the table from the Kresse (1997) provides a good guide to pesticides used both historically and currently in the state, although the frequency of use has changed with current practices. The lack of accurate and quantitative numbers for actual usage underscores the lack of information required by investigators for purposes of both planning and correlation analyses at the level of quality desired, and, combined with differences in the instrumentation and detection limits for individual agencies, creates problems in interpreting the data statewide.

The above discussion is not necessarily an academic exercise. The Arkansas Plant Board requires data on the occurrence of pesticides in ground water to evaluate which pesticides pose problems to the environment. The USGS data, prior to 1997, would not have revealed the frequency of which bentazon is detected in ground water, whereas the detection frequency by the AWRC (6%) would suggest that very few wells have detectable pesticide concentrations. Various mathematical models have been used by the U of A at Fayetteville to predict the occurrence of pesticides based on site characteristics or vulnerability indices. Because they originally used the AWRC data base, the data were too limited to produce statistical significance and to draw any substantiative conclusions. Results of the modeling to date have been only marginally successful (Lin et al., 1999). However, many of the problems complicating the correlation and prediction process may be related more directly to the resolution of the data layers (vulnerability indices) and spatial variability in the soil characteristics than the detection limits and type of pesticide data (Don Scott, personal communication, 2001). Additional factors include short-circuiting or bypass, in which back-siphoning, direct entry along well annulus, or spillage in conjunction with preferential transport via macropore regions in the soil allow rapid transport to the ground-water table. The movement of pesticides from streams to areas of induced recharge (whether permanent or temporal) provides another mechanism of short-circuiting, which would tend to undermine models based on soil infiltration. Because most vulnerability models primarily are designed to evaluate transport based solely on site characteristics, and bypass can occur in vulnerable and non-vulnerable areas, such occurrences can limit the success of the models in correlating pesticide detections to vulnerable areas.

In spite of the problems associated with the correlation of observed data to that of predicted data, the ADEQ continues to detect only medium to high solubility pesticides in ground water; a fact that would seem to validate prediction models. Figures 8 and 9 graphically depict the correlation between solubility and adsorption (Koc) for pesticides with two or more detections by the ADEQ in ground water and surface water, respectively. The high detection of low-solubility pesticides in surface water attests to the fact that transport of pesticides sorbed to fine-grained sediments during rainstorm events acts to deliver virtually insoluble pesticides into streams and other surface water bodies. The lack of detection of insoluble pesticides in ground water fits predictive models, which theorize that pesticides with a high affinity for organic matter and low solubilities are vertically retarded with respect to percolating recharge waters and, as such, have a low probability for transport to ground water. The figures also reveal the high number of pesticide detections in surface water as compared to the detections in ground water. The detection of dominantly high-solubility, low-adsorption pesticides in ground water lends support to the assumption that inadequate data layers and spatial variability may be the dominant factor affecting vulnerability modeling in Arkansas.

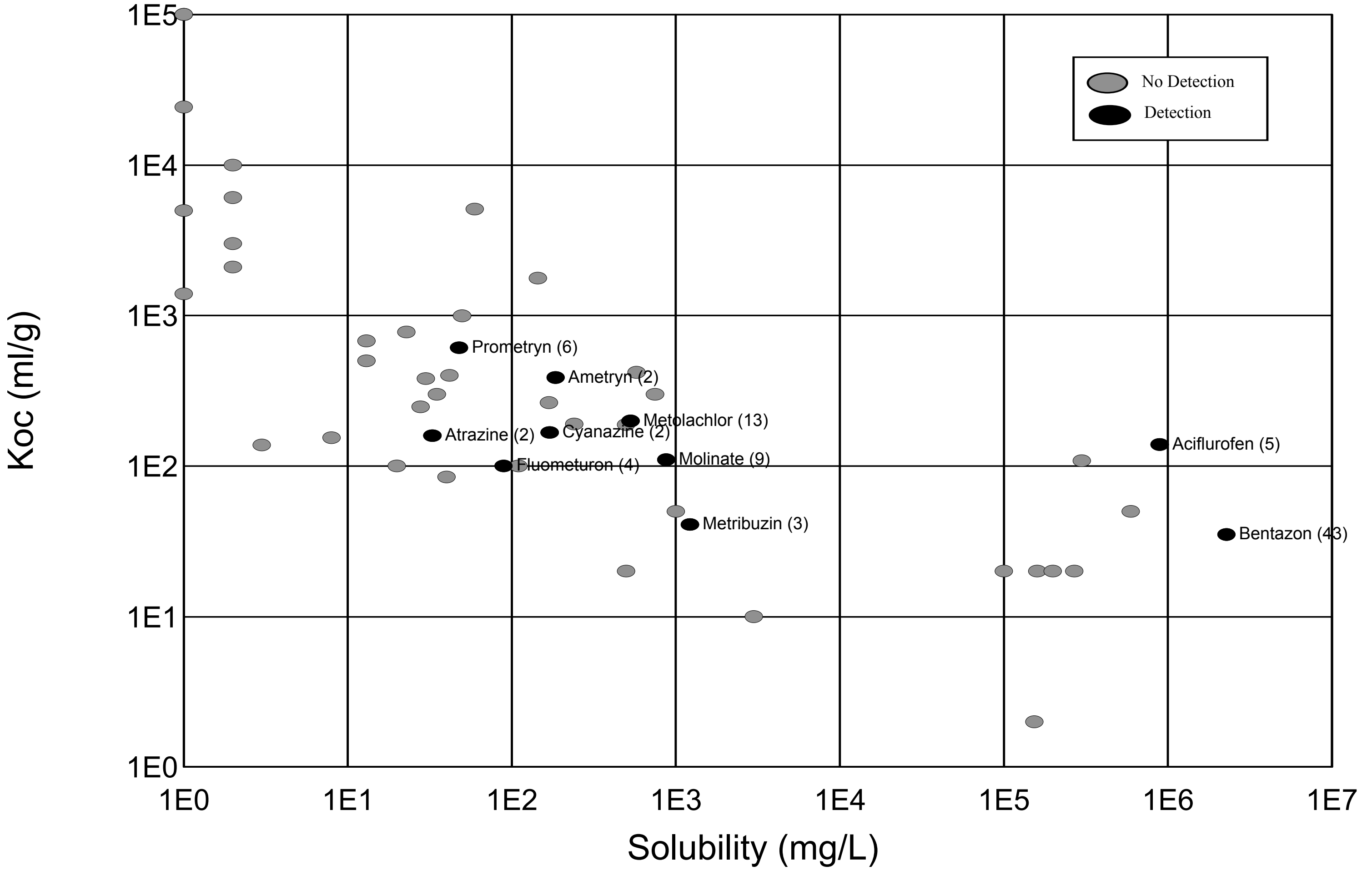

Figure 8. Pesticide solubility versus sorption (Koc) for high-use pesticides in Arkansas. Detected pesticides represent pesticides with two or more detections in ground water to date. Number in parentheses represents number of detections.

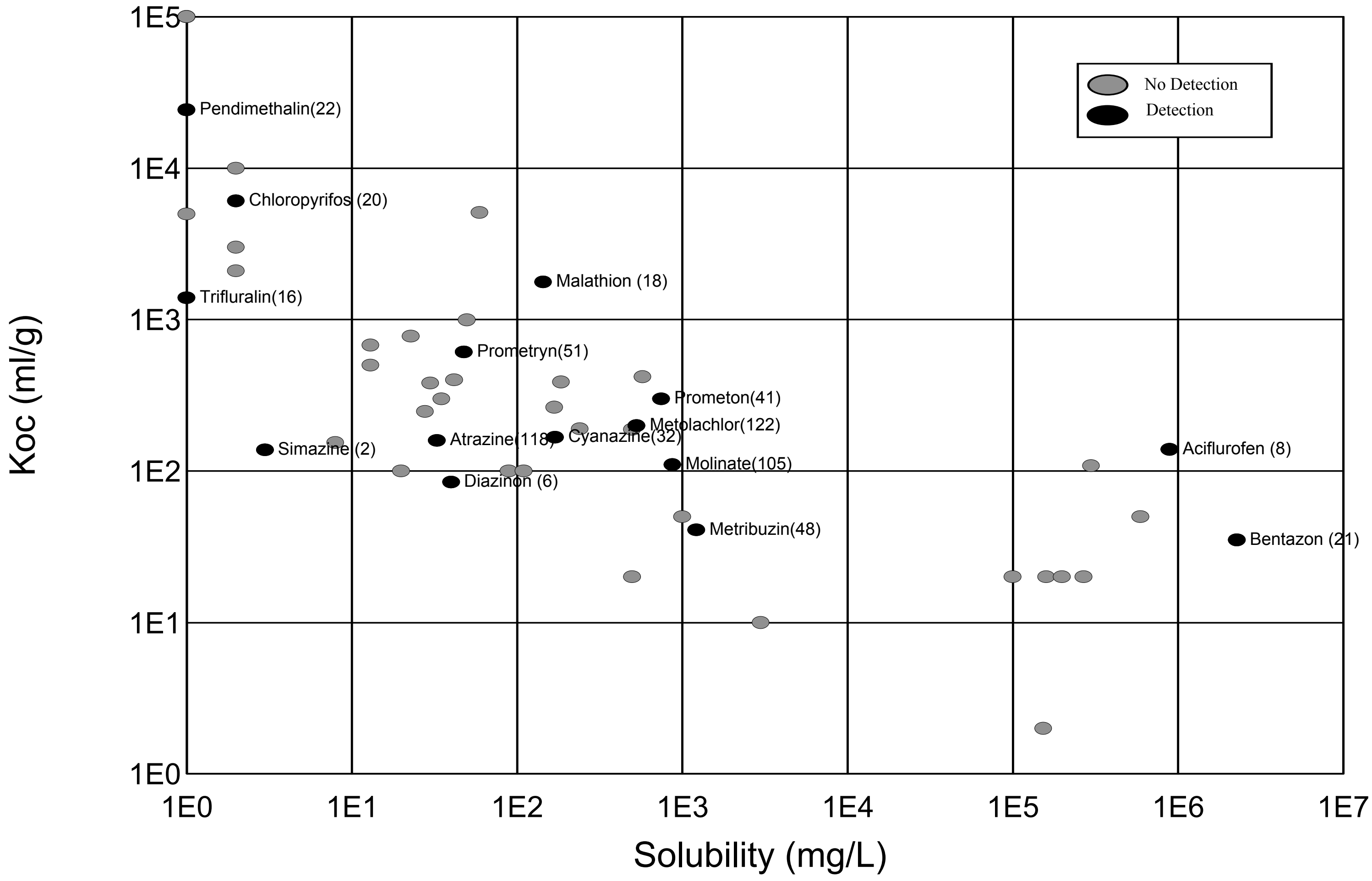

Figure 9. Pesticide solubility versus sorption (Koc) for high-use pesticides in Arkansas. Detected pesticides are those with two or more detections in surface water to date. Number in parentheses represents number of detections.

Sources of Pesticide Contamination in the Alluvial Aquifer

Through the summer of 2000, more than 110 pesticide detections have been recorded in almost as many wells by the combined efforts of the ADEQ and the AWRC. Approximately 600 wells have been sampled for the occurrence of pesticides in the Mississippi Embayment and Costal Plain regions of the state. However, very little progress has been made toward determination of the source and/or transport mechanisms by which pesticides are reaching the ground-water table. Statements in the literature concerning reported field observations, and the resulting implications of these observations can lead to erroneous predictions of pesticide transport mechanisms. For instance, there are abundant statements in the literature related to the limited extent of residues in a field soil core or laboratory column, which in many cases is believed to represent the maximum extent of vertical transport for a given pesticide. Examples such as "lysimeter studies clearly demonstrate bentazone does not leach" (Meister, 1996), and "bentazone is degraded more quickly than it can leach" (BCPC, 1999), together with the fact that it is listed as having a "medium" leaching potential as a result of the relatively short field half-life of 10 days (Wauchope, 1988), suggest a very low potential for ground-water contamination by bentazon. In view of the statements concerning the non-leaching nature of bentazon, an initial assumption would be that its occurrence is dominantly the result of a point-source or near-wellhead source. However, bentazon accounts for over half of the pesticide detections and has been detected in over 50 wells in Arkansas. In addition, bentazon was banned for use on flooded rice and for all use in the winter months in California because of observed leaching problems (John Troiano, Dept. of Pesticide Regulation, California, personal communication, 2001).

Speculations concerning the source of pesticides in the alluvial aquifer in Arkansas have directly suffered from such misinformation concerning the fate and transport for specific pesticides. The Arkansas Soil and Water Conservation Commission (ASWCC, 1996) in an amendment to its Nonpoint Source Pollution Management Program stated that "The detection of a specific pesticide, bentazon (not known to leach below the plow layer), suggests that improperly constructed water wells may provide contaminant pathways into ground water." Although improperly-constructed wells are potential pathways for ground-water contamination, the detection of bentazon as an implication of a point-source of contamination is contrary to its transport characteristics based on the chemical properties for bentazon. Bentazon in its soluble salt formulation is infinitely soluble; in deionized water, 2.3 kg of sodium bentazon will dissolve in one liter of water. In combination with a relatively low Koc value of 34 ml/g, these characteristics indicate a high mobility and high potential for ground-water contamination. Bentazon, although a fairly high-use pesticide, especially in soybean production, was listed only as #14 on the list of most-frequently used pesticides in Arkansas (Kresse, 1997); however, it is the pesticide most frequently detected in ground water in Arkansas.

Cavalier et al. (1989) noted only one well with a positive pesticide detection and attributed the source to localized spillage or handling error, as previous and subsequent sampling at this well failed to detect any pesticides; thus correlating transiency of pesticide detection to point-source contamination. They additionally attributed the lack of detections to abundant clay soils, low percolation rates and deeper ground-water table, which culminate in a low vulnerability for Arkansas soils. However, bentazon was not one of the analytes, and the detection limits ranged from 0.1 to 0.5 µg/L. Senseman et al. (1997) focused on mixing/loading sites and stated that pesticide proximity to wells during mixing/loading activities was a greater influence on ground-water contamination than chemical or site characteristics, because most of the soils were not listed as well-drained, and, as such, were not perceived as conducive to leaching by pesticides.

Statistical comparisons between vulnerability indices and ground-water detections in Arkansas have sought to distinguish contamination from normal application versus "quasi" point sources of pesticides (Lin et al., 1999). Because these studies have met with only limited success, there is a tendency to explain the lack of correlation by contamination at the wellhead and exclude normal application practices as a dominant source. However, this may be unrealistic in view of the large scale for the data layers and spatial variability of soils at the site level. Barbash and Resek (1999) stated that most of the vulnerability studies nationwide have been unsuccessful in predicting contaminant occurrence in ground water; of the 19 studies reviewed, only 10 of these had significant results, two of which observed relations opposite to that expected (i.e., more severe contamination in areas deemed to be less vulnerable). Of the 10 studies reviewed that used the DRASTIC (Aller et. al., 1987) system or another arbitrary scoring system, only three revealed significant, positive correlations between predicted and observed contamination. They listed a number of reasons for the limited success including (1) neglect of significant physical and chemical processes that influence the transport and fate of pesticides in the subsurface, including preferential transport and transformations, (2) the inappropriate use or weighting of one or more vulnerability factors, and (3) the use of large-scale input data for predicting contamination occurring on a local scale.

Other attempts at defining sources of contamination in Arkansas have been based on purely corollary observations. ASWCC (1996) stated that "Because there is an inconsistent pattern of pesticide detections ... the threat is likely from pseudo point sources such as inflow through improperly constructed wells, spillage at mixing and handling facilities, and improper handling of bulk quantities of chemicals rather than from general application and leaching pesticides." Nichols et al. (1993) and Steele et al. (1993) both noted the possibility of back-siphoning or some form of wellhead contamination to explain both the spatial variance in the pesticide detections and the temporal nature of their occurrence (not detected in re-sampling events). However, Steele et al. (1993) did note the possibility of preferential transport through macropore zones as a possible route. Barbash and Resek (1999) discussed the ongoing debate by researchers concerning pesticide sources across the nation and noted three commonly-used criteria that were used to distinguish between point and nonpoint sources including: (1) spatial patterns of contamination: (2) transiency of pesticide detections in individual wells: and (3) severity of contamination. In comparisons of nationwide, site-specific studies on both point and nonpoint sources for pesticides, they indicated that none of the above criteria can reliably distinguish the source of contamination, although point sources are constantly invoked to explain spatial variance and transiency of detections in the Arkansas data.

Kresse et al. (1996) conducted a site investigation in Augusta, Arkansas, in which repeated sampling by the AWRC and the ADEQ had confirmed the presence of elevated concentrations of bentazon (upwards to 70 µg/L) in a domestic well surrounded by crop land. Installation of four monitoring wells also revealed the presence of dinoseb, a pesticide that had been banned since 1986, upgradient from the domestic well. Bentazon had not been used by the present owner since acquisition of the land, indicating that both dinoseb or bentazon had been present in the ground water for over 10 years, although void of a surface input source over this period of time. Determination of ground-water flow directions, analytical water chemistry, soil type, pesticide transport characteristics, and review of the site history and past pesticide usage indicated that the contamination had occurred from repeated spills associated with mixing/loading activities and possible releases from the numerous pesticide containers found at the site during the land acquisition. Well-water samples continue to reveal bentazon and dinoseb at greater than 10 μg/L (last sampling in July, 2001). The persistence of such high-solubility pesticides over time was attributed to diffusion from less-permeable micropore regions in the soil profile. The investigation also illustrated the potential dangers in relying on field half-lives for predicting pesticide leaching potential, as bentazon has a reported field half life of 10 days (Wauchope, 1988). It should be noted that site investigations of this sort are geared toward sites with the highest pesticide concentrations and/or multiple detections, and, as such, the sources identified at these sites should not be viewed as representative of common sources statewide.

Much of the above discussion concerning sources of pesticides in ground water illustrates the lack of information concerning the dominant mechanisms by which pesticides are transported to the ground-water table in Arkansas. In view of the lack of information at the site level in combination with the lack of success of present modeling efforts, the possibility of contamination from normal application cannot be overlooked by investigators. Most of the wells sampled for the present investigation were in the middle of fields, and not in proximity to established or potential mixing/loading sites. The abundance of low-level detections of soluble pesticides throughout the watershed and the lack of detection for hydrophobic classes of pesticides, together with information to date concerning the numerous pesticide detections throughout the delta, provide strong corollary evidence for vertical migration of pesticides through normal application practices. The determination of dominant transport mechanisms for pesticide transport to the subsurface will be gained only through additional site investigations and improvement in the resolution of vulnerability indices used in current models.

Geochemistry of the Alluvial Aquifer

In addition to the general water-quality parameters and pesticides discussed in the previous section, a complete chemical analysis including major cations and anions, alkalinity and trace metals was performed on all samples The possession of a complete chemical analyses in conjunction with statistical methods allows for inspection of quality control associated with the laboratory analysis; fingerprinting of the aquifer based on a unique set of chemical constituents, and identification of trends in the data which can provide information on the chemical evolution of the water along its flow paths and/or anthropogenic impacts affecting water chemistry.

Least-Squares linear regression analyses was applied to the water-quality data using QuattroPro to compare the relationships between various chemical parameters. This analysis method tests the variance between a set of independent and dependent variables. The coefficient of determination (r^2) explains the variation within the linear model, and represents the reliability of the regression with a value between zero and unity. The linear relationship is more reliable as r^2 approaches unity. Graphical and statistical methods were also employed to describe the geochemistry of the three aquifer systems in the project area.

Quality Assurance/Quality Control

A set of commonly measured field parameters include temperature, pH and specific conductance (conductance). It has long been recognized that conductance has a strong linear correlation with total dissolved solids (TDS), and many researchers use conductance to predict total dissolved solids, using a coefficient that represents the slope of a best-fit line between the two parameters with a zero intercept. However, this should be used in only the most general sense because of the range of expected error. Hem (1989) showed a range of 0.54 to 0.96 for the coefficient (A) represented by the formula, $KA=S$; where K equals the conductance value and S is equal to the TDS. However, the waters represented a wide range of environments, including deep brines, and a more common range provided for natural waters was 0.55 to 0.75. Ground-water data from the ADEQ files for various aquifer systems show a general range of 0.54 to 0.71 for this coefficient using a zero intercept. Additionally, best fit lines generated for all ADEQ data show that this line rarely passes through zero, such that the equation (using the above terminology) is better defined by $S = KA + B$; where A represents the X coefficient describing the slope of the line, and B is a constant, represented by a value for S where K equals zero. In short, a line passing through zero will show an increased error factor for low or high values of conductance depending on the slope of the line.

Regardless of the error in predicting TDS from conductance, TDS does reveal a strongly positive relationship with conductance, and points which significantly deviate from this trend indicate potential error in one of the values. Without a complete chemical analyses of all major contributing ions, decisions regarding the erroneous value will be highly speculative; however, re-analyzing the TDS for the suspect sample is prudent. Figure 10 reveals a strongly positive relationship between TDS and conductance with an $r^2 = 0.95$. In addition to the laboratory TDS, as measured by gravimetric means at 180 degrees, TDS may be calculated by addition of all major ions contributing to the dissolved solids content. In regard to alluvial waters in Arkansas, these major ions would include Ca, Mg, K, Na, Cl, SO_4, HCO_3, SiO_2 and Fe.

Figure 11 depicts an equally strong relationship between calculated TDS and conductance ($r^2 = 0.96$) as that revealed in Figure 10 for measured TDS versus conductance. The fact that sample points DREW06 and CHI03 are similarly displaced in both figures and both TDS values (measured versus calculated) are derived independently, implies the conductance value is in error for the each of the samples. The fact that there is less deviation and a stronger linear correlation between the calculated TDS values versus conductance than the measured values versus conductance, suggests that the calculated values more accurately represent the true TDS concentration for the sampled population. The value for ASH09 in Figure 11 shows significant deviation from the best-fit line; however, ASH09 lies on the best-fit line in Figure 10, indicating an potential error in the analyses for one of the ions contributing to the calculated TDS.

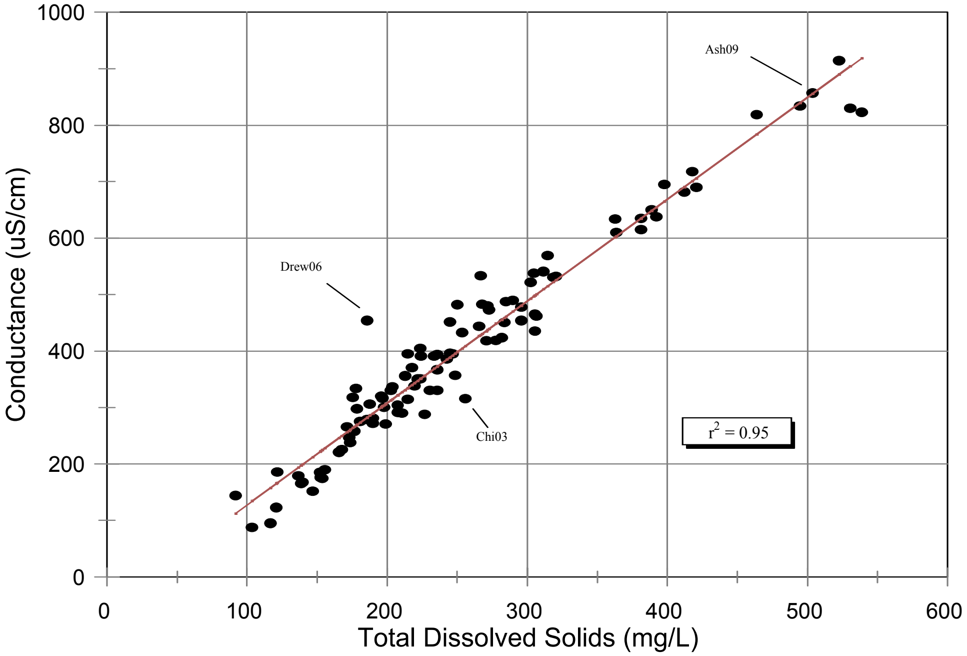

Figure 10. Linear relationship of total dissolved solids versus specific conductance. Goodness of fit represented by r^2 value.

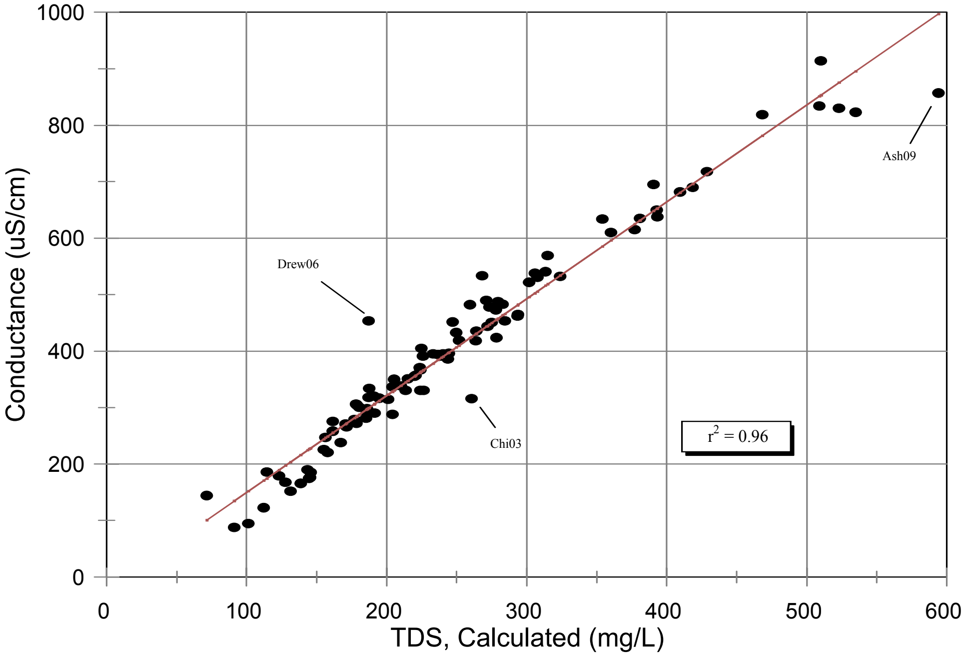

Figure 11. Linear relationship of calculated total dissolved solids versus field conductance. Goodness of fit represented by r^2 value.

The best relationships for inspection of laboratory analyses are measured TDS versus calculated TDS (Figure 12) together with cations in meq/l versus anions in meq/L (Figure 13), as these relationships are strictly defined by laboratory-measured parameters. Because ground water is electrically neutral, a one-to-one relationship should be revealed by comparison of the total major cations (Ca, Mg, Na, and K) in meq/L to the total major anions (SO_4, Cl, and HCO_3) in meq/L. Calculated TDS versus measured TDS (Figure 12) reveals an excellent correlation with an $r^2 = 0.98$. Together with the regression analysis of cations versus anions ($r^2 = 0.96$), these relationships reveal a high level of confidence in the laboratory data. In regard to the relationship described between TDS and conductance, it is reasonable that both total cation and anion values also should exhibit a strongly positive correlation with conductance, which is clearly demonstrated by figures 14 and 15. These figures also assist in determining errors in individual analyses. ASH09, which appears to have an erroneous calculated TDS value based on its deviation from the best-fit line in figures 11 and 12, can be narrowed down to a potential problem with one of the anions based on Figure 15. Further analyses (discussed below) pointed to a potential error with the Cl analyses.

Chemical Variation within the Alluvial Aquifer Ground Water

As described in the section above titled "Water Quality," the alluvial aquifer is typically a strongly Ca-HCO_3 water type throughout Arkansas. However, various processes within the aquifer, together with anthropogenic impacts at the surface, can change the chemical composition of ground water. Processes within the aquifer affecting the water chemistry include the spacial distribution, abundance and solubility of matrix minerals, ion-exchange processes, precipitation of carbonate minerals along the flow path, and mixing of waters from other sources within, above or below the aquifer. Anthropogenic influences include various land-use activities which can influence both the chemistry and infiltration rates of recharge waters including agricultural, industrial, and other land uses, activities of which affect both atmospheric gases (smokestacks, cars, etc.) and land surface inputs (fertilizer and pesticide use, waste disposal, etc.). This section of the report focuses on graphically depicting changes in the alluvial chemistry, and the following section provides possible explanations for the evolution of water chemistry within the alluvial aquifer.

Figure 16 depicts changes in pH values with increases in TDS concentration. There is a strongly positive trend reflecting increases in pH with increasing TDS concentrations up to approximately 350 mg/L, at which point the pH values cease to rise and appear to decrease with further increases in TDS concentration. The two separate trends in changes in pH relative to increasing TDS are shown in Figure 17, with approximate boundaries delineating the variation within the pH values for both populations. The figure graphically illustrates the consumption of hydrogen ions in the process of dissolving aquifer matrix materials, primarily calcite. The pH continues to rise to >7.4 at a TDS concentration of approximately 350 mg/L. Further increases in TDS beyond 350 mg/L result in concomitant decreases in pH, with pH values falling below 7.0 at TDS concentrations exceeding 700 mg/L.

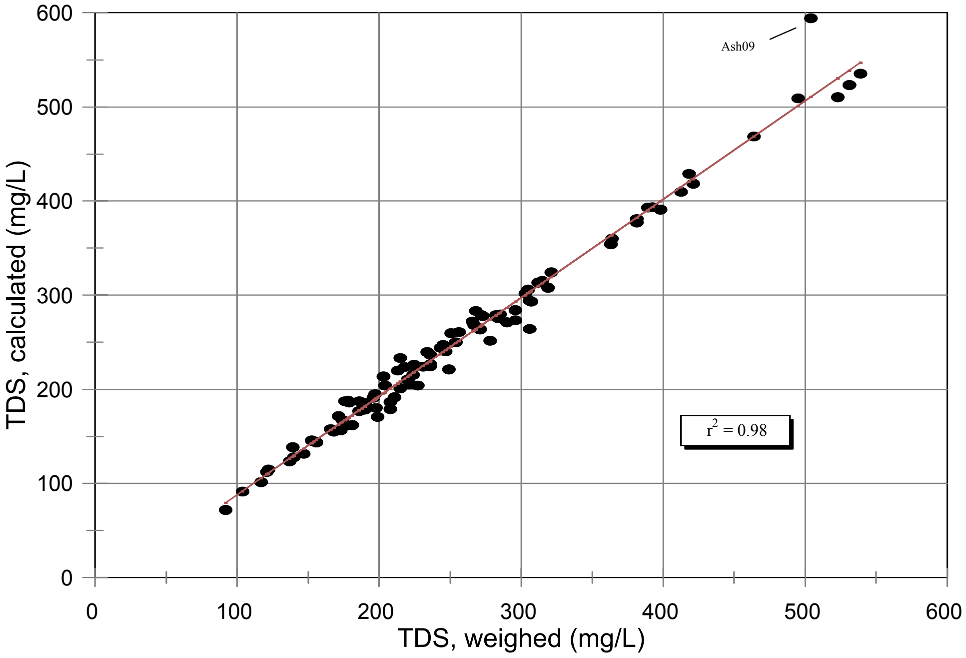

Figure 12. Linear relationship of measured total dissolved solids versus calculated total dissolved solids. Goodness of fit represented by r^2 value.

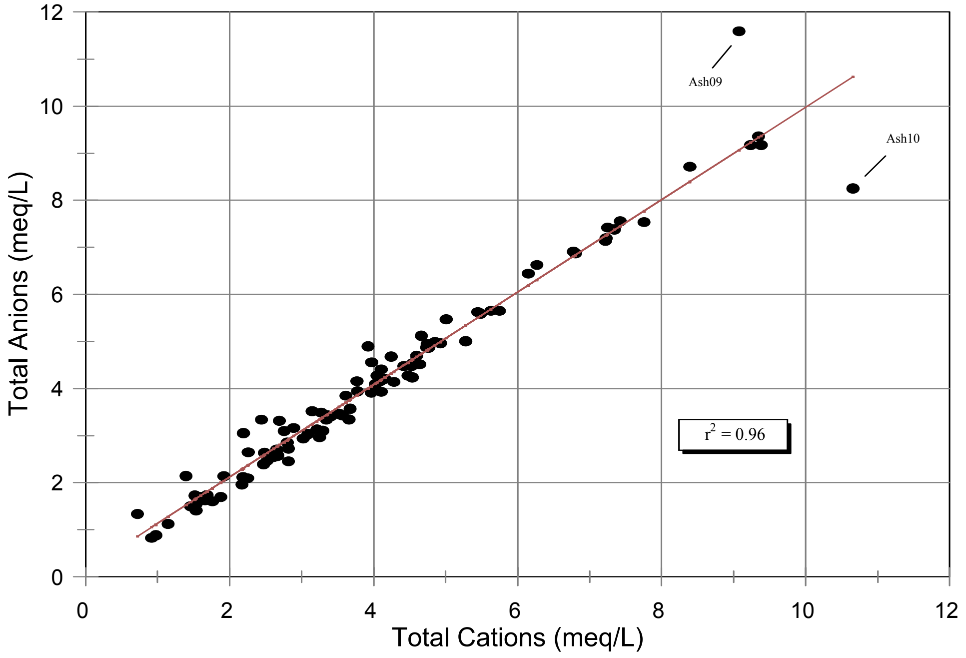

Figure 13. Linear relationship of total cations versus total anions in meq/L. Goodness of fit represented by r^2 value.

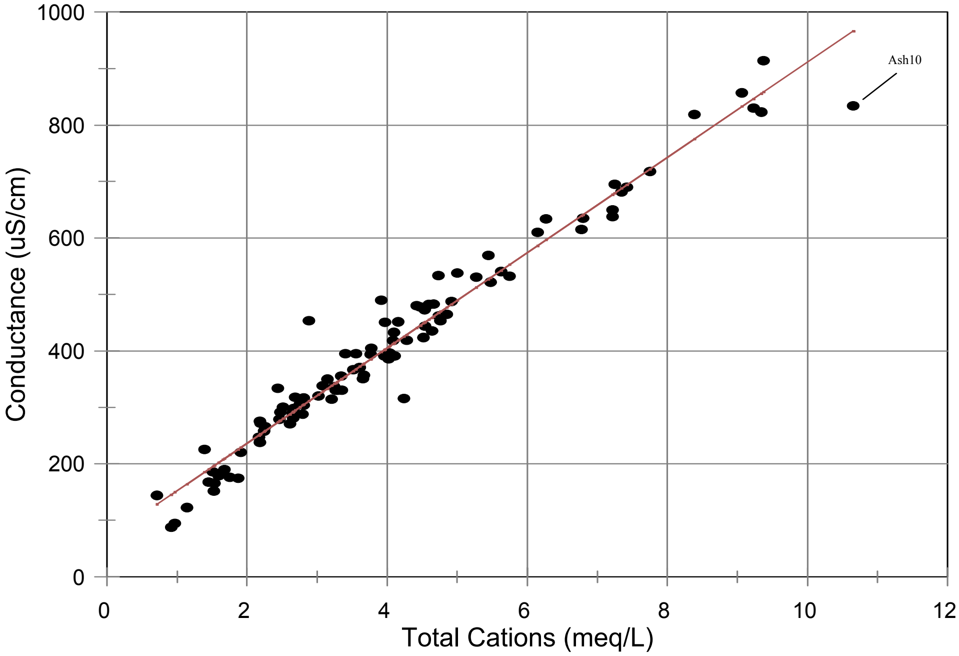

Figure 14. Linear relationship of total cations versus specific conductance. Goodness of fit represented by r^2 value.

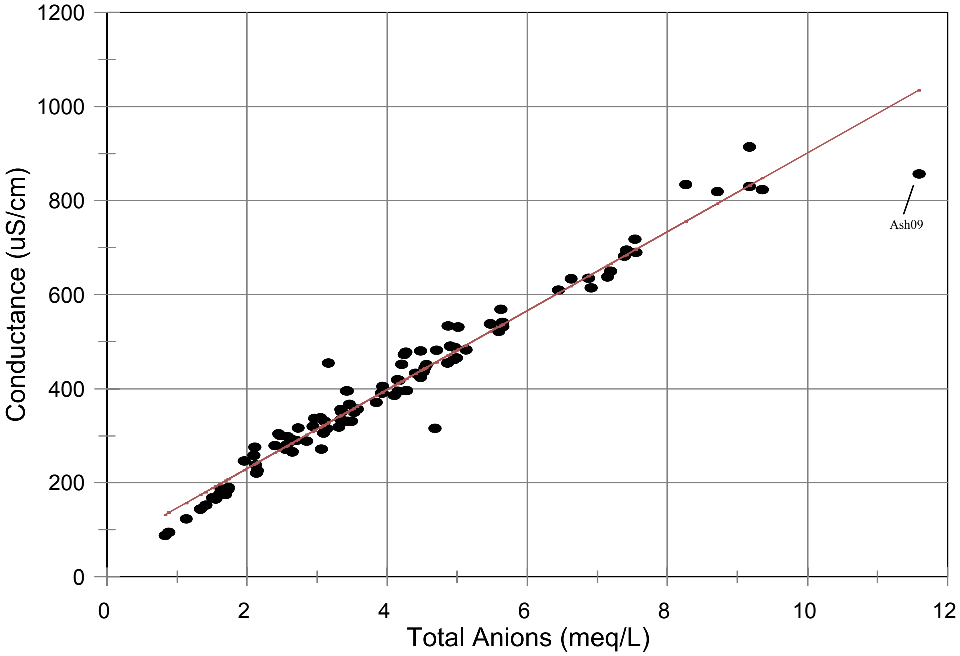

Figure 15. Linear relationship of total anions versus specific conductance. Goodness of fit represented by r^2 value.

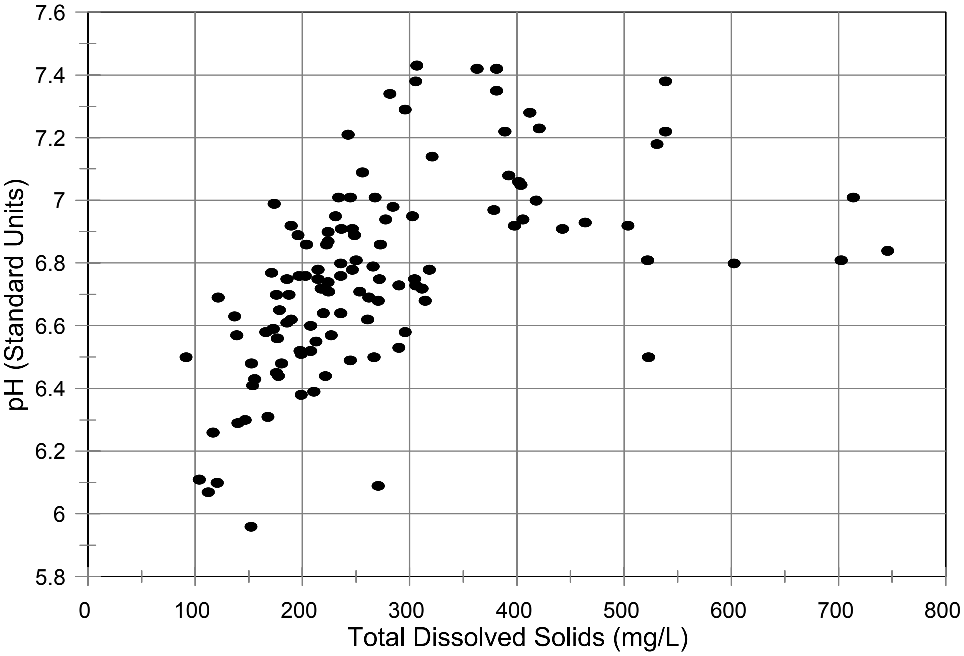

Figure 16. Total dissolved solids versus field pH.

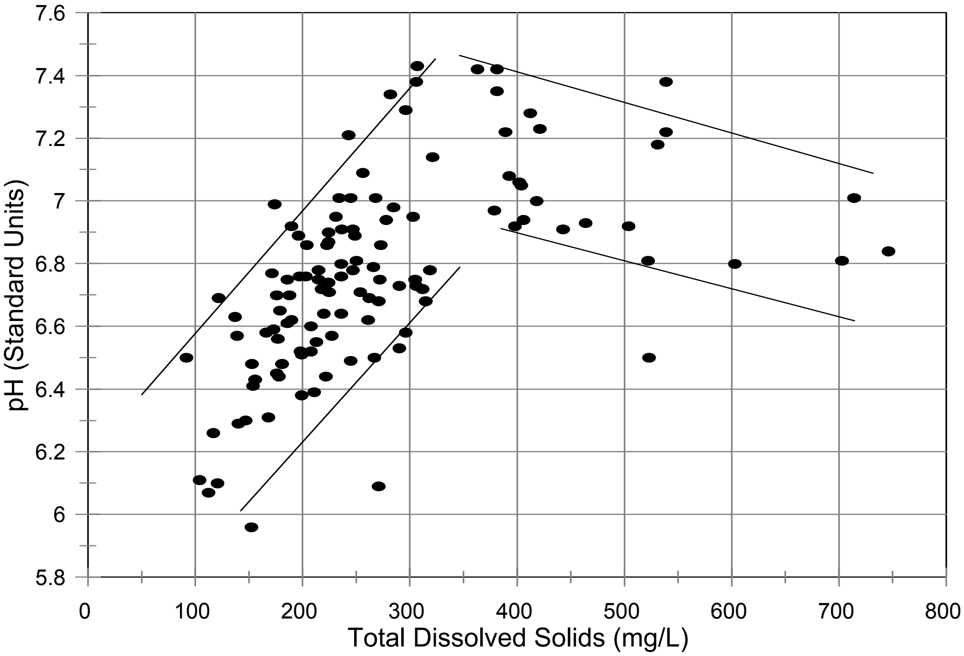

Figure 17. Total dissolved solids versus field pH, with trend lines depicting the approximate boundaries for each population of points.

Figure 18 depicts Fe versus TDS concentrations. As previously discussed, Fe is ubiquitous throughout the alluvial aquifer and its concentration in any one area dominantly would depend on availability in the form of iron oxide staining on aquifer materials and the Eh and pH of the ground water. As such, no relationship should be expected between Fe and TDS concentrations, and indeed there is no linear relationship revealed in Figure 18. However, there is an interesting feature which corresponds to the decrease in pH revealed in Figure 17 for TDS concentrations exceeding approximately 350 mg/L. Iron concentrations vary between 0 and greater than 40,000 µg/L in a scattered pattern up to the same break in TDS concentrations as in Figure 17 and beginning at approximately 350 mg/L. At this point, Fe drops below 15,500 µg/L, and remains near 10,000 µg/L at TDS concentrations exceeding 400 mg/L. In the absence of further information related to the cause for the apparent differences, the graphs of pH and Fe versus TDS suggest the possibility of a two separate populations; one for data points less than 350 mg/L TDS and one for TDS concentrations exceeding 350 mg/L.

The previous graphs of conductance versus TDS (both measured and calculated), total cations and total anions (figures 10, 11, 14 and 15, respectively) all reveal a large number of points tailing off or falling below the line for TDS concentrations of approximately 100 and 175 mg/L. With the information gained from Figures 17 and 18, it is instructive to revisit the graph of TDS versus conductance. Figure 19 shows best-fit lines placed for the points; now depicted as two distinct populations as defined by the change of slope noted in the graph for pH versus TDS. Although there was basically no change in the slope for points with TDS concentrations exceeding 350 mg/L (the break), a new slope is developed for points below the break, which appear to fit these data points better than the single best-fit line in Figure 10; especially those points at the upper and lower end of the first population (TDS . 100-175 mg/L and 275-325).

A careful review of the water chemistry is necessary to further assess the potential for the two distinct populations with different geochemical fingerprints. One approach is to assess changes in the chemical composition, primarily ion concentrations and ion percentages of the total ionic mass, with increases in TDS concentrations. Figures 20 through 25 show the relationship of TDS to Ca, Mg, Na, Cl, SO_4, and HCO_3, respectively. The graphs show a general trend of increases in all parameters with increases in TDS. However, some changes are noted between the two populations for points below and above the break. Calcium (Figure 20) increases from lows of approximately 7 mg/L to highs of approximately 70mg/L at the upper end of the first population of points; a ten-fold increase in calcium concentrations. This rate of increase rapidly diminishes for data comprising the second population of points, in which Ca only increases from approximately 70 - 100 mg/L over a similar range of TDS concentrations as the first population; an increase of approximately 1.5X. A similar pattern is noted for HCO_3 (Figure 25), which similarly shows an approximate 10 fold increase prior to the break, only to increase thereafter by approximately 1.5 times from 300 mg/L to 450 mg/L.

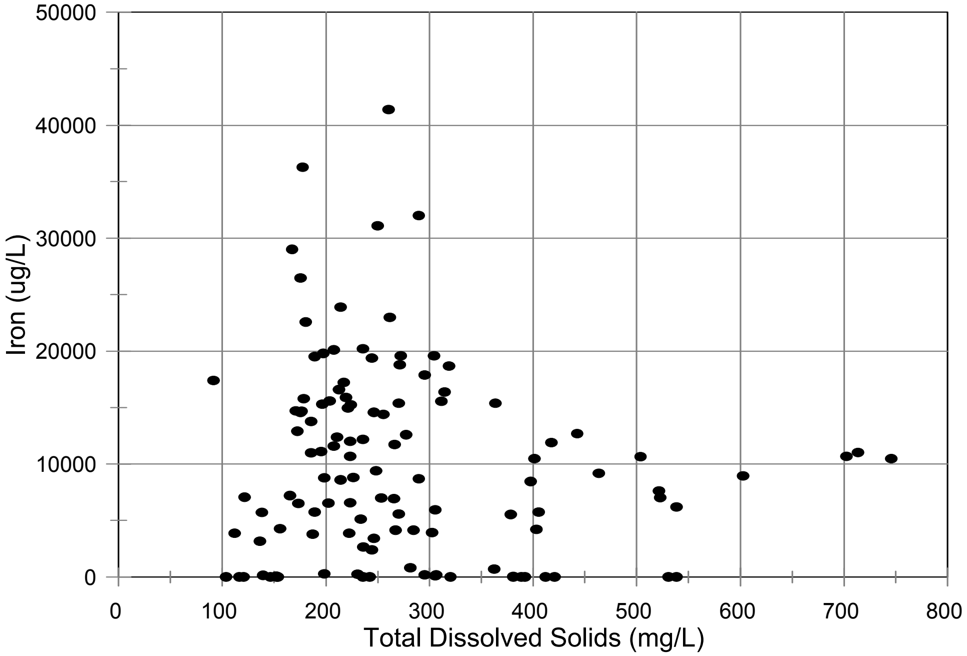

Figure 18. Total dissolved solids versus iron concentrations. Data points >350 mg/L show less variation than those <350 mg/L.

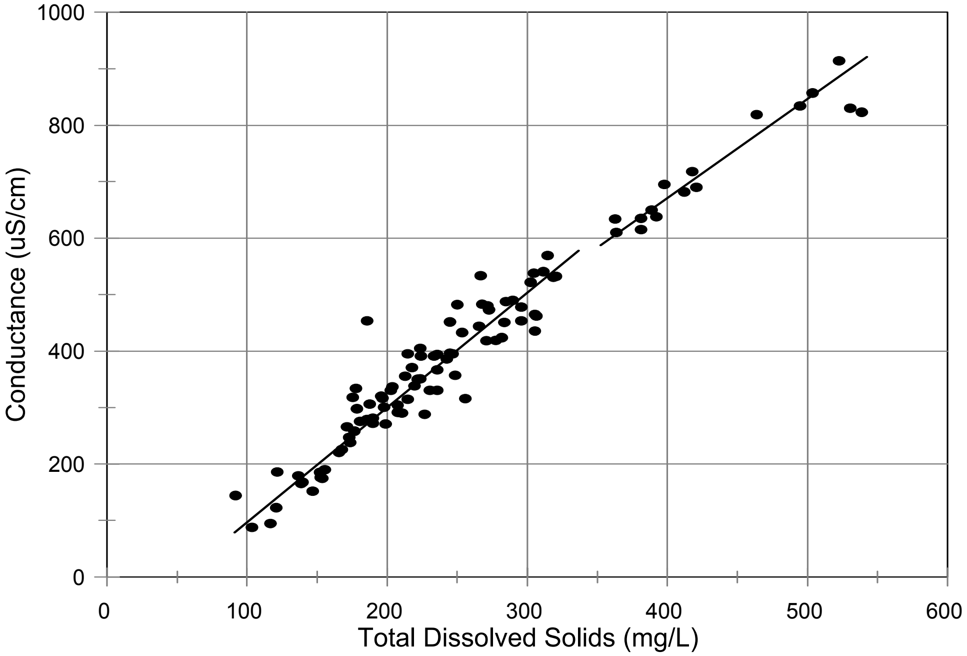

Figure 19. Total dissolved solids versus specific conductance with same well depicted in Figure 10. This figure depicts the relationship as two separate populations.

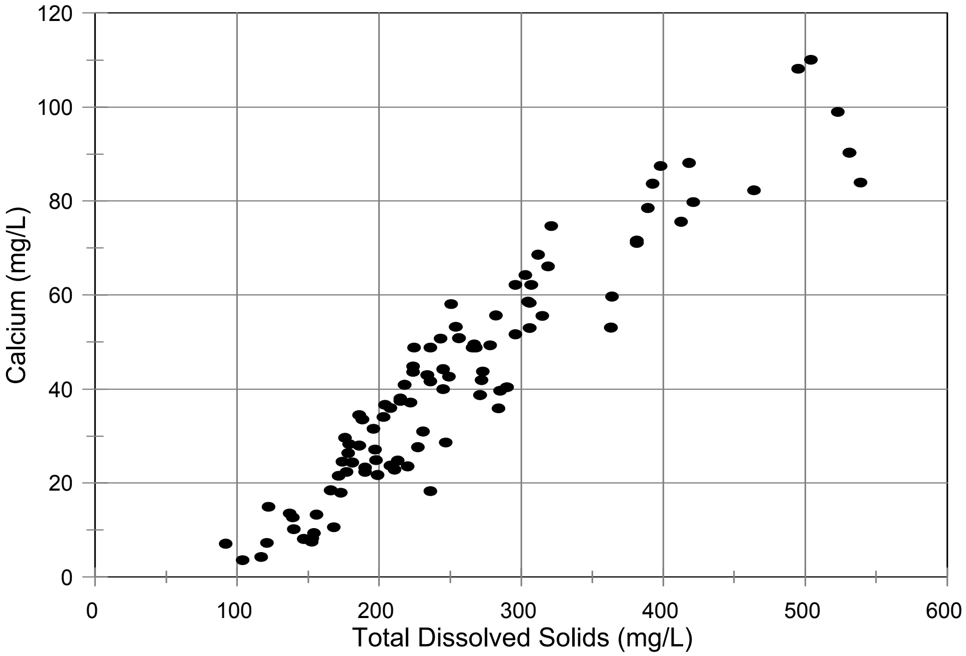

Figure 20. Total dissolved solids versus calcium concentrations. The rate of increase for calcium is diminished past a TDS of 350 mg/L.

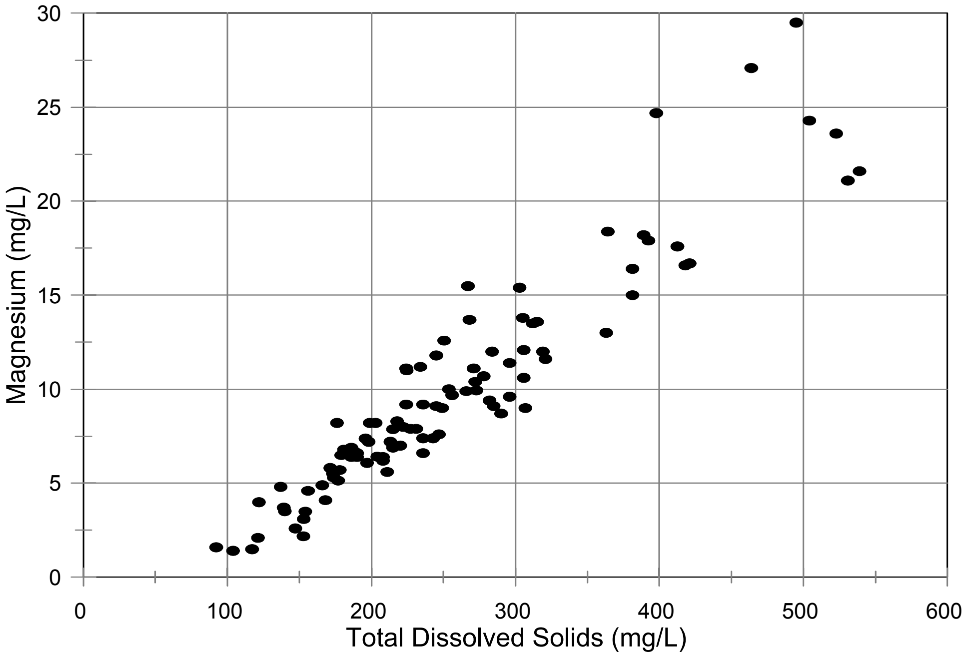

Figure 21. Total dissolved solids versus magnesium concentrations.

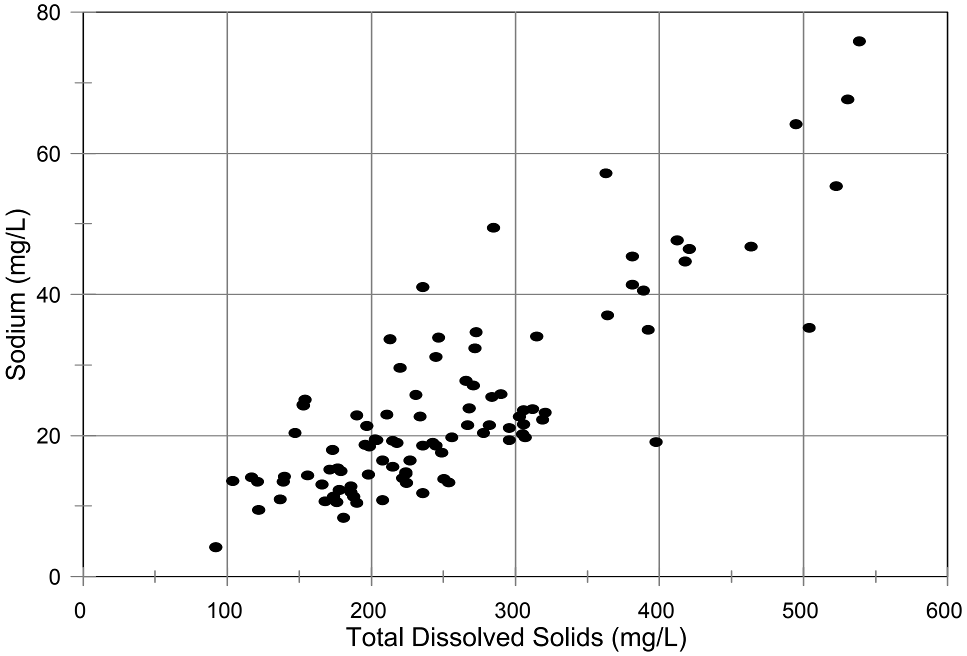

Figure 22. Total dissolved solids versus sodium concentrations.

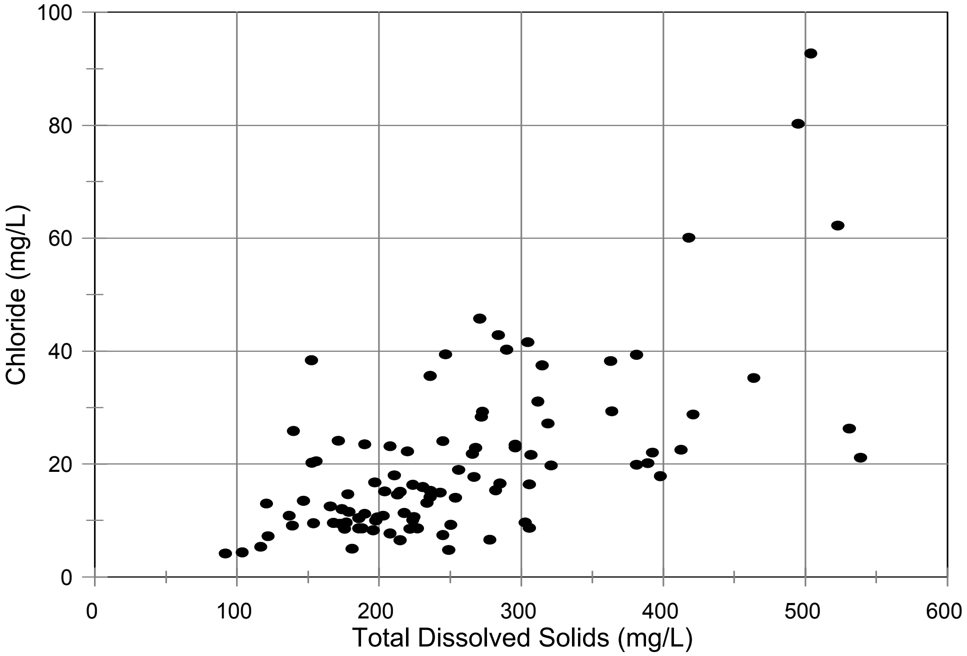

Figure 23. Total dissolved solids versus chloride concentrations. Cl concentrations increase dramatically past a TDS of 350 mg/L.

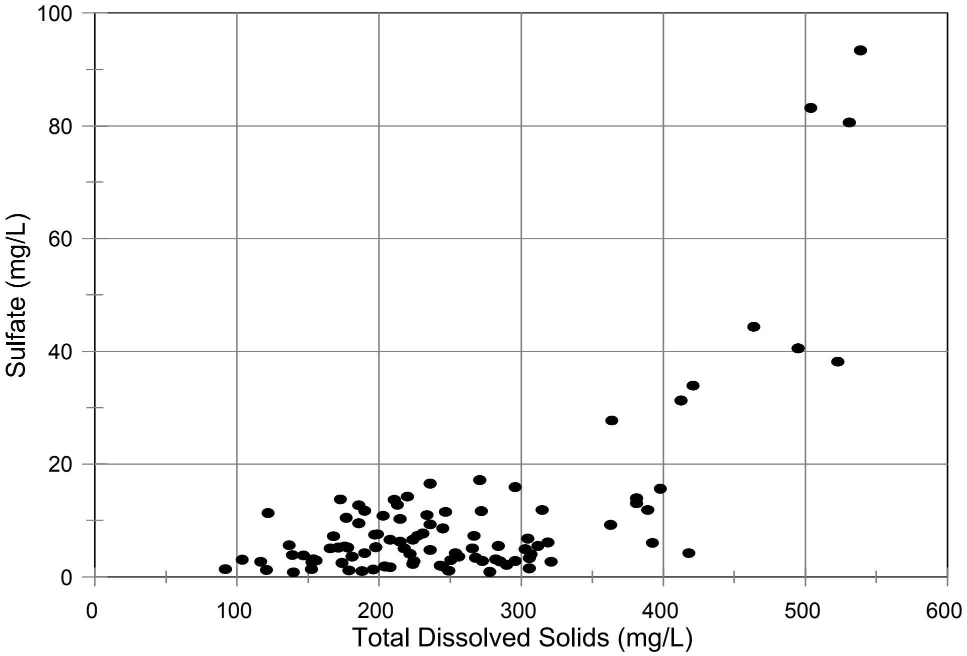

Figure 24. Total dissolved solids versus sulfate concentrations. A sharp increase in sulfate concentrations is noted for sample points >350 mg/L TDS.

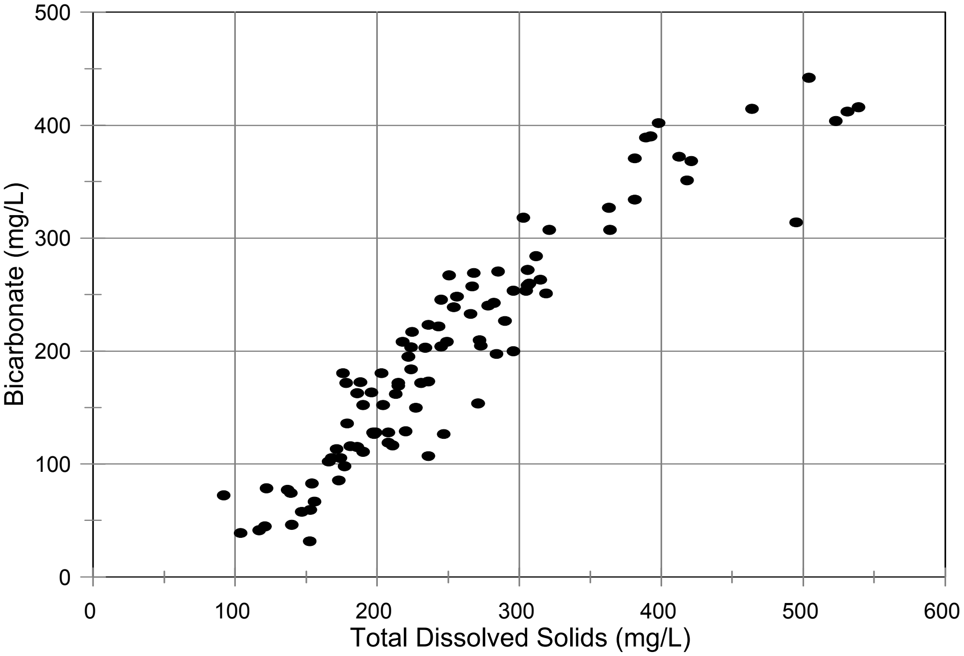

Figure 25. Total dissolved solids versus bicarbonate concentrations. A decreasing slope is noted for points >350 mg/L TDS.

The graphs of Mg and Na versus TDS (Figures 21 and 22) both show a general trend of increasing concentrations over the entire range of TDS concentrations, with virtually no change in slope from one population to the next, although an argument could be made for higher rate of increase in Na concentrations relative to TDS in the second population of Figure 22. The graphs of Cl and SO_4 versus TDS (Figures 23 and 24) both show slight increases within the first population, and an increasing rate of concentration within the second population of data points. Chloride concentrations, which are represented by mean and median values of 20.4 and 16.2 mg/L, respectively, are mostly below 40 mg/L for first-population data points, but reach upwards to greater than 90 mg/L in the second population. Sulfate concentrations are consistently below 20 mg/L in the first population, and demonstrate a weakly-positive increasing trend of SO_4 concentrations in this population. However, nine of the sample points in the second population have SO_4 concentrations exceeding 20 mg/L, and extend upwards to a peak concentration of 93 mg/L.

Changes in the rate of increase for differing ion concentrations suggest that the molar percentages for each of the ions should reveal similar changes between the two defined populations. Figures 26-28 depict percentages of total cation equivalent concentrations for the each of the major cations (Ca, Mg, and Na) versus TDS, and Figures 29-31 depict similar relationships for anion percentages (of total equivalent anion concentrations) versus TDS. Figure 26 reveals that the % Ca increases from lows of approximately 20% at low TDS concentrations upwards to approximately 65% of the total cations within the first population, but decrease with increasing TDS in the second population to less than 50% of the total cations. Similarly, the % HCO_3 (Figure 31) increases from lows of approximately 50-60% (and one anomalously low value of 30%) upwards to values of approximately 95%, before decreasing within the second population to values in the range of 60% of the total anions. As such, Ca-HCO_3 dominates the chemistry to the greatest extent at the upper TDS range of the first population of data points, and is diminished in its dominance with increasing TDS concentrations within the second population.

A negative relationship is noted for Na, Cl, and SO_4 percentages versus TDS. Figure 28 reveals that Na percentages drop dramatically from highs near 65% to lows ranging from 13-17% of the total cations within the first population. However, these percentages increase within the second population upwards to approximately 35% of the total cations. Chloride percentages similarly drop within the first population (Figure 29) from greater than 65% of the anions to approximately 5% at the break; only to rise again within the second population to values nearing 30%. Sulfate comprises a much smaller percentage of the anion total within the first population, from high values of only 15% to nearly 0% at the break. However, these percentages increase drastically within the second population; exceeding 20% of the total anions at TDS concentrations of greater than 500 mg/L (Figure 30). There are no obvious trends for % Mg versus TDS (Figure 27), and two interpretations are possible; first, that the percentages are steadily increasing, albeit with significant deviation in the values, between both populations, and, second, that there is a slight decrease in percentages within the first population (disregarding the lower percentage values, which could be viewed as 'outliers') from highs greater than 25% to lows near 15%, and increasing in the second population to highs exceeding 20% of the total anions. The amount of scatter in the points for % Mg versus TDS does not provide for an easy interpretation of potential trends.

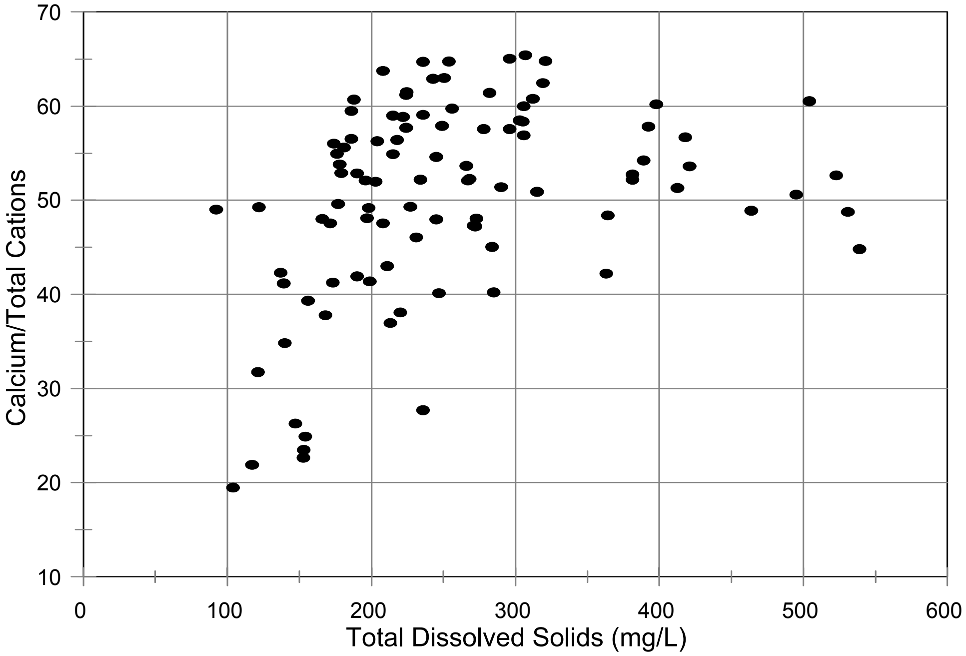

Figure 26. Total dissolved solids versus % calcium of the total cation concentration (meq/L). A sharp decrease in % Ca is noted for points >350 mg/L TDS.

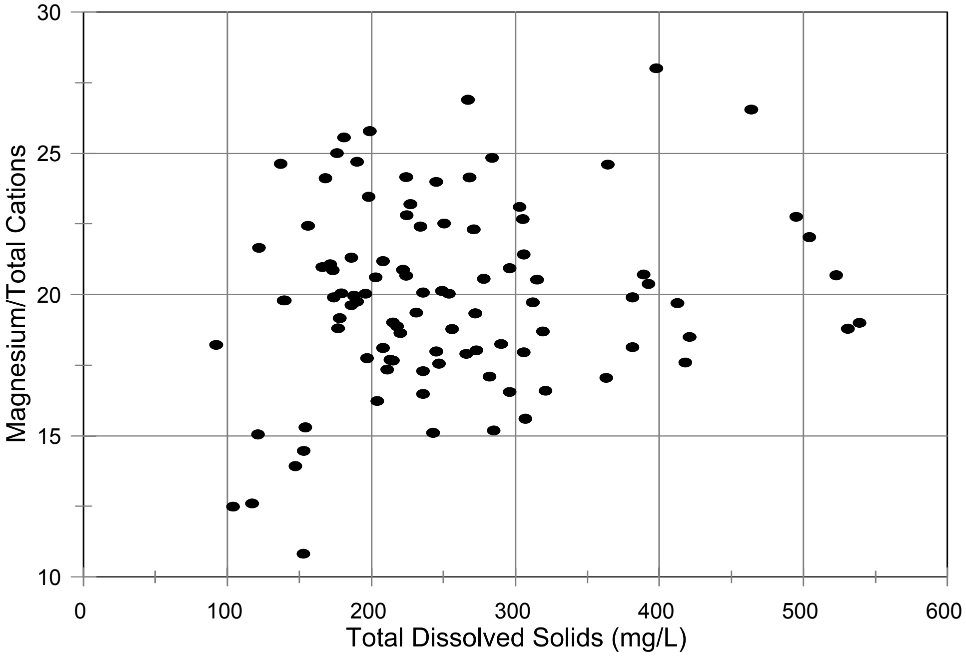

Figure 27. Total dissolved solids versus % magnesium of total cations in meq/l.

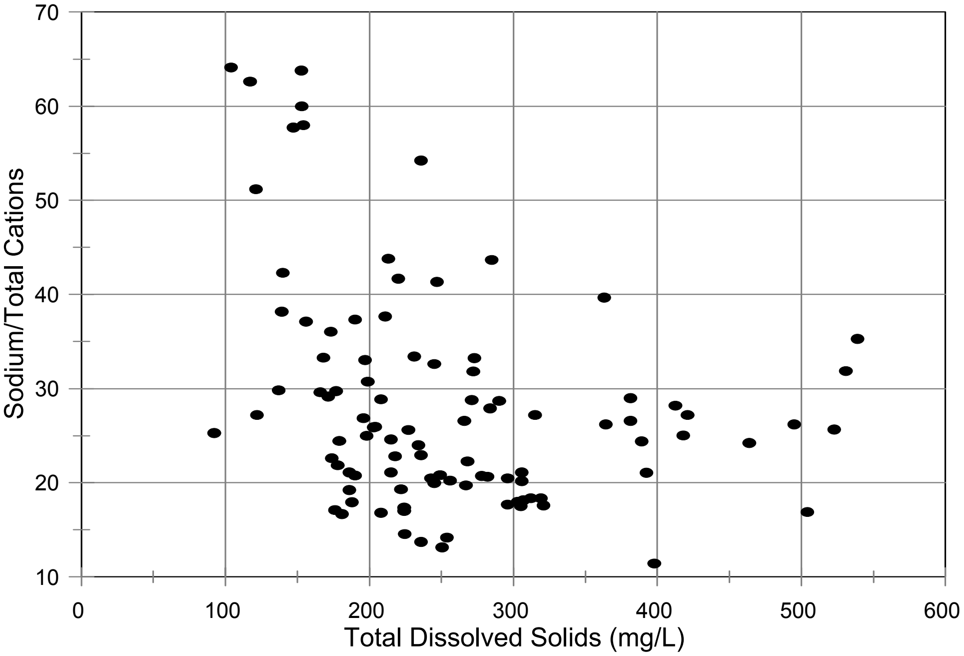

Figure 28. Total dissolved solids versus % sodium of total cations in meq/l.

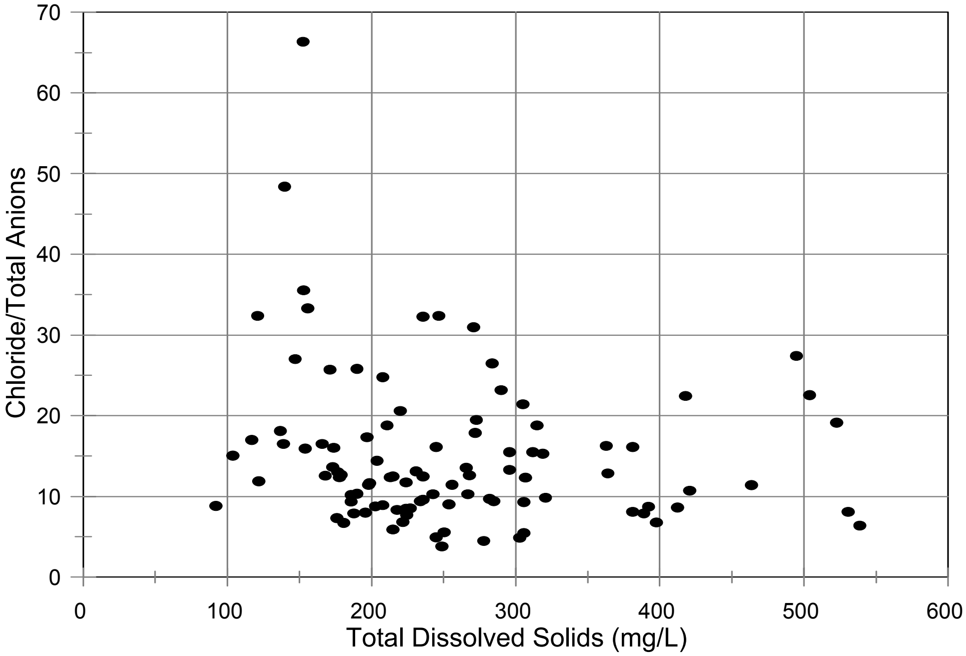

Figure 29. Total dissolved solids versus % chloride of total anions in meq/l. Percentages increase for points >350 mg/L TDS after large decrease.

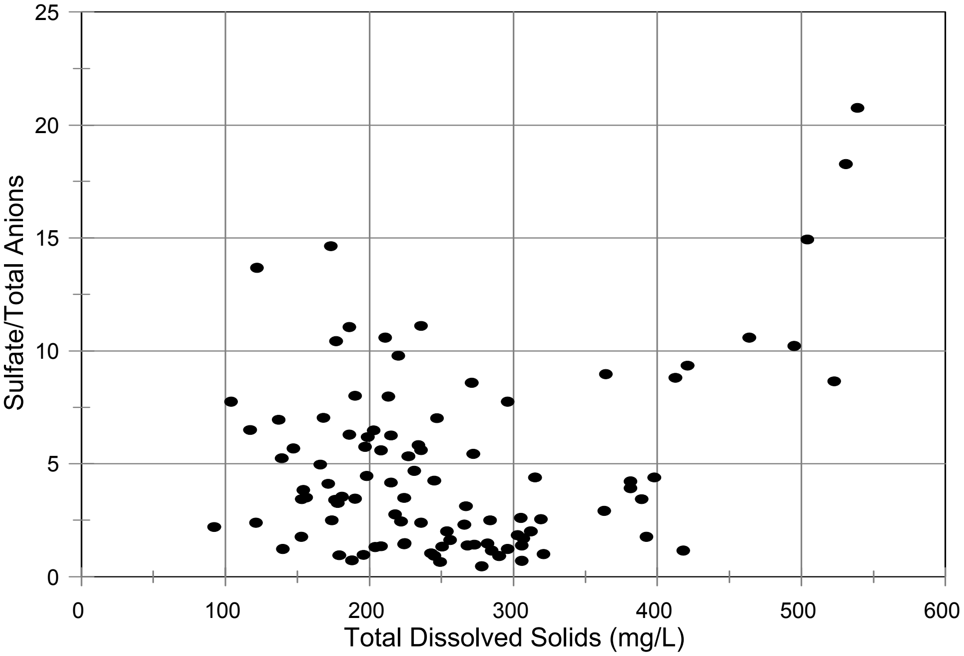

Figure 30. Total dissolved solids versus % sulfate of total anions in meq/l. Percentages increase for points>350 mg/L TDS.

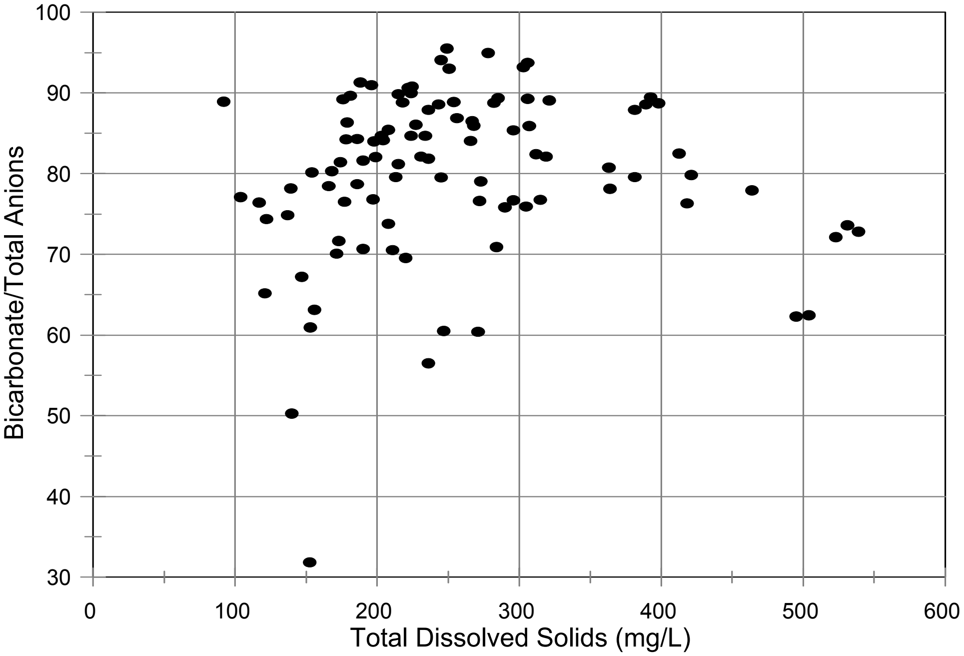

Figure 31. Total dissolved solids versus % bicarbonate of total anions in meq/l. Percentages decrease for points >350 mg/L TDS.

Conceptual Model of Geochemical Evolution of Alluvial Aquifer Ground Water in the Study Area

Trends in the concentrations and ion percentages for the major ions in the alluvial aquifer ground-water provide a foundation for the development of a conceptual model of the chemical evolution of these waters along their flow path. In order to describe the evolution of ground-water chemistry within the aquifer, it is important to ascertain the chemistry of percolating recharge water, and its contribution to the overall chemical composition of the ground water. The composition of rainwater near the coast strongly resembles that of dilute seawater (Appelo and Postma, 1999); however, this composition changes rapidly inland as a result of the washout of sea salt particles (predominantly Na and Cl) and the uptake of particulate matter and gases generated from various inland sources, both natural and anthropogenic. A review of maps on file by the National Atmospheric Deposition Program (NADP, 2001) show regional concentration trends for the major constituents as storm systems move from costal areas to inland portions of the United States. Rainwater chemistry is influenced so strongly over land masses, that the chemical composition of samples from many sites located in coastal cities bears little resemblance to diluted seawater chemistry.

Table 4 illustrates the contribution of natural and anthropogenic inland influences on the rainwater chemistry in eastern Arkansas, using data from the NADP site in Warren, Arkansas. The methodology for calculating seawater contributions was adapted from Appelo and Postma (1999), and uses Cl (as a conservative, low-fractionation ion) to develop ion/Cl ratios, which are subsequently multiplied by the concentration in Arkansas rainwater to evaluate the contribution for all other ions in the Arkansas rainwater relative to seawater. The table illustrates that for Arkansas rainwater, there is a net gain of 100% from other sources other than seawater for Ca, K, SO_4, NH_4, and NO_3; whereas, the seawater contribution accounts for virtually all of the Na, Cl, and Mg in the rainwater.

Evaporative processes act to concentrate this rainwater prior to recharge, and Cl concentrations in ground water relative to that in rainwater frequently have been used to estimate recharge in areas where recharge is difficult to measure by other methods (Appelo and Postma, 1999). Mahon and Ludwig (1990) provide estimates of recharge ranging from 1-10 inches for the alluvial aquifer in eastern Arkansas. Because average rainfall amounts in this part of the state are approximately 50 inches/year (Freiwald, 1984), this would correlate to a concentration factor ranging from 5-50. Table 5 illustrates the theoretical range in ground-water composition solely as a result of evaporative processes. It is interesting to note that evapotranspiration theoretically can generate a TDS concentration of greater than 100 mg/L, in the absence of further contributions from dissolution of soil and aquifer-matrix material.

A better illustration of this concept is to evaluate ground-water chemistry from the shallow-most portion of the alluvial aquifer as related to concentrated rainwater based on a concentration factor derived from site-specific chloride concentrations. As part of a pesticide contamination investigation in Augusta, Arkansas, four monitoring wells were advanced and screened in the upper 10 feet of the saturated zone (Kresse et al., 1996). Mean concentrations for the major ions in ground-water samples from these wells are provided in Table 6. Comparing the mean concentration for Cl (3.1 mg/L) to the mean Cl concentration in rainwater data from the Warren site, yields an approximate concentration factor of 12 (3.1 mg/L/0.25 mg/L), which results in a reasonable recharge rate of approximately four inches per year (50 inches per year/12).

Table 4. Comparison of rainwater composition from Warren, AR (NADP, 2001) to diluted seawater composition (based on relative Cl concentration).

Parameter	Rainwater [(1)] Warren, AR (mg/L)	Seawater Contribution (mg/L)	Other Sources	Other Sources (%)
Calcium	0.11	0.005	0.11	100
Magnesium	0.027	0.024	0.003	11
Potassium	0.061	0.005	0.06	100
Sodium	0.15	0.21	0	0
Chloride	0.25	0.25	0	0
Sulfate	1.1	0.013	1.1	100
Ammonia	0.23	0	0.23	100
Nitrate	0.78	0	0.78	100

(1) Average of annual means from 1982-1999.

Table 5. Theoretical composition of recharge water by evaporative processes based on values for recharge in Mahon and Ludwig (1990)

Parameter	Rainwater Warren, AR (mg/L)	Concentration Factor (1)	
		5X	50X
Calcium	0.11	0.57	5.7
Magnesium	0.027	0.14	1.4
Potassium	0.061	0.31	3.1
Sodium	0.15	0.75	7.5
Chloride	0.25	1.25	12.5
Sulfate	1.1	5.5	55.0
NH_4-N + NO_3-N	0.37	1.9	19.0
Total Dissolved Solids	2.1	10.4	104.2

(1) Concentration factors based on range of recharge rates of 1-10 inches/year divided by annual mean rainfall of 50 inches/year cited in Freiwald (1984)

Table 6. Net gain and/or loss of ions to ground water from dissolution/precipitation and ion-exchange processes in the unsaturated zone.

Parameter	Shallow Well Mean Conc. mg/L	Rainwater Concentration Factor (12X)	Net Ground Water Gain		
			mg/L	% gain	meq/L
Calcium	7.6	1.4	6.2	84.2	0.31
Potassium	1.2	0.7	0.5	41.7	0.01
Magnesium	0.3	0.3	0	0	0
Sodium	11.9	1.8	10.1	84.9	0.44
Chloride	3.1	3.1	0	0	0
Sulfate	9.1	13.2	-4.1	0	-0.09
Bicarbonate	40.7	0	40.7	100	0.67
NH_4-N+NO_3-N	4.6	4.4	0.2	4	NA

NA - not applicable

Subtracting the rainwater contribution from the ground-water concentrations provides information on the gain or loss of specific ions as affected by surface and subsurface processes including dissolution, precipitation, and vegetative uptake among other processes. There is basically no net gain for Mg, Cl, and NH_4-N + NO_3-N, which suggests that these constituents are provided wholly by concentrated rainwater. Large increases are noted for Ca, Na and HCO_3, while SO_4 experiences a net loss. Dissolution of calcite is an obvious candidate for the net gain for Ca and HCO_3, and the fact that equivalent concentrations of both Ca and Na are necessary to balance the net gain for HCO_3 strongly indicates that cation exchange is the primary process for the large gain in Na concentrations relative to Cl concentrations.

Nitrogen loading from atmospheric deposition must be acknowledged as being a minor component when compared to other sources of nitrogen on crop-land in eastern Arkansas, and additional studies are necessary to substantiate any relationship implied from the similarity of nitrogen concentrations in concentrated rainwater and shallow ground water in Table 6. The Texas Water Resources Institute (TWRI, 1986) notes that fertilizer input accounts for approximately 50% of the nitrogen applied to cultivated fields in Texas, followed in descending order by root residue, biological nitrogen fixation, rainfall and barnyard manure. Nitrogen deposition from rainfall cited in their study ranged from 1-13 lbs/acre/year. A review of the data collected at the Warren, Arkansas site (NADP, 2001) revealed an average nitrogen loading of approximately 6 lb/acre/year, which is far below that required for most non-leguminous crops. However, similar nitrogen loading over non-crop or leguminous crop areas in unison with evaporative processes may have a more important impact on water resources.

Hatfield (2001), studying the deposition of pesticides and NO_3-N in an Iowa watershed, stated that depositional totals for NO_3-N amounted to 25% of the amount applied from commercial sources, and that rainfall deposition of NO_3-N should be included in the annual nitrogen balance. Ockerman and Petri (2001), who investigated a 40,540 acre watershed in Texas, noted that rainfall deposition of nitrogen exceeded that in the runoff by a factor of 2.5, and accounted for approximately 1/16 of the nitrogen applied as fertilizer. Studies in the United Kingdom on global nitrogen deposition found that the highest rates of rainfall deposition (80 kg/ha) approached those used in many agricultural areas (NERC, 2001), and noted that many of the high nitrogen deposition areas were non-crop land, which were located next to agricultural areas acting as a source of the nitrogen. Although it is recognized that nitrogen cycling is complex and other processes affect the nitrogen flux, including volatilization of NH_4 and vegetative uptake of nitrogen as sinks, and application of fertilizers and nitrogen fixation as additional input sources, the impact of atmospheric deposition cannot be discounted under equilibrium conditions over time, especially in un-managed, non-agricultural areas.

Table 6 also provides evidence for extensive cation exchange within the unsaturated zone as the dominant process responsible for the increased percentage of Na relative to the total ions in the lower TDS water of the first population data points. Figure 32 demonstrates that increases in Na/Cl ratios result in decreasing Ca+Mg/HCO_3 ratios, and strongly suggests that exchange processes affect these ratios. Figure 33 reveals that the lowest TDS waters have the lowest Ca+Mg/HCO_3 ratios, and that the highest ratios correspond to the highest TDS concentrations, which additionally suggest that much of the cation exchange is occurring in the unsaturated zone. This correlates well with the fact that most of the clays, which provide the available sites for cation exchange, are located in the upper section of the aquifer. However, as ground water moves along its flow path within the deeper sections of the aquifer, the availability of carbonate minerals dominates the soluble aquifer matrix material, giving rise to the dominance of Ca and HCO_3 ions in the ground-water solution at the upper range of TDS concentrations in the first population.

Ca(Mg)/HCO_3 ratios greater than one appear to be strongly influenced by the addition of Ca by dissolution of gypsum. Evidence for this theory is provided in Figure 34, which shows that increases in SO_4 occur where the Ca+Mg/HCO_3 ratios are highest. The points appear to have been shifted to the left; theoretically, as a result of the affects of cation exchange processes. In theory, the addition of Ca by dissolution of gypsum should be reflected by the increase in sulfate of greater than 20 mg/L occurring at Ca(Mg)/HCO_3 ratios greater than one. However, inspection of Figure 34 shows that the increase occurs at ratios of approximately 0.8. Figure 35 depicts Ca+Mg concentrations versus HCO_3 concentrations, and reveal that Ca+Mg concentrations of 5 meq/L correlate to a HCO_3 concentration of approximately 6 meq/L. It is apparent from the above discussions that cation exchange has lowered the concentration of Ca relative to HCO_3, and the Ca concentration would have to be increased by approximately 20% to match the one-to-one relationship under simple dissolution of a carbonate in the absence of exchange processes. As such, the graph of Ca+Mg/HCO_3 versus SO_4 concentrations (Figure 34) has effectively shifted approximately 20% to the left as a result of cation exchange (i.e., increases in SO_4 of greater than 20 mg/L occur at Ca+Mg/HCO_3 ratios of approximately 0.8 rather than 1.0).

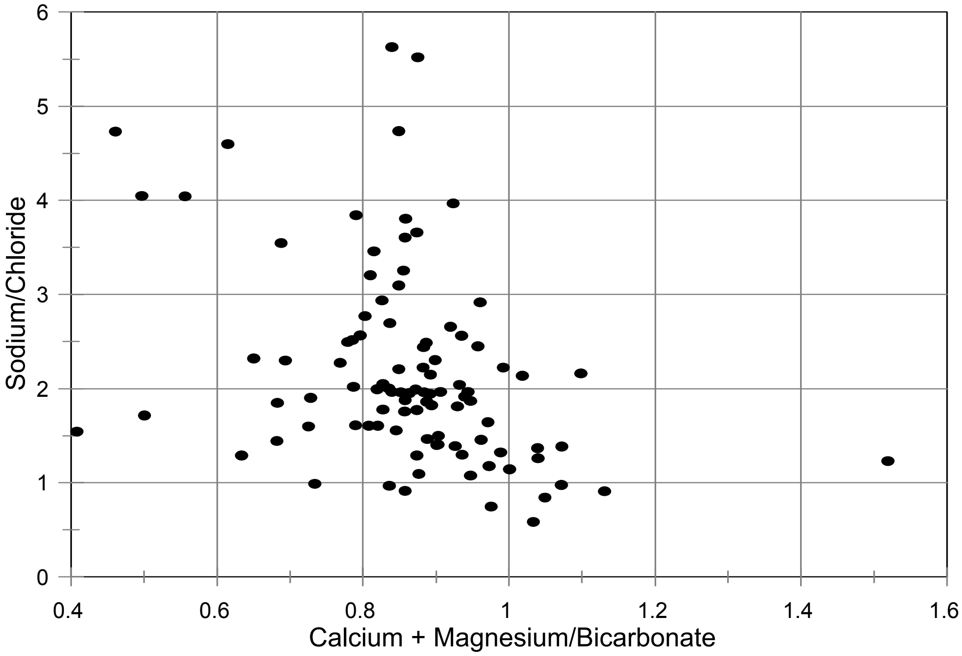

Figure 32. Molar ratio of calcium+magnesium/bicarbonate versus the molar ratio of sodium/chloride. Increases in Na/Cl ratios result in overall decreasing Ca+Mg/HCO_3 ratios.

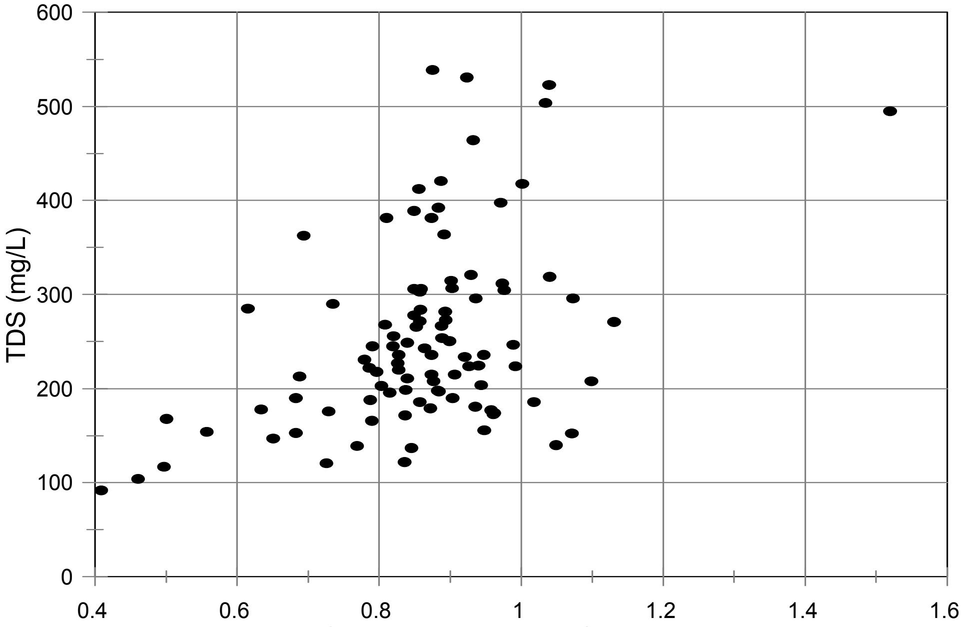

Figure 33. Molar ratio of calcium+magnesium/bicarbonate versus total dissolved solids. Increases in Ca+Mg/HCO_3 ratios generally coincide with increases in TDS.

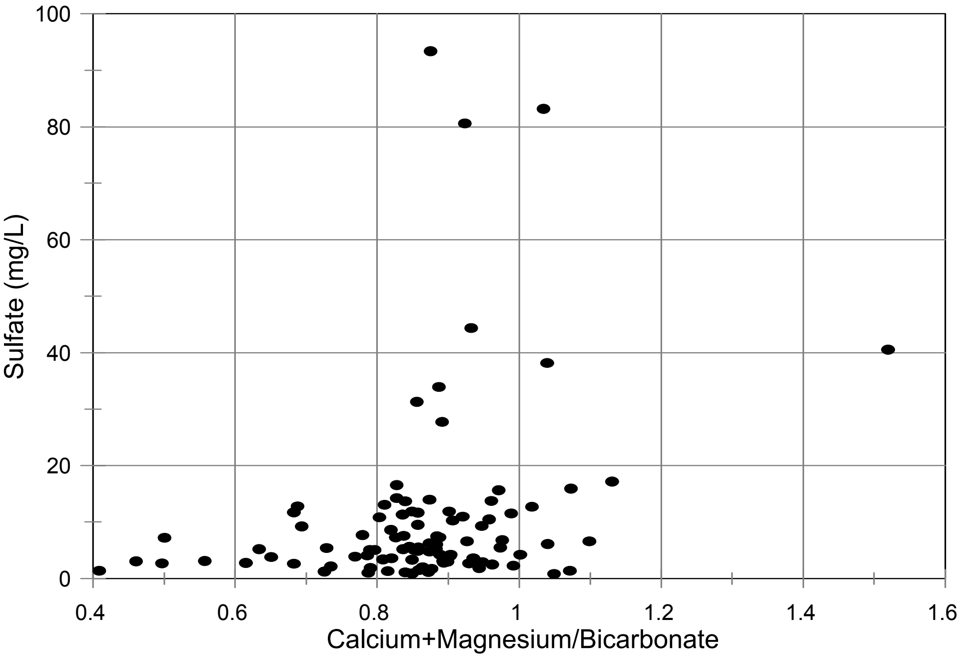

Figure 34. Molar ratio of calcium+magnesium/bicarbonate versus sulfate concentrations. Increases in sulfate generally coincide with increasing Ca+Mg/HCO_3 ratios

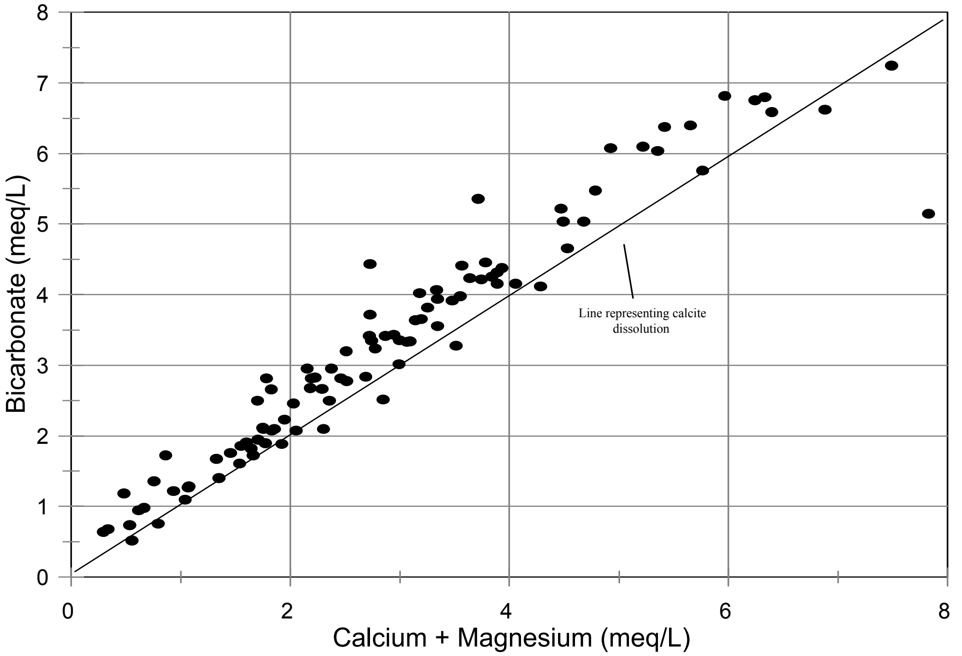

Figure 35. Calcium+magnesium versus bicarbonate concentrations. The points deviate from a line representing carbonate dissolution as a result of loss of calcium to cation exchange processes.

The above scenario describes the evolution of ground-water chemistry within the first-population data points. In summary, the water evolves from a chemistry strongly influenced by Na, Cl and SO_4 at the lower TDS concentrations to a water type dominated by Ca-HCO_3 at TDS concentrations nearing 350 mg/L. The water chemistry is impacted strongly by ion-exchange processes and variation in the chemical composition of the aquifer matrix. The second population of points, described earlier and represented by TDS concentrations exceeding 350 mg/L, deviates significantly from the evolutionary trend revealed within the first population. Determining the cause and/or source for the increased Na, SO_4 and Cl in the higher TDS waters is noteworthy not only from a research perspective, but also has direct implications to water users as documented under the section titled "Water Quality."

As discussed earlier, samples exceeding approximately 350 mg/L appear to represent a separate population of data points based on trends in chemical composition including field pH values. A decreasing trend in pH values was noted along with increased concentrations for Na, Cl and SO_4. Mixing of poorer quality water from another source provides one explanation for the reversal of the trend noted for the first population dat points. Sources of poor quality water would include ancestral water trapped in fine matrix material (interbedded, overlying or underlying clays), transport from which may be controlled by chemical diffusion, periodic and limited flushing, and/or draining associated with lowering of the water table; leakage from underlying Tertiary aquifers which may be of a poorer quality; irrigation return flows coupled with high evapotranspiration and ion-exchange processes in the soil zone; and recharge of saline water from the Arkansas River. Past and current research by the authors, coupled with research by R. K. Davis (U of A at Fayetteville, personal communication, 2002), tend to discount migration of poor quality water from lower Tertiary aquifers. Most of the data from lower Tertiary aquifers suggest a better quality water than the alluvial aquifer in the same area of study, and consistently reveal elevated pH values relative to the alluvial aquifer. Recharge from the Arkansas River (in its modern-day position) also does not appear to be a good candidate based on the fact that wells closer to the river than those wells in the high Cl areas often contain water lower in Cl.

If mixing of poor quality water is responsible for the increases in TDS concentrations beyond approximately 350 mg/L, then a question arises as to the total TDS concentrations attainable by alluvial aquifer ground water along a given flow path in the absence of mixing. Ground water within the first population evolves toward a strongly Ca-HCO_3 water type, with percentages of HCO_3 upwards to 95% of the total anions and percentages of Ca exceeding 65% of the cations. As such, one possible solution is to calculate the equilibrium of calcite dissolution at the upper end of the first population, in addition to those points representing the break beyond 350 mg/L, in order to ascertain if the ground water is supersaturated or under-saturated with respect to calcite.

Table 7 lists selected chemical analyses, pH, ionic strength, equilibrium pH and resulting saturation indices for eight samples at the upper TDS range for the first population, and seven samples from the second population of data points. Equilibrium pH values for first-population data points ranged from 7.45 to 7.7, and demonstrate that many of the samples at the upper range of pH and TDS values were approaching equilibrium pH. All samples within the first population for Table 7 are undersaturated with respect to calcite, whereas all points in the second population are supersaturated with respect to calcite. Figure 36 highlights the wells with corresponding values for their respective saturation indicies from Table 7.

Table 7. Saturation Indices (S.I.) and criteria for calculation of ionic strength and S.I.

Site - (Population)*	Ca	HCO_3	pH	Temp. deg. C	TDS	Ionic Strength	Equilibrium pH	S.I.
Ash20 (1)	51	222	7.21	19.0	243	.006	7.5	-0.29
Drew34 (1)	58	272	7.38	18.5	306	.007	7.6	-0.22
Drew36 (1)	56	243	7.34	18.9	243	.0063	7.45	-0.11
Drew37 (1)	62	260	7.43	18.5	260	.007	7.6	-0.17
Drew38 (1)	62	254	7.29	18.0	254	.0068	7.4	-0.11
Ash19 (1)	75	307	7.14	19.7	321	.0078	7.7	-0.56
Desha01 (1)	69	284	6.72	17.9	312	.0084	7.7	-0.98
Drew25 (1)	66	251	6.78	17.7	319	.0078	7.7	-0.92
Ash02 (1)	64	318	6.95	18.5	303	.0079	7.7	-0.75
Ash15 (2)	53	327	7.42	18.8	363	.0084	7.4	+0.02
Ash22 (2)	84	416	7.38	19.5	539	.0133	7.2	+0.18
Ash23 (2)	71	334	7.42	19.7	382	.0094	7.2	+0.24
Ash24 (2)	80	368	7.23	19.6	421	.0105	7.2	+0.01
Ash25 (2)	90	412	7.18	19.7	531	.0132	7.15	+0.03
Ash29 (2)	72	371	7.35	19.6	382	.0095	7.2	+0.15
Ash30 (2)	79	389	7.22	19.6	389	.0101	7.15	+0.07

*Based on geochemical trends in the data set, the data are divided into two populations; the first represented by TDS concentrations < 350 mg/L, and the second by concentrations > 350 mg/L.

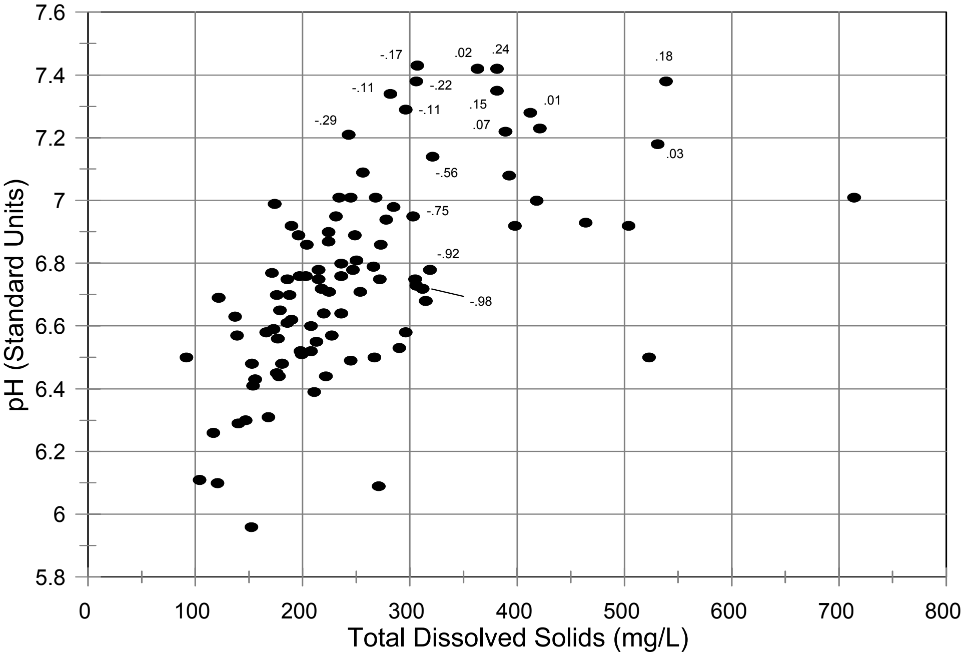

Figure 36. Total dissolved solids versus pH with calcite saturation indices superimposed on those wells for which determinations of calcite solubility were calculated.

The evidence for supersaturation of calcite within the second population of data points provides another explanation for the two geochemically different populations; a natural evolution of chemistry based on calcite precipitation and increased dissolution of halite, gypsum and other minerals at TDS concentrations exceeding 350 mg/L. The establishment of calcite saturation does not negate the additional input of Ca and HCO_3 to the total dissolved content of the alluvial aquifer ground water, as evidenced in Figures 20 and 25. Effects of chemical processes including increased ionic strength and ion-pairing, among others, allow some additional carbonate dissolution within the system, but the rate of dissolution is severely depressed by supersaturation of calcite at TDS concentrations exceeding 350 mg/L. This process accounts for both the slower rate of increase for both Ca and HCO_3 concentrations within the second population, and the overall decrease in the percentage of these ions relative to the total ion concentration. The precipitation of calcite additionally produces H^+ ions, which accounts for the decreasing trend in pH values within the second population of data points, as noted in Figure 17. Future efforts to test this theory should include both quantitative geochemical modeling and site-specific field investigations for evaluation of calcite precipitation along the flow path, including coring and analyses of the aquifer matrix, among other activities.

In summary of the geochemistry, graphical and computational analysis of the alluvial aquifer water-quality data reveal two separate populations based on geochemical trends in the data. The chemistry of the water trends rapidly toward a water type dominated by Ca-HCO_3 up to a TDS concentration nearing 350 mg/L. Thereafter, the rate of increase for both Ca and HCO_3 is greatly diminished, and their percentages of the total cations and anions, respectively, fall from over 65% to less than 45% for Ca, and from over 95% to less than 70% for HCO_3 at TDS concentrations greater than 500 mg/L. Although mixing of poor quality water enriched in Na, Cl and SO_4 can account for the differing geochemical makeup in the second population of points, the authors additionally propose a model based on calcite precipitation followed by the generation of H+ ions to account for much of the variation between the two populations. The model was tested in a cursory manner by calculation of calcite-saturation indices for data points immediately above and below the break which denotes the change in chemistry for the two populations. First-population data points were revealed to be undersaturated with respect to calcite; whereas, those points in the second population were supersaturated with respect to calcite. Additional studies have been proposed under the joint efforts of both the University of Arkansas at Fayetteville and the ADEQ for (1) geochemical modeling of existing data, and (2) collecting additional site-specific data from areas of elevated chloride concentrations, including coring and analysis of the unsaturated and saturated zone, sampling of existing wells over a growing season for observation of trends in salt concentrations, examination of local and regional soil types, and monitoring of water levels over time.

Summary and Conclusions

Ground-water quality was assessed in the Bayou Bartholomew watershed through the analysis of 119 wells and one spring sample. All the wells were completed in Quaternary deposits; 25 in the upland terrace and 93 in the delta portion of the watershed, with the exception of one well completed in the Jackson Formation. Concentrations for all parameters in samples from the alluvial aquifer are below the primary drinking water standards, with the exception of one well, which exceeded the maximum contaminant level for As. Violations for secondary maximum contaminant levels, which are instituted for aesthetic reasons as opposed to health concerns, were noted for Fe, Mn and Al.

A proposed revision in the MCL for As was published in the Federal Register (66 FR 6976) on January 22, 2001, which effectively lowered the drinking water standard for As from 50 µg/L to 10 µg/L. Only one well exceeded the 50 µg/L level for the present study; however, 21 wells in the delta region exceeded the 10 µg/L level, which suggests a potential health threat where the water is used for drinking-water purposes. The absence of elevated levels (> 10 µg/L) in the terrace deposits, together with other ancillary evidence, suggests the source of As may be inorganic and related to the mineralogy of the delta alluvial deposits.

The samples were analyzed for 61 pesticides and pesticide byproducts. Pesticides were detected in 28 of the 119 wells. Bentazon was the most frequently detected pesticide, accounting for 56% of the detections. Pesticide concentrations were low, ranging from 0.002 µg/L to 0.519 µg/L, which are approximately 3-5 orders of magnitude below listed MCLs and/or health advisory limits. The low pesticide and nitrate concentrations indicate minimal agricultural impacts to ground water. The frequent occurrence of bentazon indicates that it has a strong leaching potential, and suggests the need for further monitoring to evaluate its extent and magnitude within the watershed. There has been very little research into the sources for ground-water contamination by pesticides in Arkansas, and statements and references to potential sources have been based largely on indirect evidence. Although the bulk of the references within Arkansas literature have suggested point sources as the leading cause of the contamination, there is little data to support this theory. In light of the number of detections and the hydrophilic nature of the pesticides in the current ground-water data base, ground-water contamination by application and leaching of pesticides through normal agricultural practices cannot be discounted as a major potential source.

The one sample taken from a well completed in the Jackson Formation revealed elevated concentrations of Na, SO_4, B and Zn. The poor quality and low yield of water from the Jackson Formation has been documented in several older USGS reports. The Jackson Formation was extensively used in the past for domestic supply, but the growth of community water systems has negated the present use as a drinking-water supply. As such, little emphasis was placed on documenting water quality in this aquifer system for the present report.

One spring sample from the Pliocene(?) deposits, which overlie the Jackson Formation, revealed an elevated NO_3-N concentration of 6.5 mg/L. The source of NO_3-N appears to be the result of an upgradient poultry house. Overall, there are few poultry operations in the watershed, and these were not viewed as major nonpoint-source inputs within the watershed. The low pH (4.9) and TDS concentration (76 mg/L) suggest that the spring water had a short residence time in the system and is from a near source input with little buffering. Ground water from the Pliocene deposits, similar to that from the Jackson Formation, was previously used for small domestic supply purposes; however, community systems have also precluded use of these waters as current drinking-water sources.

A detailed review of the water-quality data, including geochemical trends for individual parameters versus TDS, revealed two populations with different geochemical signatures. The first population of points, ranging from TDS concentrations of <100 mg/L to approximately 350 mg/L, evolves toward a strongly Ca-HCO_3 water type with Ca and HCO_3 ions composing over 65% and 95% of the total cations and total anions, respectively. Values for pH rise within the first population to approximately 7.4, reflecting the consumption of H^+ ions with the dissolution of carbonate material. However, Ca and HCO_3 percentages decrease with increasing TDS in the second population of data points, which are characterized by increasing concentrations of Na, Cl and SO_4 and decreasing pH values at TDS concentrations >350 mg/L. Mixing of poorer quality water has previously been proposed as a mechanism for producing these areas of higher TDS waters enriched in Na, Cl and SO_4. However, calculation of saturation indices demonstrate that first population points are undersaturated with respect to calcite, whereas second population points are supersaturated with calcite. A geochemical evolution of alluvial ground water along its flow path involving calcite precipitation and the generation of H^+ ions, is proposed as an additional mechanism to account for much of the chemical differences noted in these areas of poor-quality, high Cl concentration water types.

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Appendix I

Well Location Data

Appendix I - Well Location Data

WELL NAME	Collection Date	County	Latitude	Longitude
	Location			(Sec. Twnshp. Rng.)
ASH01	08/23/1999	Ashley	33 20 00.40	91 30 44.89
	1.5 mi. west of Boydell			(Sec. 28, T15S,R4W)
ASH02	08/23/1999	Ashley	33 21 14.12	91 31 18.75
	1.5 mi. west of US165, southwest of Boydell			(Sec. 33, T15S, R4W)
ASH03	08/23/1999	Ashley	33 20 00.98	91 28 30.63
	1.25 mi. east of US 165, southeast of Boydell			(Sec. 1, T16S, R4W)
ASH04	08/23/1999	Ashley	33 22 46.17	91 29 45.55
	1.o mi west of US 165, northwest of Boydell			(Sec. 22, T15S, R4W)
ASH05	09/07/1999	Ashley	33 00 33.51	91 39 01.57
	1.75 mi. west of US 165 southwest of Wilmot			(Sec 31, T19S, R5W)
ASH06	09/07/1999	Ashley	33 00 40.64	91 37 58.62
	0.75 mi. west of US 165 southwest of Wilmot			(Sec. 32, T19S, R5W)
ASH07	09/07/1999	Ashley	33 03 27.13	91 36 15.46
	2.0 mi. west of US165, west of Wilmot			(Sec. 10, T19S, R5W)
ASH08	09/07/1999	Ashley	33 03 47.86	91 35 14.61
	1.25 mi. west of US 165 west of Wilmot			(Sec. 11, T19S, R5W)
ASH09	09/07/1999	Ashley	33 04 06.65	91 38 14.93
	4.o mi. west of US 165, 0.5 mi. north of Hwy. 52, west of Wilmot			(Sec. 8, T19S, R5W)
ASH10	09/07/1999	Ashley	33 04 19.82	91 37 03.50
	3.0 mi. west of US 165 just off Hwy 52 west of Wilmot			(Sec. 4, T19S, R5W)
ASH11	09/07/1999	Ashley	33 05 35.04	91 34 37.03
	1.5 mi. west of US 165 north of Wilmot, northern well in Section 35			(Sec. 35, T18S, R5W)
ASH12	09/07/1999	Ashley	33 05 17.24	91 34 57.19
	1.5 mi. west of US 165 north of Wilmot, southern well in Section 35			(Sec. 35, T18S, R5W)
ASH13	09/20/1999	Ashley	33 10 50.61	91 33 12.97
	1.5 mi. east of US 165 west of Sunshine			(Sec. 31, T17S, R4W)
ASH15	09/20/1999	Ashley	33 11 14.20	91 35 52.78
	4.0 mi. west of US 165 west of Sunshine			(Sec. 27, T17S, R5W)
ASH17	09/20/1999	Ashley	33 15 19.54	91 35 02.84
	4.0 mi. west of US 165, 2.5 mi. south of US 82, northwest of Portland			(Sec. 2, T17S, R5W)
ASH18	9/20/1999	Ashley	33 14 37.36	91 35 39.37
	5.0 mi. west of US 165, 3 mi. south of US 82, west of Portland			(Sec. 11, T17S, R5W)
ASH19	09/20/1999	Ashley	33 14 51.80	91 39 56.33
	2.0 mi. south of US 82 east of Hamburg			(Sec. 12, T17S, R6W)

WELL NAME	Collection Date	County	Latitude	Longitude
	Location			(Sec. Twnshp. Rng.)
ASH20	09/20/1999	Ashley	33 16 53.58	91 40 26.47
	0.25 mi. north of US 82, 11 mi. west of US 165, west of Montrose			(Sec. 25, T16S, R6W)
ASH21	09/05/2000	Ashley	33 15 22.70	91 48 32.28
	0.2 mi west of US 425 1.5 mi. north of US 82 north of Hamburg			(Sec. 3, T17S, R7W)
ASH22	09/05/2000	Ashley	33 15 01.62	91 50 49.62
	0.1 west of Hwy. 189, 3.0 mi. northwest of Hamburg			(Sec. 5, T17S, R7W)
ASH23	09/05/2000	Ashley	33 14 07.02	91 48 46.32
	0.1 mi. west of Hwy. 189, 0.75 mi. northwest of Hamburg			(Sec. 15, T17S, R7W)
ASH24	09/05/2000	Ashley	33 10 14.99	91 52 25.26
	south of Hwy. 52, 3.25 mi. west of US 425 southwest of Hamburg			(Sec. 1, T18S, R8W)
ASH25	09/05/2000	Ashley	33 08 11.11	91 54 29.30
	north of US 82, 5.5 mi. west of US 425 east of Crossett			(Sec. 15, T18S, R8W)
ASH26	09/05/2000	Ashley	33 04 41.83	91 45 51.28
	4.75 mi. east of US 425, near Berlin, south of Hamburg			(Sec. 6, T19S, R6W)
ASH27	09/05/2000	Ashley	33 01 53.83	91 46 08.43
	4.75 mi. east of US 425, near Extra Church, Berlin, south of Hamburg			(Sec. 24, T19S, R7W)
ASH28	09/05/2000	Ashley	33 16 44.17	91 42 40.48
	0.75 mi. north of US 82, 5.5 mi. east of Hamburg near Mist			(Sec. 27, T16S, R6W)
ASH29	09/05/2000	Ashley	33 17 45.09	91 43 32.50
	2.5 mi. north of US 82, northwest of Mist			(Sec. 20, T16S, R6W)
ASH30	09/05/2000	Ashley	33 17 21.86	91 44 10.65
	0.75 mi. north of US 82, 4.0 mi. east of Hamburg near Mist			(Sec. 29, T16S, R6W)
CHI01	08/23/1999	Chicot	33 25 35.09	91 27 11.92
	0.5 mi. east of US 165, 2.5 mi. north of Hwy 144 northeast of Boydell			(Sec. 6, T15S, R3W)
CHI02	08/29/2000	Chicot	33 33 14.54	91 27 13.33
	4.0 mi. west of US 65, 2.0 mi. north of Hwy. 35 north of Dermott			(Sec. 19, T13S, R3W)
CHI03	08/23/1999	Chicot	33 26 44.58	91 27 03.64
	o.1 mi. west of US 165, 1.0 mi. north of Hwy 922 south of Dermott			(Sec. 03, T14S, R3W)
CHI04	08/23/1999	Chicot	33 25 07.61	91 27 03.64
	1.5 mi. east of US 165, 1.5 mi. north of Hwy 144 northeast of Boydell			(Sec. 8, T15S, R3W)
DES01	08/09/1999	Desha	33 47 31.82	91 29 44.77
	2.0 mi. west of US 65, 7.0 miles south of Dumas			(Sec. 34, T10S, R4W)
DES02	08/09/1999	Desha	33 49 43.47	91 31 21.90
	2.75 mi. west of US 65, 4 mi. south of Dumas			(Sec. 17, T10S, R4W)

WELL NAME	Collection Date	County	Latitude	Longitude
	Location			(Sec. Twnshp. Rng.)
DES03	07/11/2000	Desha	33 37 31.77	91 25 53.77
	0.5 mi. south of Hwy 4, 3.0 mi. west of US 65, west of McGehee			(Sec. 29, T12S, R3W)
DRE01	08/09/1999	Drew	33 40 15.45	91 29 32.32
	2.0 mi. south of Hwy 277, 3.0 mi. east of Hwy 4 southwest of Tillar			(Sec. 10, T12S, R4W)
DRE02	08/09/1999	Drew	33 35 57.92	91 31 05.35
	0.2 mi north of Hwy 4, 3 mi south of Hwy 277 southwest of Tillar			(Sec. 28, T12S, R4W)
DRE03	08/09/1999	Drew	33 40 08.01	91 27 51.40
	2.0 mi. west of US 65, 2.5 mi. south of Tillar			(Sec. 12, T12S, R4W)
DRE04	08/09/1999	Drew	33 44 20.03	91 28 49.04
	1.25 mi west of US 65, 2.0 mi. south of Winchester			(Sec. 14, T11S, R4W)
DRE05	08/23/1999	Drew	33 25 10.73	91 29 38.10
	2.0 mi. west of US 165, 1.5 mi. south of Hwy. 922 west of Jerome			(Sec. 3, T15S, R4W)
DRE06	08/29/2000	Drew	33 26 35.48	91 28 34.59
	1.75 mi. west of US 165, adjacent to Hwy. 922 north of Jerome			(Sec. 35, T14S, R3W)
DRE07	07/11/2000	Drew	33 35 48.25	91 28 40.89
	5.5 mi. west of US 165, 2.0 mi. south of Hwy. 4, northwest of Dermott			(Sec. 2, T13S, R4W)
DRE08	07/11/2000	Drew	33 34 14.92	91 30 21.20
	7.5 mi. west of US 165, 3 mi. north of Hwy. 35 northwest of Dermott			(Sec. 16, T13S, R4W)
DRE09	07/11/2000	Drew	33 34 00.54	91 29 50.63
	6.5 mi. west of US 165, 2.5 mi. north of Hwy. 4 northwest of Dermott			(Sec. 15, T13S, R4W)
DRE10	07/11/2000	Drew	33 32 16.82	91 29 22.64
	4.5 mi. west of US 65, 1.0 mi. north of Hwy. 35, west of Dermott			(Sec. 26, T13S, R4W)
DRE11	07/11/2000	Drew	33 32 05.60	91 29 36.40
	4.75 mi. west of US 65, 0.5 mi. north of Hwy. 35, west of Dermott			(Sec. 34, T13S, R4W)
DRE12	07/11/2000	Drew	33 31 58.52	91 30 46.95
	5.75 mi. west of US 65, 0.5 mi. north of Hwy. 35, west of Dermott			(Sec. 33, T13S, R4W)
DRE13	07/11/2000	Drew	33 30 44.59	91 29 22.76
	4.5 mi. west of US 65, 1.25 mi. south of Hwy 35, west of Dermott			(Sec. 2, T14S, R4W)
DRE14	07/11/2000	Drew	33 29 54.17	91 30 20.60
	4.0 mi. west of US 65, 2.25 mi. south of Hwy. 35, west of Dermott			(Sec. 9, T14S, R4W)
DRE15	07/11/2000	Drew	33 28 21.12	91 29 54.70
	3.25 mi. west of Us 65, 3.75 mi. south of Hwy 35, south of Dermott			(Sec. 22, T14S, R4W)
DRE16	08/29/2000	Drew	33 42 00.42	91 27 59.59
	1.5 mi. west of US 165, adjacent to Hwy. 277, southwest of Tillar			(Sec. 35, T11S, R4W)

WELL NAME	Collection Date	County	Latitude	Longitude
	Location			(Sec. Twnshp. Rng.)
DRE17	08/01/2000	Drew	33 41 50.06	91 29 48.75
	3.25 mi. west of US 165, 0.5 mi. north of Hwy. 277, west of Tillar			(Sec. 34, T11S, R4W)
DRE18	08/01/2000	Drew	33 40 37.68	91 31 04.70
	5.0 mi. west of US 165, adjacent to Hwy. 277, southwest of Tillar			(Sec. 9, T12S, R4W)
DRE19	08/01/2000	Drew	33 45 43.02	91 33 04.97
	5.0 mi. west of US 65, adjacent to Hwy. 138, west of Winchester			(Sec. 7, T11S, R4W)
DRE20	08/01/2000	Drew	33 45 31.97	91 31 36.93
	4.0 mi. west of US 65, just south of Hwy. 138, west of Winchester			(Sec. 8, T11S, R4W)
DRE21	08/01/2000	Drew	33 44 18.11	91 33 10.24
	5.5 mi. west of US 65, just east of Hwy. 138, southwest of Winchester			(Sec. 19, T11S, R4W)
DRE22	08/29/2000	Drew	33 45 13.78	91 36 02.37
	2.0 mi. east of Hwy. 293, 1.75 mi. north of Hwy. 238, north of Selma			(Sec. 15, T11S, R5W)
DRE23	08/01/2000	Drew	33 45 10.36	91 35 21.91
	2.5 mi. east of Hwy. 293, 1.5 mi. north of Hwy. 238, north of Selma			(Sec. 14, T11S, R5W)
DRE24	08/01/2000	Drew	33 45 12.47	91 30 30.37
	2.5 mi. west of US 65, 1.5 mi. south of Hwy. 138, southwest of Winchester			(Sec. 16, T11S, R4W)
DRE25	08/01/2000	Drew	33 45 30.75	91 28 36.56
	1.2 mi. west of US 65, 1.2 mi. south of Hwy 138, south of Winchester			(Sec. 11, T11S, R4W)
DRE26	08/15/2000	Drew	33 43 32.56	91 42 04.02
	4.0 mi. east of Hwy. 83, 3.0 mi. north of Hwy. 138 northeast of Monticello			(Sec. 4, T11S, R6W)
DRE27	08/15/2000	Drew	33 42 04.53	91 42 27.97
	3.5 mi. east of Hwy. 83, 2.5 mi. north of Hwy. 138 northeast of Monticello			(Sec. 3, T12S, R6W)
DRE28	08/15/2000	Drew	33 44 02.77	91 40 29.85
	4.0 mi. east of Hwy. 83, 3.5 mi. north of Hwy. 138 northeast of Monticello			(Sec. 24, T11S, R6W)
DRE29	08/15/2000	Drew	33 40 02.53	91 40 03.36
	0.75 mi. south of Hwy. 138, 7.0 mi. northeast of Monticello			(Sec. 12, T12S, R6W)
DRE30	08/15/2000	Drew	33 39 36.57	91 42 39.97
	0.25 mi. south of Hwy. 138, 5.0 mi. northeast of Monticello			(Sec. 15, T12S, R6W)
DRE31	08/15/2000	Drew	33 38 12.30	91 41 05.18
	adjacent to Hwy 4, 6.0 mi. east of Monticello			(Sec. 26, T12S, R6W)
DRE32	08/22/2000	Drew	33 35 56.69	91 42 11.66
	adjacent to Hwy 35, 5.0 mi. southeast of Monticello			(Sec. 3, T13S, R6W)
DRE33	08/22/2000	Drew	33 33 44.19	91 40 05.08
	1.0 mi. south of Hwy. 35, 6.0 mi. east of Hwy 83, southeast of Monticello			(Sec. 13, T13S, R6W)

WELL NAME	**Collection Date**	**County**	**Latitude**	**Longitude**
	Location			**(Sec. Twnshp. Rng.)**
DRE34	08/22/2000	Drew	33 32 40.53	91 42 54.13
	3.75 mi. south of Hwy. 35, 3.0 mi. east of Hwy 83, southeast of Monticello			(Sec. 27, T13S, R6W)
DRE35	08/22/2000	Drew	33 33 20.85	91 43 53.51
	3.2 mi. south of Hwy. 35, 2.25 mi. east of Hwy 83, southeast of Monticello			(Sec. 21, T13S, R6W)
DRE36	08/22/2000	Drew	33 33 26.61	91 43 25.13
	3.25 mi. south of Hwy. 35, 2.5 mi. east of Hwy 83, southeast of Monticello			(Sec. 21, T13S, R6W)
DRE37	08/22/2000	Drew	33 33 58.54	91 42 53.70
	2.25 mi. south of Hwy. 35, 3.5 mi. east of Hwy 83, southeast of Monticello			(Sec. 16, T13S, R6W)
DRE38	08/22/2000	Drew	33 28 59.02	91 40 08.46
	6.75 mi. south of Hwy. 35, 4.5 mi. east of Hwy 83, southeast of Monticello			(Sec. 13, T14S, R6W)
JEF01	05/09/2000	Jefferson	34 06 58.27	91 48.56.30
	0.5 mi. east of Hwy 199, 3.0 mi. south of US 65, south of Moscow			(Sec. 17, T7S, R7W)
JEF02	05/09/2000	Jefferson	34 06 49.79	91 48 35.09
	adjacent to Hwy 199, 3.0 mi. south of US 65, south of Moscow			(Sec. 16, T7S, R7W)
JEF03	05/09/2000	Jefferson	34 06 45.34	91 45 51.75
	0.5 mi. west of US 65 west of Tamo			(Sec. 14, T7S, R7W)
JEF04	07/18/2000	Jefferson	34 09 56.59	91 54 28.74
	0.5 mi. east of US425, 1.5 mi. south of US 65, north of Ladd			(Sec. 28, T6S, R8W)
JEF05	07/18/2000	Jefferson	34 09 50.69	91 54 59.55
	adjacent to US425, 1.75 mi. south of US 65, north of Ladd			(Sec. 28, T6S, R8W)
JEF06	07/18/2000	Jefferson	34 07 44.09	91 52 49.81
	0.5 mi. east of US 425, 3.5 mi. south of US 65, southeast of Ladd			(Sec. 11, T7S, R8W)
JEF07	07/18/2000	Jefferson	34 07 12.77	91 52 25.84
	0.5 mi. east of US 425, 4.0 mi. south of US 65, southeast of Ladd			(Sec. 14 T7S, R8W)
JEF08	07/18/2000	Jefferson	34 06 09.07	91 51 13.45
	1.0 mi. east of US 425, 4.5 mi. south of US 65, southeast of Ladd			(Sec. 24, T7S, R8W)
JEF09	07/18/2000	Jefferson	34 07 22.43	91 49 56.42
	1.5 mi. west of Hwy. 199, 3.0 mi. south of US 65, southwest of Moscow			(Sec. 17, T7S, R7W)
JEF10	07/18/2000	Jefferson	34 05 58.61	91 50 09.32
	2.25 mi. east of US 425, 4.0 mi. south of US 65, southeast of Ladd			(Sec. 19, T7S, R7W)
JEF11	07/18/2000	Jefferson	34 08 42.56	91 49 56.46
	1.5 mi. west of Hwy. 199, 1.0 mi. south of US 65, west of Moscow			(Sec. 5, T7S, R7W)
JEF12	07/18/2000	Jefferson	34 09 42.81	91 50 15.46
	adjacent to US 65, 2.25 mi. west of Hwy 199, west of Moscow			(Sec. 31, T6S, R7W)

WELL NAME	Collection Date	County	Latitude	Longitude
	Location			**(Sec. Twnshp. Rng.)**
JEF13	07/18/2000	Jefferson	34 11 17.21	91 53 03.39
	adjacent to US 65, 1.0 mi. west of Hwy 199, west of Moscow			(Sec. 33, T6S, R7W)
JEF14	08/08/2000	Jefferson	34 05 37.14	91 52 28.14
	adjacent to Jefferson County Line Road, 0.25 mi. west of US 425			(Sec. 23, T7S, R8W)
JEF15	08/08/2000	Jefferson	34 05 36.69	91 52 56.00
	adjacent to Jefferson County Line Road, 1.0 mi. west of US 425			(Sec. 22, T7S, R8W)
JEF16	08/08/2000	Jefferson	34 06 24.14	91 54 23.44
	1.0 mi. north of Jefferson County Line Road, 2.0 mi. west of US 425			(Sec. 21, T7S, R8W)
JEF17	08/08/2000	Jefferson	34 05 40.37	91 56 08.92
	adjacent to Jefferson County Line Road, 4.0 mi. west of US 425			(Sec. 19, T7S, R8W)
JEF18	08/08/2000	Jefferson	34 05 47.05	91 56 54.37
	2.5 mi. east of Hwy 15, 5.0 mi. west of US 425, east of Pinebergen			(Sec. 19, T7S, R8W)
JEF19	08/08/2000	Jefferson	34 06 09.43	91 57 35.15
	2.0 mi. east of Hwy 15, 5.5 mi. west of US 425, east of Pinebergen			(Sec. 24, T7S, R9W)
JEF20	08/08/2000	Jefferson	34 06 52.43	91 57 35.52
	2.0 mi. east of Hwy 15, 5.0 mi. west of US 425, northeast of Pinebergen			(Sec. 23, T7S, R9W)
JEF21	08/08/2000	Jefferson	34 07 57.43	91 57 26.93
	2.0 mi. west of Hwy 15, 4.5 mi. south of US 65, west of Ladd			(Sec. 12, T7S, R9W)
JEF22	08/08/2000	Jefferson	34 38 58.69	91 56 47.78
	2.0 mi. west of US 425, 3.25 mi. south of US 65, west of Ladd			(Sec. 6, T7S, R8W)
JEF23	08/08/2000	Jefferson	34 10 06.44	91 56 50.23
	2.0 mi. west of US 425, 1.5 mi. south of US 65, northwest of Ladd			(Sec. 30, T6S, R8W)
LIN01	08/09/1999	Lincoln	33 49 19.38	91 34 43.32
	2.0 mi. east of Hwy. 293, 5.5 mi. south of Hwy 54, west of Pickens			(Sec. 23, T10S, R5W)
LIN02	08/09/1999	Lincoln	33 50 40.83	91 36 45.50
	0.5 mi. west of Hwy 293, 2.25 mi. south of Hwy 54, west of Pickens			(Sec. 16, T10S, R5W)
LIN03	08/09/1999	Lincoln	33 52 02.14	91 39 51.45
	adjacent to Hwy 54, 3.o mi. west of Hwy 293, west of Garrett Bridge			(Sec. 6, T10S, R5W)
LIN04	08/16/2000	Lincoln	33 52 47.10	91 40 24.62
	1.5 mi. north of Hwy 54, northwest of Garrett Bridge			(Sec. 36, T9S, R6W)
LIN05	08/16/2000	Lincoln	33 51 27.39	91 39 31.59
	1.0 mi. south of Garrett Bridge, southwest of Garrett Bridge			(Sec. 7, T10S, R5W)
LIN06	08/16/2000	Lincoln	33 51 10.41	91 41 24.64
	1.0 mi. north of Hwy 54, 1.75 mi. west of Garrett Bridge			(Sec. 11, T10S, R6W)

WELL NAME	Collection Date	County	Latitude	Longitude
	Location			**(Sec. Twnshp. Rng.)**
LIN07	05/09/2000	Lincoln	34 05 20.15	91 49 08.20
	1.0 mi. west of Hwy 199, 1.75 mi. north of US 425, northeast of Tarry			(Sec. 29, T7S, R7W)
LIN08	07/25/2000	Lincoln	34 05 40.03	91 46 28.29
	2.0 mi. east of Hwy 199, 2.0 mi. south of US 65, south of Tamo			(Sec. 26, T7S, R7W)
LIN09	07/25/2000	Lincoln	34 05 25.63	91 45 23.40
	3.0 mi. east of Hwy 199, 1.5 mi. south of US 65, south of Tamo			(Sec. 25, T7S, R7W)
LIN10	07/25/2000	Lincoln	34 04 42.78	91 45 20.89
	3.5 mi. east of US 425, 2.5 mi. south of US 65, south of Tamo			(Sec. 36, T7S, R7W)
LIN11	07/25/2000	Lincoln	34 02 21.44	91 45 43.79
	2.75 mi. east of US 425, 4.75 mi. north of Hwy 11, east of Yorktown			(Sec. 14, T8S, R7W)
LIN12	07/25/2000	Lincoln	34 00 32.76	91 45 32.72
	3.25 mi. east of US 425, 3.0 mi. north of Hwy 11, east of Yorktown			(Sec. 24, T8S, R7W)
LIN13	07/25/2000	Lincoln	33 57 13.78	91 45 04.76
	0.5 mi. south of Hwy 11, 1.0 mi. west of Hwy 293, west of Fresno			(Sec. 6, T9S, R6W)
LIN14	07/25/2000	Lincoln	33 57 33.15	91 42 44.63
	0.25 mi. south of Hwy 11, 1.25 mi. east of Hwy 293, south of Fresno			(Sec. 3, T9S, R6W)
LIN15	07/25/2000	Lincoln	33 57 24.10	91 41 54.59
	0.75 mi. south of Hwy 11, 2.0 mi. east of Hwy 293, south of Fresno			(Sec. 3, T9S, R6W)
LIN16	07/25/2000	Lincoln	33 56 25.82	91 40 30.36
	2.0 mi. south of Hwy 114, 2.75 mi. west of Hwy 293, south of Fresno			(Sec. 12, T9S, R6W)
LIN17	07/25/2000	Lincoln	34 02 01.57	91 42 23.37
	0.5 mi. east of Hwy. 11, 4.75 mi. north of Hwy 114, south of Grady			(Sec. 16, T8S, R6W)
LIN18	08/15/2000	Lincoln	34 02 01.79	91 48 53.72
	0.25 mi. east of US 425, 5.25 mi. north of Hwy 11, north of Yorktown			(Sec. 16, T8S, R7W)
LIN19	08/15/2000	Lincoln	33 58 36.84	91 49 45.25
	adjacent to US 425, 2.0 mi. north of Hwy. 11, north of Star City			(Sec. 32, T8S, R7W)
LIN20	08/15/2000	Lincoln	33 53 31.30	91 47 31.18
	3.5 mi. east of US 425, 2.25 mi. north of Hwy 54 at Calhoun			(Sec. 35, T95S, R7W)
LIN21	08/15/2000	Lincoln	33 54 20.82	91 42 25.98
	adjacent to Hwy 293, 3.5 mi. south of Hwy 11, south of Fresno			(Sec. 27, T9S, R6W)
LIN22	08/22/2000	Lincoln	34 02 07.10	91 50 52.96
	2.5 mi. east of US 425, 5.0 mi. north of Hwy 114, west of Yorktown			(Sec. 24, T8S, R8W)
LIN23	08/22/2000	Lincoln	34 02 04.99	91 51 13.25
	2.0 mi. west of US 425, 6.0 mi. north of Hwy 114, northwest of Yorktown			(Sec. 13, T8S, R8W)
LIN24	08/15/2000	Lincoln	33 44 02.77	91 40 29.85
	1.0 mi. south of Jefferson County Line Road, 5.0 mi. west of US 425			(Sec. 29, T7S, R8W)

Appendix II

General and Inorganic Water-Quality Analyses

Appendix II - General and Inorganic Water Quality Analyses

Station_ID	Aluminum u g/L	Arsenic u g/L	Barium u g/L	Beryllium u g/L	Boron u g/L	Cadmium u g/L	Calcium mg/L	Chromium u g/L	Cobalt u g/L	Copper u g/L	Iron u g/L	Lead u g/L	Magnesium mg/L
DREW01	<127	1.92	290.9	<0.11	13.5	<0.14	26.4	0.5	<0.50	<0.5	36270.0	<0.3	5.7
DREW02	<127	5.86	229.1	<0.11	17.8	<0.14	38.8	<0.4	<0.50	<0.5	5581.0	<0.3	11.1
DREW03	<127	1.12	296.0	<0.11	14.0	<0.14	29.7	0.5	<0.50	<0.5	26480.0	<0.3	8.2
DREW04	<127	2.17	295.4	<0.11	26.3	<0.14	48.9	0.6	<0.50	<0.5	15260.0	<0.3	11.0
DESHA01	129.2	11.76	377.0	<0.11	31.7	<0.14	68.6	0.6	<0.50	<0.5	15560.0	<0.3	13.5
DESHA02	<127	20.75	243.7	<0.11	21.9	<0.14	58.1	0.5	<0.50	<0.5	31100.0	<0.3	12.6
LINC01	<127	4.07	272.2	<0.11	20.5	<0.14	48.9	<0.4	<0.50	<0.5	20220.0	<0.3	9.2
LINC02	<127	7.41	216.2	<0.11	29.6	<0.14	40.9	0.4	<0.50	<0.5	17220.0	<0.3	8.3
LINC03	<127	19.34	115.4	<0.11	8.9	<0.14	21.6	<0.4	0.55	<0.5	14730.0	<0.3	5.8
ASH01	<127	4.42	301.6	<0.11	17.2	<0.14	40.0	0.4	<0.50	<0.5	19400.0	<0.3	9.1
ASH02	<127	10.35	248.4	<0.11	51.4	<0.14	64.3	0.5	0.83	<0.5	3940.0	<0.3	15.4
ASH03	<127	32.31	401.1	<0.11	17.1	<0.14	87.5	0.5	<0.50	<0.5	8480.0	<0.3	24.7
ASH04	<127	1.63	381.6	<0.11	<4.5	<0.14	55.6	<0.4	<0.50	0.7	16400.0	<0.3	13.6
DREW05	<127	1.12	120.8	<0.11	<4.5	<0.14	15.0	<0.4	<0.50	<0.5	7070.0	<0.3	4.0
CHI01	<127	<1.00	297.8	<0.11	8.9	<0.14	53.3	<0.4	<0.50	<0.5	7000.0	<0.3	10.0
CHI02	<127	2.24	205.9	<0.11	<4.5	<0.14	43.7	<0.4	<0.50	<0.5	12000.0	<0.3	11.1
DREW06	<127	1.4	212.1	<0.11	<4.5	<0.14	34.5	<0.4	<0.50	<0.5	11000.0	<0.3	6.9
CHI03	<127	1.07	267.5	<0.11	<4.5	<0.14	50.9	0.4	<0.50	<0.5	14400.0	<0.3	9.7
CHI04	<127	<1.00	335.1	<0.11	<4.5	<0.14	58.6	<0.4	<0.50	<0.5	19600.0	<0.3	13.8
ASH05	167.1	2.21	304.6	<0.11	55.0	<0.14	49.5	0.9	<0.50	1.1	11720.0	<0.3	15.5
ASH06	133.9	<1.00	246.8	<0.11	34.8	<0.14	37.2	0.5	<0.50	<0.5	14970.0	<0.3	8.0
ASH07	<127	<1.00	136.5	<0.11	32.6	<0.14	7.1	0.5	<0.50	<0.5	17400.0	<0.3	1.6
ASH08	<127	<1.00	124.0	<0.11	26.0	<0.14	33.6	0.9	<0.50	<0.5	3824.0	<0.3	6.7
ASH09	286.5	2.25	426.4	<0.11	45.7	<0.14	110.1	1.1	<0.50	1.0	10650.0	<0.3	24.3
ASH10	296	2.18	143.4	<0.11	37.8	<0.14	108.2	0.6	<0.50	1.6	11050.0	<0.3	29.5
ASH11	<127	1.54	346.5	<0.11	44.5	<0.14	40.4	0.7	<0.50	<0.5	32000.0	<0.3	8.7
ASH12	<127	<1.00	205.8	<0.11	16.6	<0.14	23.3	0.6	<0.50	<0.5	19520.0	<0.3	6.6
ASH13	<127	<1.00	202.9	<0.11	106.7	<0.14	39.7	<0.4	<0.50	1.1	4160.0	<0.3	9.1
ASH15	<127	<1.00	329.1	<0.11	178.0	<0.14	53.1	<0.4	<0.50	1.2	704.0	<0.3	13.0
ASH17	<127	5.52	489.4	<0.11	22.8	<0.14	82.3	<0.4	<0.50	<0.5	9180.0	<0.3	27.1
ASH18	<127	12.73	415.0	<0.11	<4.5	<0.14	59.7	<0.4	<0.50	<0.5	15400.0	<0.3	18.4
ASH19	<127	<1.00	204.0	<0.11	11.8	<0.14	74.7	1.1	<0.50	<0.5	<15.0	<0.3	11.6
ASH20	<127	<1.00	93.8	<0.11	13.3	<0.14	50.8	1.0	<0.50	<0.5	<15.0	<0.3	7.4
LIN04	<127	11.84	279.9	<0.11	37.4	<0.14	24.6	2.0	<0.50	0.7	41390.0	<0.3	6.8
LIN05	<127	<1.00	84.2	<0.11	16.6	<0.14	23.3	1.3	<0.50	<0.5	291.0	<0.3	7.2
LIN06	<127	<1.00	44.3	<0.11	9.8	<0.14	7.4	1.1	<0.50	<0.5	3881.0	<0.3	2.0
JEF01	312.7	5.25	589.6	<0.11	41.6	<0.14	143.1	3.0	<0.50	0.9	10700.0	<0.3	32.4
JEF02	280	4.25	523.1	<0.11	41.8	<0.14	102.1	2.6	<0.50	0.7	7631.0	<0.3	25.7
JEF03	219.4	3.49	334.7	<0.11	48.6	<0.14	74.2	2.2	<0.50	<0.5	5549.0	<0.3	20.8
LIN07	<127	3.96	203.7	<0.11	44.9	<0.14	42.3	1.6	<0.50	<0.5	2658.0	<0.3	11.3
DESHA03	<127	2.03	401.3	<0.11	<4.5	<0.14	37.5	<0.4	<0.50	<0.5	23900.0	<0.3	7.9

NA - Not Analyzed; NR - Not Recorded

Appendix II - General and Inorganic Water Quality Analyses

Station_ID	Aluminum *u* g/L	Arsenic *u* g/L	Barium *u* g/L	Beryllium *u* g/L	Boron *u* g/L	Cadmium *u* g/L	Calcium mg/L	Chromium *u* g/L	Cobalt *u* g/L	Copper *u* g/L	Iron *u* g/L	Lead *u* g/L	Magnesium mg/L
DREW07	<127	1.2	165.3	<0.11	<4.5	<0.14	31.6	<0.4	<0.50	<0.5	11100.0	<0.3	7.4
DREW08	<127	1.72	212.7	<0.11	<4.5	<0.14	28.7	<0.4	<0.50	<0.5	14600.0	<0.3	7.6
DREW09	<127	<1.00	195.6	<0.11	<4.5	<0.14	27.2	0.5	<0.50	<0.5	15300.0	<0.3	6.1
DREW10	<127	1.48	174.6	<0.11	<4.5	<0.14	22.4	<0.4	<0.50	<0.5	14700.0	<0.3	5.2
DREW11	<127	1.67	185.6	<0.11	<4.5	<0.14	18.0	<0.4	<0.50	<0.5	12900.0	<0.3	5.5
DREW12	<127	1.53	237.1	<0.11	<4.5	<0.14	43.8	<0.4	<0.50	<0.5	19600.0	<0.3	10.0
DREW13	<127	<1.00	228.1	<0.11	<4.5	<0.14	36.7	<0.4	<0.50	1.1	15600.0	<0.3	6.4
DREW14	<127	<1.00	207.0	<0.11	<4.5	<0.14	44.9	0.7	<0.50	<0.5	10700.0	<0.3	9.2
DREW15	169.9	<1.00	424.8	<0.11	13.6	<0.14	88.2	<0.4	<0.50	<0.5	11900.0	<0.3	16.6
JEF04	<127	2.93	269.6	<0.11	<4.5	0.19	48.7	<0.4	<0.50	4.6	15400.0	<0.3	10.1
JEF05	<127	17.25	265.8	<0.11	<4.5	<0.14	48.5	<0.4	1.47	<0.5	23000.0	<0.3	10.3
JEF06	<127	11.96	128.4	<0.11	8.6	<0.14	48.6	<0.4	<0.50	<0.5	8720.0	<0.3	11.7
JEF07	<127	12.78	122.8	<0.11	10.5	<0.14	37.6	<0.4	<0.50	<0.5	6600.0	<0.3	9.6
JEF08	<127	12.56	160.0	<0.11	22.0	<0.14	40.5	<0.4	<0.50	<0.5	3890.0	<0.3	9.6
JEF09	<127	7.74	775.8	<0.11	8.6	<0.14	134.2	0.5	0.7	1.4	10500.0	<0.3	33.5
JEF10	<127	2.34	192.5	<0.11	29.6	<0.14	48.3	<0.4	<0.50	<0.5	3410.0	<0.3	12.4
JEF11	<127	1.55	337.9	<0.11	24.4	<0.14	90.6	0.6	<0.50	1.1	5740.0	<0.3	22.3
JEF12	152.4	22.73	367.2	<0.11	16.7	<0.14	113.3	0.7	<0.50	<0.5	10500.0	<0.3	20.7
JEF13	158.4	2.55	457.5	<0.11	16.6	<0.14	100.7	<0.4	<0.50	<0.5	12700.0	<0.3	24.6
LIN08	159.9	7.64	476.4	<0.11	30.4	<0.14	99.0	<0.4	<0.50	2.4	7030.0	<0.3	23.6
LIN09	<127	4.34	464.0	<0.11	36.1	<0.14	83.0	<0.4	0.68	1.0	4230.0	<0.3	19.2
LIN10	147.9	4.3	607.5	<0.11	21.5	<0.14	113.9	<0.4	<0.50	2.0	8950.0	0.7	25.4
LIN11	<127	9.43	260.6	<0.11	14.1	<0.14	48.9	<0.4	<0.50	0.7	6930.0	<0.3	9.9
LIN12	<127	9.51	234.3	<0.11	<4.5	<0.14	28.3	0.4	<0.50	0.9	15800.0	<0.3	6.5
LIN13	<127	15.3	219.5	<0.11	<4.5	<0.14	41.9	<0.4	1.72	0.9	18800.0	<0.3	10.4
LIN14	<127	13.21	228.8	<0.11	36.3	<0.14	48.9	<0.4	0.77	0.8	4140.0	0.4	13.7
LIN15	<127	9.54	266.1	<0.11	30.1	<0.14	44.3	<0.4	0.57	0.7	2410.0	<0.3	11.8
LIN16	<127	3.96	194.8	<0.11	22.5	<0.14	43.0	<0.4	<0.50	0.7	5120.0	<0.3	11.2
LIN17	156.6	3.59	355.4	<0.11	31.9	<0.14	99.4	0.6	<0.50	1.3	6210.0	<0.3	23.7
DREW16	<127	4.00	240.6	<0.11	<4.5	0.28	24.4	<0.4	<0.50	<0.5	22600.0	0.4	6.8
DREW17	<127	<1.00	312.1	<0.11	<4.5	0.34	36.0	<0.4	<0.50	<0.5	11600.0	0.4	6.2
DREW18	<127	1.04	235.9	<0.11	<4.5	0.4	28.0	<0.4	<0.50	<0.5	13800.0	0.5	6.4
DREW19	<127	1.32	225.0	<0.11	<4.5	0.45	24.9	<0.4	<0.50	<0.5	19800.0	0.6	7.2
DREW20	<127	<1.00	332.6	<0.11	<4.5	0.18	51.7	<0.4	<0.50	<0.5	17900.0	0.3	11.4
DREW21	<127	2.82	123.7	<0.11	16.7	0.23	22.4	<0.4	<0.50	0.5	5770.0	0.4	6.4
DREW22	<127	2.15	72.1	<0.11	<4.5	0.7	13.3	<0.4	1.67	3.0	4310.0	1.3	4.6
DREW23	<127	8.71	67.7	<0.11	<4.5	<0.14	12.7	<0.4	<0.50	2.1	5730.0	0.5	3.7
DREW24	<127	<1.00	261.4	<0.11	<4.5	0.45	41.7	<0.4	<0.50	<0.5	12200.0	0.7	7.4
DREW25	<127	<1.00	467.3	<0.11	<4.5	0.42	66.1	<0.4	<0.50	<0.5	18700.0	0.7	12.0
JEF0014	<127	50.67	126.9	<0.11	22.3	<0.14	53.0	<0.4	<0.50	<0.5	5970.0	<0.3	12.1
JEF0015	<127	40.18	122.3	<0.11	6.8	<0.14	49.4	0.5	<0.50	<0.5	12600.0	<0.3	10.7

NA - Not Analyzed; NR - Not Recorded

Appendix II - General and Inorganic Water Quality Analyses

Station_ID	Aluminum *u* g/L	Arsenic *u* g/L	Barium *u* g/L	Beryllium *u* g/L	Boron *u* g/L	Cadmium *u* g/L	Calcium mg/L	Chromium *u* g/L	Cobalt *u* g/L	Copper *u* g/L	Iron *u* g/L	Lead *u* g/L	Magnesium mg/L
JEF0016	<127	31.82	151.1	<0.11	10.5	<0.14	42.7	0.7	0.94	<0.5	9390.0	<0.3	9.0
JEF0017	<127	13.55	152.7	<0.11	<4.5	<0.14	23.7	0.6	<0.50	<0.5	20100.0	<0.3	6.4
JEF0018	<127	2.58	166.2	<0.11	<4.5	<0.14	23.6	0.9	<0.50	<0.5	15900.0	<0.3	7.0
JEF0019	<127	1.66	213.0	<0.11	<4.5	<0.14	22.9	0.9	<0.50	<0.5	12400.0	<0.3	5.6
JEF0020	<127	3.29	159.4	<0.11	<4.5	<0.14	21.7	0.8	<0.50	<0.5	8780.0	<0.3	8.2
JEF0021	<127	20.22	182.4	<0.11	<4.5	<0.14	27.7	<0.4	<0.50	<0.5	8830.0	<0.3	7.9
JEF0022	<127	2.05	161.5	<0.11	<4.5	<0.14	10.6	0.6	0.66	<0.5	29000.0	<0.3	4.1
JEF0023	<127	1.91	122.7	<0.11	<4.5	<0.14	38.0	0.8	<0.50	0.6	8610.0	<0.3	6.9
LIN18	<127	20.29	224.7	<0.11	18.4	<0.14	34.1	0.6	0.71	<0.5	6570.0	<0.3	8.2
LIN19	<127	<1.00	17.6	<0.11	1356.0	<0.14	21.1	<0.4	<0.50	4.7	50.2	<0.3	6.5
LIN20	<127	<1.00	106.8	0.2	8.3	<0.14	1.5	0.5	2.38	5.2	<15.0	0.6	3.4
LIN21	<127	26.16	118.6	<0.11	<4.5	<0.14	24.8	<0.4	6.6	0.8	16600.0	<0.3	7.2
DREW26	<127	<1.00	43.4	<0.11	18.3	<0.14	8.3	1.6	<0.50	<0.5	<15.0	<0.3	3.1
DREW27	<127	<1.00	83.5	<0.11	60.9	<0.14	18.3	2.6	<0.50	0.6	<15.0	<0.3	6.6
DREW28	<127	<1.00	22.0	<0.11	11.9	<0.14	3.6	0.8	<0.50	0.6	<15.0	<0.3	1.4
DREW29	<127	<1.00	24.8	<0.11	10.8	<0.14	4.3	1.1	<0.50	<0.5	<15.0	<0.3	1.5
DREW30	<127	<1.00	35.5	<0.11	16.6	<0.14	8.1	1.7	<0.50	0.5	<15.0	<0.3	2.6
DREW31	<127	<1.00	61.0	<0.11	23.6	<0.14	9.4	0.8	<0.50	0.7	<15.0	<0.3	3.5
DREW32	<127	2.34	34.1	<0.11	<4.5	<0.14	24.6	<0.4	0.86	<0.5	6510.0	<0.3	5.3
DREW33	<127	<1.00	38.0	<0.11	4.9	<0.14	7.3	1.7	<0.50	<0.5	<15.0	<0.3	2.1
DREW34	<127	<1.00	58.4	<0.11	17.8	<0.14	58.4	<0.4	<0.50	<0.5	135.0	<0.3	10.6
DREW35	<127	<1.00	46.6	<0.11	23.9	<0.14	31.0	1.1	<0.50	0.5	250.0	<0.3	7.9
DREW36	<127	<1.00	36.4	<0.11	14.4	<0.14	55.7	0.4	<0.50	<0.5	833.0	<0.3	9.4
DREW37	<127	1.51	60.3	<0.11	11.4	<0.14	62.2	<0.4	<0.50	0.6	176.0	<0.3	9.0
DREW38	<127	3.55	148.5	<0.11	8.3	<0.14	62.2	<0.4	<0.50	0.7	192.0	<0.3	9.6
LINC22	<127	9.87	85.1	<0.11	<4.5	<0.14	18.5	<0.4	0.50	<0.5	7230.0	<0.3	4.9
LINC23	<127	2.99	54.7	<0.11	4.7	<0.14	13.6	<0.4	<0.50	<0.5	3170.0	<0.3	4.8
LINC24	<127	3.49	282.1	<0.11	<4.5	<0.14	35.9	<0.4	<0.50	<0.5	14600.0	<0.3	12.0
ASH0021	<127	<1.00	95.0	<0.11	70.4	<0.14	75.6	<0.4	<0.50	0.6	<15.0	<0.3	17.6
ASH0022	<127	<1.00	53.7	<0.11	147.5	<0.14	84.0	<0.4	<0.50	0.9	<15.0	<0.3	21.6
ASH0023	<127	1.18	155.1	<0.11	52.0	<0.14	71.2	<0.4	<0.50	<0.5	42.4	<0.3	15.0
ASH0024	<127	<1.00	124.0	<0.11	62.7	<0.14	79.8	<0.4	<0.50	<0.5	<15.0	<0.3	16.7
ASH0025	<127	<1.00	79.5	<0.11	101.2	<0.14	90.3	<0.4	<0.50	1.3	<15.0	<0.3	21.1
ASH0026	<127	<1.00	158.3	<0.11	7.8	0.14	10.2	<0.4	2.64	<0.5	148.0	<0.3	3.5
ASH0027	<127	<1.00	56.9	<0.11	7.6	<0.14	7.6	<0.4	<0.50	1.4	93.9	0.35	2.2
ASH0028	<127	<1.00	216.2	<0.11	28.3	<0.14	83.8	<0.4	<0.50	0.9	<15.0	<0.3	17.9
ASH0029	<127	<1.00	154.0	<0.11	45.3	<0.14	71.7	<0.4	<0.50	0.7	<15.0	0.4	16.4
ASH0030	<127	<1.00	216.9	<0.11	46.6	<0.14	78.6	<0.4	<0.50	1.2	<15.0	<0.3	18.2

NA - Not Analyzed; NR - Not Recorded

Appendix II - General and Inorganic Water Quality Analyses

Station_ID	Manganese *u* g/L	Nickel *u* g/L	Potassium mg/L	Selenium *u* g/L	Sodium mg/L	Vanadium *u* g/L	Zinc *u* g/L	Hardness mg/L $CaCO_3$	SiO2 mg/L	pH std units	Water Temp deg C	Alkalinity mg/L $CaCO_3$
DREW01	828.1	<2	4.9	<3	12.3	<1.0	<1.0	89.0	34.0	6.4	17.9	141.0
DREW02	786.1	<2	2.5	<3	27.1	<1.0	2.0	143.0	46.0	6.1	18.5	126.0
DREW03	490.3	<2	3.1	<3	10.6	<1.0	<1.0	108.0	33.0	6.5	17.8	148.0
DREW04	607.7	<2	1.7	<3	13.3	<1.0	<1.0	168.0	31.0	6.7	18.0	178.0
DESHA01	807.0	<2	2.4	<3	23.8	<1.0	<1.0	227.0	29.0	6.7	17.9	233.0
DESHA02	534.2	<2	2.4	<3	13.9	<1.0	<1.0	197.0	29.0	6.8	17.8	219.0
LINC01	355.2	<2	2.2	<3	11.9	<1.0	<1.0	160.0	36.0	6.6	17.9	183.0
LINC02	301.0	<2	2.6	<3	19.0	<1.0	1.9	136.0	34.0	6.7	18.0	171.0
LINC03	421.0	<2	1.9	<3	15.2	<1.0	1.6	78.0	42.0	6.8	18.9	93.0
ASH01	716.3	<2	2.3	<3	31.2	<1.0	<1.0	137.0	31.5	6.5	18.1	167.5
ASH02	498.2	2.3	0.8	<3	22.7	2.1	1.9	224.0	27.5	7.0	18.5	261.0
ASH03	1490.0	<2	0.9	<3	19.1	<1.0	<1.0	320.0	27.6	6.9	18.0	329.5
ASH04	707.2	<2	2.9	<3	34.1	<1.0	<1.0	195.0	30.1	6.7	18.4	216.0
DREW05	461.4	<2	1.1	<3	9.5	<1.0	<1.0	54.0	27.8	6.7	17.9	64.5
CHI01	562.2	<2	1.6	<3	13.4	<1.0	1.0	174.0	35.8	6.7	19.6	196.0
CHI02	862.4	<2	1.6	<3	14.8	<1.0	3.4	155.0	30.9	6.9	18.0	167.0
DREW06	681.8	<2	1.8	<3	12.8	<1.0	<1.0	115.0	31.5	6.8	18.4	133.5
CHI03	379.1	<2	2.0	<3	19.8	<1.0	<1.0	167.0	34.0	7.1	18.2	203.5
CHI04	1062.0	<2	2.7	<3	20.2	<1.0	1.4	203.0	37.7	6.8	18.3	208.0
ASH05	947.0	<2	2.3	<3	21.5	1.2	?0.0	187.0	28.0	6.5	18.8	211.0
ASH06	592.3	<2	1.1	<3	14.0	1.2	?0.0	126.0	36.6	6.4	18.4	160.0
ASH07	792.4	<2	2.1	<3	4.2	<1.0	?0.0	24.0	15.5	6.5	18.1	59.5
ASH08	412.3	<2	1.5	<3	11.4	2.1	?0.0	111.0	30.5	6.7	18.4	141.5
ASH09	1289.0	2.16	1.8	<3	35.3	1.5	?0.0	375.0	29.5	6.9	18.4	362.5
ASH10	1090.0	<2	1.7	<3	64.2	<1.0	?0.0	392.0	30.3	7.0	19.1	257.6
ASH11	900.9	<2	2.5	<3	25.9	<1.0	?0.0	137.0	40.0	6.5	18.6	186.0
ASH12	591.3	<2	1.4	<3	10.5	<1.0	?0.0	85.0	39.1	6.6	18.2	125.0
ASH13	253.0	<2	1.7	<3	49.5	<1.0	1.4	137.0	27.2	7.0	18.1	222.0
ASH15	119.6	<2	2.5	<3	57.2	<1.0	2.0	186.0	20.1	7.4	18.8	268.0
ASH17	312.1	<2	0.9	<3	46.8	<1.0	1.8	317.0	28.0	6.9	18.3	340.0
ASH18	666.2	<2	1.8	<3	37.1	<1.0	<1.0	225.0	35.0	NA	NA	252.0
ASH19	<0.5	<2	2.2	<3	23.3	2.5	2.3	234.0	38.7	7.1	19.7	252.0
ASH20	15.3	<2	2.3	<3	19.0	1.7	3.2	157.0	38.4	7.2	19.0	182.0
LIN04	688.6	<2	2.7	<3	33.2	1.8	1.8	90.0	NA	6.6	18.5	NA
LIN05	34.6	<2	1.9	<3	20.9	<1.0	3.7	88.0	NA	6.4	18.8	NA
LIN06	81.9	<2	1.3	<3	13.9	<1.0	4.5	27.0	NA	6.1	18.9	NA
JEF01	966.3	2	2.9	<3	71.9	2.0	1.2	491.0	NA	6.8	17.7	NA
JEF02	855.1	2.04	2.1	<3	54.7	1.7	1.0	361.0	NA	6.8	18.0	NA
JEF03	374.5	<2	1.3	<3	31.2	1.5	1.7	271.0	NA	7.0	17.6	NA
LIN07	307.0	<2	1.3	<3	20.8	<1.0	2.0	152.0	NA	6.9	18.3	NA
DESHA03	484.6	<2	1.9	<3	19.3	<1.0	2.3	126.0	34.0	6.8	18.3	139.0

NA - Not Analyzed; NR - Not Recorded

Appendix II - General and Inorganic Water Quality Analyses

Station_ID	Manganese *u* g/L	Nickel *u* g/L	Potassium mg/L	Selenium *u* g/L	Sodium mg/L	Vanadium *u* g/L	Zinc *u* g/L	Hardness mg/L $CaCO_3$	SiO2 mg/L	pH std units	Water Temp deg C	Alkalinity mg/L $CaCO_3$
DREW07	224.3	<2	1.2	<3	18.7	<1.0	1.7	109.0	31.2	6.9	18.2	134.0
DREW08	755.0	<2	1.3	<3	33.9	<1.0	<1.0	103.0	41.0	6.8	18.5	104.0
DREW09	373.4	<2	1.2	<3	21.4	<1.0	6.9	93.0	36.5	6.8	18.1	105.0
DREW10	448.0	<2	1.6	<3	15.4	<1.0	2.5	77.0	33.9	6.6	18.2	80.5
DREW11	282.1	<2	1.6	<3	18.0	1.0	<1.0	68.0	35.3	6.6	18.1	70.3
DREW12	551.4	<2	1.1	<3	34.7	<1.0	<1.0	150.0	36.0	6.9	18.2	168.0
DREW13	327.3	<2	2.0	<3	19.4	<1.0	7.0	118.0	32.2	6.9	18.1	125.0
DREW14	427.8	<2	1.1	<3	14.6	2.1	2.3	150.0	31.9	6.9	16.4	151.0
DREW15	494.7	<2	1.9	<3	44.7	<1.0	1.6	289.0	28.7	7.0	18.4	288.0
JEF04	287.5	<2	1.4	<3	26.1	<1.0	<1.0	163.0	36.8	6.7	17.8	NA
JEF05	573.3	2.15	1.5	<3	22.6	<1.0	<1.0	164.0	35.1	6.7	17.7	NA
JEF06	414.8	<2	4.9	<3	21.1	<1.0	<1.0	170.0	38.0	6.7	17.8	NA
JEF07	383.3	<2	4.2	<3	17.6	<1.0	<1.0	133.0	38.9	6.7	17.9	NA
JEF08	409.4	<2	3.4	<3	18.0	<1.0	<1.0	141.0	38.3	6.9	17.8	NA
JEF09	844.3	2.92	1.7	<3	64.3	<1.0	<1.0	473.0	29.4	6.8	17.9	NA
JEF10	287.4	<2	<0.46	<3	17.9	<1.0	1.6	172.0	36.6	6.9	18.1	NA
JEF11	1068.0	<2	<0.46	<3	33.1	<1.0	1.1	318.0	28.0	6.9	17.9	NA
JEF12	663.6	2.15	<0.46	<3	12.2	1.1	<1.0	368.0	24.7	7.1	18.0	NA
JEF13	1802.0	<2	<0.46	<3	26.6	1.3	2.0	353.0	32.1	6.9	17.3	NA
LIN08	1184.0	2.43	3.6	<3	55.4	1.9	6.2	344.0	29.2	6.5	18.0	223.8
LIN09	357.7	2.13	2.9	<3	36.4	2.2	3.0	286.0	26.8	7.1	18.1	NA
LIN10	639.7	2.74	3.8	<3	62.3	1.3	4.4	389.0	28.1	6.8	18.3	NA
LIN11	295.9	<2	3.3	<3	27.8	<1.0	1.5	163.0	33.9	6.8	17.6	191.0
LIN12	393.5	<2	2.7	<3	15.0	<1.0	3.6	97.0	38.3	6.7	17.9	111.6
LIN13	1121.0	<2	2.7	<3	32.4	1.1	5.3	147.0	29.5	6.8	18.3	171.9
LIN14	1065.0	<2	2.4	<3	23.9	<1.0	2.7	179.0	31.5	7.0	18.2	220.7
LIN15	787.1	<2	2.2	<3	18.6	<1.0	4.6	159.0	35.3	7.0	18.2	201.3
LIN16	272.6	<2	2.2	<3	22.7	<1.0	2.4	153.0	31.3	7.0	17.7	166.7
LIN17	800.4	2.26	3.2	<3	58.1	1.1	8.2	346.0	26.0	7.2	18.0	NA
DREW16	741.5	<2	1.8	<3	8.4	<1.0	<1.0	89.0	32.4	6.5	17.1	95.0
DREW17	494.5	<2	1.4	<3	10.9	<1.0	<1.0	115.0	35.7	6.6	18.1	105.0
DREW18	684.5	<2	1.0	<3	12.0	<1.0	1.1	96.0	37.9	6.6	18.1	94.5
DREW19	488.6	<2	2.3	<3	14.5	<1.0	<1.0	92.0	34.2	6.5	18.3	104.0
DREW20	501.6	<2	1.7	<3	21.1	<1.0	<1.0	176.0	32.1	6.6	18.4	164.0
DREW21	661.3	<2	1.0	<3	22.9	<1.0	<1.0	82.0	44.7	6.9	18.4	91.0
DREW22	717.3	11.64	0.7	<3	14.4	<1.0	3.2	52.0	50.0	6.4	18.1	55.0
DREW23	830.4	<2	0.5	<3	13.5	1.3	1.3	47.0	53.1	6.6	18.4	61.0
DREW24	353.3	<2	0.9	<3	18.6	<1.0	<1.0	135.0	33.9	6.8	18.2	142.0
DREW25	406.0	<2	1.0	<3	22.3	<1.0	<1.0	214.0	30.9	6.8	17.7	206.0
JEF0014	453.2	<2	2.6	<3	21.6	<1.0	1.7	182.0	31.7	6.7	17.9	212.0
JEF0015	562.4	<2	1.9	<3	20.4	<1.0	2.4	167.0	31.2	6.9	17.9	197.0

NA - Not Analyzed; NR - Not Recorded

Appendix II - General and Inorganic Water Quality Analyses

Station_ID	Manganese *u* g/L	Nickel *u* g/L	Potassium mg/L	Selenium *u* g/L	Sodium mg/L	Vanadium *u* g/L	Zinc *u* g/L	Hardness mg/L $CaCO_3$	SiO2 mg/L	pH std units	Water Temp deg C	Alkalinity mg/L $CaCO_3$
JEF0016	791.6	<2	1.6	<3	17.6	<1.0	2.4	144.0	32.3	6.9	17.9	171.0
JEF0017	699.6	<2	2.3	<3	16.5	<1.0	2.0	85.0	34.1	6.5	17.5	97.5
JEF0018	639.0	<2	1.9	<3	29.6	<1.0	1.1	88.0	32.2	6.6	17.6	106.0
JEF0019	353.0	<2	2.0	<3	23.0	<1.0	2.8	80.0	36.7	6.4	17.3	95.5
JEF0020	487.7	<2	2.1	<3	18.5	1.4	2.7	88.0	30.4	6.5	17.7	105.0
JEF0021	1320.0	<2	2.0	<3	16.5	1.1	2.0	102.0	51.7	6.6	17.6	123.0
JEF0022	527.8	<2	2.6	<3	10.7	1.0	<1.0	43.0	29.6	6.3	17.3	86.5
JEF0023	389.0	<2	2.8	<3	15.6	<1.0	3.2	123.0	32.0	6.8	17.9	141.0
LIN18	613.7	<2	1.9	<3	19.5	1.1	2.8	119.0	33.1	6.8	17.9	148.0
LIN19	233.3	<2	8.5	<3	243.0	1.1	431.3	79.0	24.0	7.7	20.3	260.0
LIN20	63.9	2.18	3.3	<3	7.7	<1.0	10.0	18.0	14.1	4.9	20.5	0.0
LIN21	1013.0	2.6	2.0	<3	33.7	<1.0	14.5	91.0	28.6	6.6	18.1	133.0
DREW26	3.5	<2	1.4	<3	24.3	<1.0	2.9	33.0	56.2	6.5	18.5	49.0
DREW27	7.9	<2	2.0	<3	41.1	2.3	3.2	73.0	53.8	6.8	18.5	88.0
DREW28	0.5	<2	1.4	<3	13.6	<1.0	4.2	15.0	44.7	6.1	17.6	32.0
DREW29	<0.5	<2	1.1	<3	14.1	1.4	3.5	17.0	52.1	6.3	18.5	34.0
DREW30	<0.5	<2	1.2	<3	20.4	<1.0	2.8	31.0	53.5	6.3	18.8	47.5
DREW31	0.7	<2	1.3	<3	25.1	1.2	3.6	38.0	52.2	6.4	18.5	68.0
DREW32	605.1	<2	1.2	<3	11.4	<1.0	4.6	83.0	52.1	7.0	18.7	86.5
DREW33	<0.5	<2	0.9	<3	13.5	2.2	3.8	27.0	52.2	6.1	18.0	37.0
DREW34	61.2	<2	1.7	<3	23.6	1.7	3.1	189.0	46.3	7.4	18.5	223.0
DREW35	79.5	<2	1.5	<3	25.8	1.8	3.1	110.0	49.7	7.0	19.1	141.0
DREW36	199.4	<2	1.4	<3	21.5	1.5	3.0	178.0	52.0	7.3	18.9	199.0
DREW37	142.8	<2	1.5	<3	19.8	1.7	3.4	192.0	47.5	7.4	18.5	213.0
DREW38	316.5	<2	1.3	<3	19.4	1.6	4.0	195.0	41.2	7.3	18.0	208.0
LINC22	596.4	<2	1.0	<3	13.1	<1.0	3.4	66.0	45.2	6.6	17.7	84.0
LINC23	585.0	<2	2.0	<3	11.0	<1.0	3.5	54.0	34.4	6.6	NA	63.5
LINC24	898.8	<2	3.4	<3	25.5	<1.0	2.0	139.0	38.5	6.7	17.7	162.0
ASH0021	<0.5	<2	2.2	<3	47.7	3.5	7.1	261.0	29.9	7.3	18.9	305.0
ASH0022	7.5	<2	3.2	<3	75.9	3.2	2.3	299.0	31.6	7.4	19.5	341.0
ASH0023	2.5	<2	1.7	4.1	45.4	2.2	2.2	240.0	30.1	7.4	19.7	274.0
ASH0024	1.7	<2	1.9	<3	46.5	1.8	2.2	268.0	30.0	7.2	19.6	302.0
ASH0025	<0.5	<2	2.0	<3	67.7	2.6	3.5	312.0	32.6	7.2	19.7	338.0
ASH0026	2946.0	7.0	1.7	<3	14.2	1.2	14.6	40.0	48.5	6.3	19.8	38.0
ASH0027	380.7	<2	1.8	<3	24.4	<1.0	8.8	28.0	54.5	6.0	19.0	26.0
ASH0028	34.4	<2	2.0	<3	35.0	2.5	5.6	283.0	34.9	7.1	19.5	320.0
ASH0029	<0.5	<2	2.1	<3	41.4	1.9	5.4	246.0	30.6	7.4	19.6	304.0
ASH0030	<0.5	<2	1.7	<3	40.6	2.7	2.6	271.0	30.8	7.2	NA	319.0

NA - Not Analyzed; NR - Not Recorded

Appendix II - General and Inorganic Water Quality Analyses

Station_ID	Conductivity *u* S/cm	Bromide mg/L	Chloride mg/L	Fluoride mg/L	Sulfate mg/L	NH3-N mg/L	NO3-N mg/L	O-PHOS mg/L	T-PHOS mg/L	TKN mg/L	TOC mg/L	TSS mg/L	TDS mg/L
DREW01	334.0	0.1	14.70	0.17	5.26	0.75	0.01	0.05	0.68	1.023	NA	32.5	178.0
DREW02	418.0	0.2	45.80	0.25	17.20	0.16	0.05	0.02	0.32	0.222	NA	4.5	271.0
DREW03	318.0	0.1	8.59	0.25	5.43	0.48	0.03	0.08	0.52	0.572	NA	23.0	176.0
DREW04	391.0	0.1	10.70	0.26	2.82	0.34	0.03	0.02	0.94	0.554	NA	24.5	224.5
DESHA01	541.0	0.2	31.10	0.28	5.52	0.50	0.08	0.03	0.49	0.678	NA	19.5	312.0
DESHA02	482.0	0.1	9.30	0.30	3.05	0.43	0.03	0.02	0.57	0.647	NA	53.5	250.5
LINC01	394.0	0.1	14.20	0.23	4.81	0.39	0.03	0.04	0.86	0.632	NA	21.5	236.0
LINC02	371.0	0.1	11.40	0.27	5.14	0.46	0.05	0.02	0.92	0.688	NA	24.5	218.0
LINC03	266.0	0.1	24.20	0.25	5.27	0.32	0.04	0.04	0.67	0.372	NA	10.0	171.5
ASH01	452.0	0.1	24.10	0.30	8.63	0.56	0.02	0.02	0.95	0.777	3.00	39.0	245.0
ASH02	522.0	0.1	9.70	0.38	5.00	0.87	0.11	0.02	0.55	1.185	1.27	9.5	303.0
ASH03	695.0	0.1	17.90	0.42	15.70	0.78	0.01	0.02	0.98	1.177	1.48	20.0	398.0
ASH04	569.0	0.2	37.50	0.19	11.90	0.35	0.01	0.01	0.55	0.636	1.94	30.0	315.0
DREW05	186.0	0.0	7.30	0.14	11.40	0.12	0.34	0.02	0.23	0.237	0.97	7.0	122.0
CHI01	433.0	0.1	14.10	0.25	4.29	0.38	0.02	0.02	0.57	0.686	2.35	14.5	254.0
CHI02	405.0	0.1	16.40	0.37	6.62	0.51	0.03	0.02	0.66	0.800	2.47	24.5	224.0
DREW06	454.0	0.1	10.50	0.24	9.57	0.30	0.01	0.03	0.61	0.590	2.29	17.5	186.0
CHI03	316.0	0.1	19.00	0.26	3.68	0.43	<0.010	0.03	1.01	0.662	2.70	24.0	256.0
CHI04	538.0	0.2	41.60	0.21	6.88	0.54	<0.010	0.05	0.84	0.866	2.47	29.5	305.0
ASH05	534.0	0.1	17.80	0.31	7.36	0.64	0.03	0.02	13.34	1.694	9.60	598.0	267.0
ASH06	350.0	0.1	8.58	0.31	4.17	0.58	0.02	0.03	0.90	0.796	6.20	10.0	222.0
ASH07	144.0	0.1	4.19	0.11	1.42	1.24	0.02	0.05	0.32	1.434	5.20	1.5	92.0
ASH08	306.0	0.1	8.69	0.31	1.11	0.31	<0.010	0.03	0.61	0.439	4.60	7.5	188.0
ASH09	857.0	0.8	92.70	0.41	83.20	0.66	0.04	0.01	0.67	0.731	3.50	23.0	504.0
ASH10	834.0	0.7	80.30	0.30	40.60	0.60	0.03	0.05	0.66	0.678	2.00	15.0	714.0
ASH11	490.0	0.3	40.30	0.31	2.19	0.35	<0.010	0.08	0.73	0.439	3.90	9.5	290.0
ASH12	272.0	0.1	11.20	0.27	11.80	0.19	0.02	0.06	0.41	0.173	1.60	7.0	190.0
ASH13	488.0	0.1	16.60	0.26	2.79	0.38	0.09	0.02	0.43	0.468	2.01	6.0	285.0
ASH15	634.0	0.2	38.30	0.23	9.31	0.50	0.02	0.03	0.10	0.499	0.54	<1	363.0
ASH17	819.0	0.2	35.30	0.47	44.40	1.19	0.02	0.02	0.90	1.430	1.18	18.5	464.0
ASH18	NA	0.2	29.40	0.38	27.80	0.28	0.03	0.02	0.46	0.465	2.06	26.5	364.0
ASH19	532.0	0.1	19.80	0.19	2.77	0.02	0.15	0.10	0.08	<0.05	0.40	<1	321.0
ASH20	386.0	0.1	15.00	0.27	2.06	0.02	0.20	0.13	0.11	<0.05	0.39	<1	243.0
LIN04	433.0	0.2	34.70	0.11	0.81	0.42	<0.010	<0.005	1.17	0.878	11.40	35.5	261.0
LIN05	279.0	0.4	38.90	0.10	4.49	0.00	0.22	0.14	0.19	0.270	1.53	6.5	199.0
LIN06	145.0	0.1	13.70	0.03	2.62	0.06	<0.010	0.08	0.17	0.290	1.56	3.0	112.5
JEF01	1180.0	0.5	116.00	0.33	53.10	0.45	<0.010	<0.005	0.85	0.842	1.91	16.5	703.0
JEF02	896.0	0.3	73.20	0.27	28.50	0.38	<0.010	<0.005	0.67	0.559	2.20	27.0	522.0
JEF03	639.0	0.1	23.40	0.38	1.41	0.44	<0.010	<0.005	0.70	0.699	2.00	10.5	379.0
LIN07	377.0	0.1	8.56	0.31	1.83	0.22	<0.010	0.05	0.58	0.405	1.97	31.5	236.5
DESHA03	395.0	0.1	15.12	0.18	10.31	0.26	0.05	0.04	1.03	0.440	2.60	41.0	215.0

NA - Not Analyzed; NR - Not Recorded

Appendix II - General and Inorganic Water Quality Analyses

Station_ID	Conductivity *u* S/cm	Bromide mg/L	Chloride mg/L	Fluoride mg/L	Sulfate mg/L	NH3-N mg/L	NO3-N mg/L	O-PHOS mg/L	T-PHOS mg/L	TKN mg/L	TOC mg/L	TSS mg/L	TDS mg/L
DREW07	320.0	0.1	8.33	0.22	1.39	0.28	0.02	0.06	0.90	0.455	2.01	14.0	196.0
DREW08	395.0	0.2	39.44	0.15	11.59	0.24	0.03	0.07	0.51	0.262	1.10	12.5	247.0
DREW09	317.0	0.1	16.80	0.13	7.57	0.43	0.02	0.08	0.79	0.535	1.24	10.5	197.0
DREW10	258.0	0.1	9.69	0.12	10.54	0.20	0.15	0.09	0.50	0.220	1.75	4.0	177.0
DREW11	247.0	0.1	9.51	0.11	13.80	0.15	0.95	0.06	0.54	0.096	1.80	2.5	173.0
DREW12	473.0	0.2	29.34	0.14	2.91	0.21	0.02	0.07	0.67	0.342	3.32	24.5	273.0
DREW13	337.0	0.1	15.21	0.14	1.90	0.26	0.02	0.09	0.84	0.309	2.19	10.5	204.0
DREW14	351.0	0.1	10.12	0.12	2.34	0.41	0.03	0.03	1.02	0.877	8.05	15.5	224.0
DREW15	718.0	0.3	60.10	0.21	4.28	0.65	0.02	0.05	1.00	1.093	2.88	17.5	418.0
JEF04	NA	0.1	23.57	0.18	10.32	0.31	0.02	0.03	0.84	NA	1.53	16.5	271.0
JEF05	NA	0.1	19.23	0.18	2.75	0.35	0.02	0.06	0.82	NA	1.97	24.5	262.0
JEF06	NA	0.2	43.67	0.23	2.24	0.32	0.02	0.03	0.63	NA	1.67	8.0	290.0
JEF07	NA	0.1	22.55	0.22	2.54	0.23	0.02	0.02	0.59	NA	1.65	5.0	224.0
JEF08	NA	0.1	11.89	0.22	1.24	0.23	0.02	0.01	0.46	NA	1.63	5.0	223.0
JEF09	NA	0.4	109.40	0.27	85.23	0.33	0.02	<0.005	0.64	NA	1.82	23.5	746.0
JEF10	NA	<0.01	11.35	0.25	2.56	0.16	0.02	0.01	0.43	NA	1.82	5.5	247.0
JEF11	NA	0.1	34.05	0.37	8.96	0.24	0.02	0.01	NA	NA	1.90	10.0	406.0
JEF12	NA	0.1	12.75	0.23	3.99	0.40	0.02	<0.005	NA	NA	1.84	22.5	402.0
JEF13	NA	0.1	12.12	0.28	18.10	0.32	0.08	0.05	NA	NA	4.68	14.5	443.0
LIN08	914.0	0.2	62.30	0.30	38.23	0.24	0.03	0.01	0.45	0.264	2.06	12.0	523.0
LIN09	700.0	0.1	37.39	0.32	5.84	0.26	0.15	0.01	0.52	0.277	2.66	11.0	404.0
LIN10	1031.0	0.3	137.35	0.28	42.17	0.32	0.02	0.01	0.53	0.326	2.16	14.5	603.0
LIN11	444.0	0.1	21.84	0.19	5.08	0.21	0.02	0.02	0.66	<0.05	2.17	7.0	266.0
LIN12	298.0	0.1	11.60	0.20	1.19	0.25	0.02	0.03	1.23	0.274	3.02	314.0	179.0
LIN13	480.0	0.2	28.43	0.21	11.75	0.15	0.02	0.02	0.80	<0.05	2.80	15.0	272.0
LIN14	483.0	0.1	22.94	0.34	3.45	0.22	0.02	0.01	0.34	0.060	1.84	69.5	268.0
LIN15	396.0	0.1	7.46	0.32	1.94	0.17	0.02	0.02	0.25	<0.05	1.83	5.0	245.0
LIN16	391.0	0.1	13.15	0.26	11.02	0.19	0.04	0.02	0.39	0.119	2.00	11.0	234.0
LIN17	939.0	0.3	118.85	0.33	33.94	0.33	0.02	0.01	0.52	0.279	2.08	12.5	539.0
DREW16	276.0	<0.01	5.05	0.16	3.62	0.25	<0.01	0.04	0.63	0.449	5.74	14.5	181.0
DREW17	304.0	<0.01	7.77	0.20	6.61	0.17	<0.01	0.01	0.48	0.171	1.92	7.5	208.0
DREW18	279.0	0.1	8.66	0.18	12.75	0.16	<0.01	0.01	0.48	0.114	1.51	5.5	186.0
DREW19	301.0	<0.01	10.05	0.18	5.31	0.24	<0.01	0.02	0.64	0.361	2.89	10.0	198.0
DREW20	478.0	0.2	23.46	0.20	15.95	0.35	<0.01	0.02	0.61	0.615	2.17	9.5	296.0
DREW21	281.0	0.0	23.56	0.23	4.29	0.19	<0.01	0.01	0.32	0.129	<1.0	4.0	190.0
DREW22	190.0	0.2	20.56	0.14	2.94	0.03	<0.01	0.01	0.18	0.158	<1.0	1.5	156.0
DREW23	166.0	0.1	9.15	0.17	3.94	0.06	<0.01	0.02	0.28	<0.05	<1.0	2.0	139.0
DREW24	367.0	0.1	15.33	0.20	9.36	0.19	<0.01	0.01	0.64	0.214	1.95	4.5	236.0
DREW25	531.0	0.1	27.20	0.20	6.17	0.20	<0.01	0.02	0.75	0.407	3.18	18.0	319.0
JEF0014	436.0	<0.010	8.75	0.22	1.58	0.14	0.03	0.02	0.50	0.391	1.62	13.0	306.0
JEF0015	419.0	0.1	6.64	0.23	0.95	0.13	0.03	0.02	0.76	0.397	1.32	21.5	278.0

NA - Not Analyzed; NR - Not Recorded

Appendix II - General and Inorganic Water Quality Analyses

Station_ID	Conductivity *u* S/cm	Bromide mg/L	Chloride mg/L	Fluoride mg/L	Sulfate mg/L	NH3-N mg/L	NO3-N mg/L	O-PHOS mg/L	T-PHOS mg/L	TKN mg/L	TOC mg/L	TSS mg/L	TDS mg/L
JEF0016	357.0	<0.010	4.82	0.21	1.16	0.07	0.03	0.02	0.57	0.286	1.44	12.5	249.0
JEF0017	292.0	0.2	23.21	0.15	1.74	0.11	0.02	0.10	0.45	0.192	1.10	1.5	208.0
JEF0018	338.0	0.1	22.26	0.20	14.32	0.11	0.20	0.09	0.56	0.054	1.23	4.0	220.0
JEF0019	290.0	0.1	18.04	0.20	13.76	0.08	0.21	0.09	0.43	<0.05	0.53	1.0	211.0
JEF0020	271.0	<0.010	10.58	0.20	7.60	0.05	0.87	0.06	0.31	<0.05	0.33	2.0	199.0
JEF0021	288.0	<0.010	8.65	0.21	7.34	0.21	0.20	0.06	0.35	0.559	3.01	4.0	227.0
JEF0022	226.0	<0.010	9.62	0.08	7.29	0.11	0.02	0.10	0.29	0.200	1.20	2.5	168.0
JEF0023	315.0	<0.010	6.57	0.23	6.29	0.06	0.03	0.02	0.78	0.201	0.58	12.0	215.0
LIN18	331.0	<0.010	10.85	0.28	10.90	0.16	0.04	0.07	0.41	0.319	<1.00	10.0	203.0
LIN19	1211.0	0.2	33.96	0.26	211.91	0.66	0.39	0.21	0.19	0.988	<1.00	2.5	796.0
LIN20	100.0	<0.010	8.45	0.04	1.28	0.00	6.49	0.03	0.03	<0.05	<1.00	0.5	76.0
LIN21	356.0	0.1	14.65	0.23	12.82	0.06	0.03	0.09	0.62	0.140	<1.00	13.5	213.0
DREW26	176.0	0.2	20.24	0.14	2.66	0.00	0.24	0.37	0.25	<0.05	<1.00	0.5	153.0
DREW27	331.0	0.3	35.63	0.18	16.60	0.00	0.20	0.40	0.29	<0.05	<1.00	1.0	236.0
DREW28	88.0	<0.010	4.43	0.08	3.09	0.02	0.14	0.15	0.04	<0.05	<1.00	0.5	104.0
DREW29	95.0	0.0	5.37	0.12	2.78	0.00	0.20	0.27	0.16	<0.05	<1.00	0.5	117.0
DREW30	152.0	0.1	13.55	0.12	3.86	0.00	0.18	0.24	0.12	<0.05	<1.00	0.5	147.0
DREW31	175.0	<0.010	9.57	0.15	3.14	0.00	0.07	0.29	0.17	<0.05	<1.00	0.5	154.0
DREW32	238.0	0.1	12.06	0.21	2.56	0.08	0.03	0.13	0.25	0.876	<1.00	5.5	174.0
DREW33	123.0	0.1	13.02	0.13	1.31	0.01	0.35	0.31	0.18	0.561	<1.00	0.5	121.0
DREW34	465.0	0.1	16.47	0.17	3.36	0.03	0.03	0.22	0.15	1.284	<1.00	2.0	306.0
DREW35	331.0	0.1	15.94	0.24	7.76	0.01	0.13	0.34	0.31	1.269	<1.00	1.0	231.0
DREW36	424.0	0.1	15.41	0.18	3.18	0.01	0.07	0.19	0.21	0.984	<1.00	3.0	282.0
DREW37	462.0	0.2	21.68	0.15	4.06	0.03	0.04	0.25	0.20	0.259	<1.00	1.0	307.0
DREW38	454.0	0.2	22.98	0.16	2.91	0.03	0.03	0.36	0.30	<0.05	<1.00	2.0	296.0
LINC22	221.0	0.1	12.54	0.13	5.12	0.12	0.04	0.09	0.38	0.157	<1.00	1.5	166.0
LINC23	179.0	0.1	10.88	0.15	5.67	0.00	0.02	0.06	0.15	0.881	1.91	18.5	137.0
LINC24	451.0	0.2	42.87	0.24	5.51	0.07	0.03	0.11	0.53	0.237	<1.00	4.5	176.0
ASH0021	682.0	0.2	22.60	0.22	31.30	0.00	<0.010	0.06	0.04	0.706	1.80	<1	412.5
ASH0022	823.0	0.1	21.20	0.23	93.40	0.00	<0.010	0.09	0.05	0.647	1.30	<1	539.0
ASH0023	635.0	0.3	39.40	0.23	14.00	0.00	0.18	0.06	0.04	0.556	1.20	<1	381.5
ASH0024	690.0	0.2	28.80	0.21	34.00	0.00	0.04	0.05	0.04	0.609	1.00	<1	421.0
ASH0025	830.0	0.2	26.30	0.13	80.60	0.00	0.02	0.05	0.03	0.822	1.10	<1	531.0
ASH0026	168.0	0.2	25.90	0.09	0.90	0.13	<0.010	0.36	0.30	0.866	1.10	<1	140.0
ASH0027	185.0	0.3	38.40	0.09	1.40	0.00	0.04	0.16	0.12	0.594	1.20	<1	152.5
ASH0028	638.0	0.2	22.10	0.20	6.10	0.00	0.06	0.08	0.05	0.484	1.00	<1	392.5
ASH0029	615.0	0.1	19.90	0.21	13.10	0.00	<0.010	0.06	0.04	0.770	0.90	<1	381.5
ASH0030	650.0	0.2	20.20	0.23	11.90	0.00	<0.010	0.06	0.03	0.524	1.40	<1	389.0

NA - Not Analyzed; NR - Not Recorded

Appendix III

Results of z-Test Analysis of Delta versus Terrace Water Chemistry

Appendix III - Results of z-Test Analysis of Delta versus Terrace Water Chemistry

z-Test: Two-Sample for Means	Arsenic	
	Variable 1	Variable 2
Mean	6.760967742	0.7632
Known Variance	84.073	0.5183
Observations	93	25
Hypothesized Mean Difference	0	
z	6.237049286	
P(Z<=z) one-tail	2.22951E-10	
z Critical one-tail	1.644853631	
P(Z<=z) two-tail	1.11475E-10	
z Critical two-tail	1.959963993	

z-Test: Two-Sample for Means	Barium	
	Variable 1	Variable 2
Mean	258.2419355	91.9976
Known Variance	17166.4	3851.2
Observations	93	25
Hypothesized Mean Difference	0	
z	9.034045046	
P(Z<=z) one-tail	1.0842E-19	
z Critical one-tail	1.644853631	
P(Z<=z) two-tail	5.42101E-20	
z Critical two-tail	1.959963993	

z-Test: Two-Sample for Means	Boron	
	Variable 1	Variable 2
Mean	17.87763441	32.78456
Known Variance	585.7	1193.2
Observations	93	25
Hypothesized Mean Difference	0	
z	-2.028090271	
P(Z<=z) one-tail	0.021275518	
z Critical one-tail	1.644853631	
P(Z<=z) two-tail	0.010637759	
z Critical two-tail	1.959963993	

z-Test: Two-Sample for Means	Iron	
	Variable 1	Variable 2
Mean	12547.62366	340.012
Known Variance	61000000	1681907
Observations	93	25
Hypothesized Mean Difference	0	
z	14.35504048	
P(Z<=z) one-tail	0	
z Critical one-tail	1.644853631	
P(Z<=z) two-tail	0	
z Critical two-tail	1.959963993	

z-Test: Two-Sample for Means	Calcium	
	Variable 1	Variable 2
Mean	47.83139785	45.26092
Known Variance	840.9	1010.5
Observations	93	25
Hypothesized Mean Difference	0	
z	0.365492368	
P(Z<=z) one-tail	0.357371951	
z Critical one-tail	1.644853631	
P(Z<=z) two-tail	0.178685976	
z Critical two-tail	1.959963993	

z-Test: Two-Sample for Means	Manganese	
	Variable 1	Variable 2
Mean	619.9311828	192.28996
Known Variance	95289.2	351596.9
Observations	93	25
Hypothesized Mean Difference	0	
z	3.481421907	
P(Z<=z) one-tail	0.00024938	
z Critical one-tail	1.644853631	
P(Z<=z) two-tail	0.00012469	
z Critical two-tail	1.959963993	

z-Test: Two-Sample for Means	Potassium	
	Variable 1	Variable 2
Mean	1.961827957	1.7068
Known Variance	0.8536	0.2403
Observations	93	25
Hypothesized Mean Difference	0	
z	1.860452926	
P(Z<=z) one-tail	0.031410737	
z Critical one-tail	1.644853631	
P(Z<=z) two-tail	0.015705369	
z Critical two-tail	1.959963993	

z-Test: Two-Sample for Means	Chloride	
	Variable 1	Variable 2
Mean	25.77612903	20.238
Known Variance	684.9	80.3
Observations	93	25
Hypothesized Mean Difference	0	
z	1.702910221	
P(Z<=z) one-tail	0.044292436	
z Critical one-tail	1.644853631	
P(Z<=z) two-tail	0.022146218	
z Critical two-tail	1.959963993	

z-Test: Two-Sample for Means	TDS	
	Variable 1	Variable 2
Mean	278.4892473	277.3
Known Variance	17192	16714
Observations	93	25
Hypothesized Mean Difference	0	
z	0.040709026	
P(Z<=z) one-tail	0.483763933	
z Critical one-tail	1.644853631	
P(Z<=z) two-tail	0.241881966	
z Critical two-tail	1.959963993	

Appendix IV

Pesticide Analyses

Note: The pesticide data contain a total of 16 wells with detections of malathion. This data is not listed in Table 3 of the report, and is believed to be highly questionable as to its presence in the ground water. Malathion was used extensively during the period of sampling as part of a boll weevil eradication project in the delta, and the detections are believed to be from airborne contamination. Previous sampling by the ADEQ has never revealed a single detection for malathion. Malathion has a low leaching (and runoff) potential as a result of its rapid breakdown in soil by both biological and non-biological processes. Malathion also has a moderately high organic carbon partition product (1800 ml/g), and should bind fairly strongly to many soils despite the water solubility of approximately 145 mg/L. A review of two other states showed only 12 detections out of 3,252 wells, and the high percentage for the present study (16 of 120 wells) is very unlikely. All but two of the 16 samples with detections were taken in August; the time of the heaviest spraying for malathion. The other two samples with detections were taken in mid-July. Malathion is not diluted and is sprayed in its pure form in low-volume applications (8 - 10 ounces/acre). Sprayed in its pure form, one can easily understand the contamination potential for the resulting low concentrations noted in the data base. Future sampling efforts will include trip blanks, which will be handled similar to samples taken at each site, in order to investigate the impact of airborne and other contamination sources (i.e. handling, etc.).

Appendix IV - Pesticide Analysis

Station_ID	DCAA-Surr. % recovery	3-5-Dichlorobenzoic_Acid *u* g/L	Dicamba *u* g/L	Dichlorprop *u* g/L	2-4-D *u* g/L	Pentachlorophenol *u* g/L	Silvex *u* g/L	2-4-5-T *u* g/L	Dinoseb *u* g/L	2-4-DB *u* g/L	Bentazon *u* g/L	Picloram *u* g/L
DREW01	99.661	<.01070	<.00517	<.01264	<.01233	<.00576	<.00780	<.00583	<.01228	<.01782	<.00470	<.00766
DREW02	98.676	<.01158	<.01231	<.00798	<.01038	<.00650	<.00925	<.00740	<.01039	<.01885	<.00497	<.00908
DREW03	98.433	<.01604	<.01161	<.01895	<.01643	<.01232	<.01503	<.01403	<.01641	<.03039	<.01132	<.01476
DREW04	108.8	<.00957	<.00809	<.01649	<.00715	<.00793	<.00645	<.00602	<.01056	<.02071	<.00486	<.00633
DESHA01	87.521	<.01029	<.00579	<.01518	<.00658	<.00558	<.00908	<.00848	<.00595	<.01728	<.00342	<.00892
DESHA02	46.993	<.01087	<.00962	<.01605	<.01392	<.01510	<.01228	<.00819	<.01840	<.03130	<.00661	<.01206
LINC01	98.142	<.00764	<.01033	<.01264	<.00822	<.01169	<.00792	<.00739	<.01453	<.02487	0.02511	<.00778
LINC02	24.196	<.10356	<.42600	<.33633	<.11364	<.15931	<.31566	<.09894	<.33347	<.10256	<.14724	<.31000
LINC03	97.73	<.02717	<.03263	<.01872	<.01461	<.01394	<.04722	<.01234	<.04209	<.03775	<.01280	<.04638
ASH01	92.303	<.02789	<.02277	<.04294	<.01144	<.01145	<.01696	<.00874	<.01943	<.01579	<.00628	<.01544
ASH02	98.934	<.02738	<.03896	<.02645	<.01174	<.00629	<.00816	<.00960	<.01246	<.01709	<.00806	<.00742
ASH03	91.986	<.01516	<.01062	<.02478	<.00770	<.00934	<.01345	<.00831	<.01079	<.01315	<.00697	<.01224
ASH04	86.779	<.01467	<.00771	<.02131	<.01490	<.00936	<.01213	<.00952	<.01544	<.01412	0.02401	<.01104
DREW05	94.521	<.01625	<.01387	<.02740	<.01313	<.01120	<.00726	<.00534	<.01664	<.01437	0.24759	<.00661
CHI01	99.702	<.01456	<.01130	<.02187	<.01748	<.00998	<.01869	<.01015	<.01482	<.02209	<.00958	<.01701
CHI02	96.589	<.01951	<.03093	<.03291	<.01709	<.00885	<.01377	<.01081	<.01227	<.01923	<.00680	<.01253
DREW06	99.299	<.11947	<.23382	<.57691	<.09561	<.18061	<.21485	<.11600	<.50100	<.10794	<.12250	<.19553
CHI03	69.587	<.01880	<.01671	<.02496	<.01551	<.01427	<.01918	<.01210	<.03452	<.02870	<.01116	<.01746
CHI04	61.157	<.01791	<.00659	<.02736	<.02285	<.00661	<.01599	<.01512	<.02354	<.08533	<.01269	<.01455
ASH05	78.026	<.00912	<.01831	<.01739	<.02146	<.00340	<.01521	<.01096	<.00654	<.02160	<.00422	<.01082
ASH06	84.632	<.01045	<.00696	<.01006	<.03040	<.00673	<.01160	<.01364	<.00490	<.02965	<.00636	<.00825
ASH07	76.824	<.01471	<.03540	<.02492	<.01021	<.00811	<.01495	<.01154	<.00742	<.01455	0.02358	<.01063
ASH08	88.015	<.01589	<.04972	<.03310	<.02733	<.00989	<.02032	<.01216	<.01599	<.02548	<.00642	<.01445
ASH09	62.155	<.00927	<.01145	<.01760	<.01197	<.00625	<.00844	<.01281	<.00691	<.01058	<.00485	<.00600
ASH10	81.118	<.01946	<.07135	<.03422	<.01730	<.01070	<.01209	<.01549	<.01106	<.01510	<.00284	<.00860
ASH11	88.033	<.01642	<.03989	<.02320	<.01872	<.00954	<.01316	<.01098	<.01114	<.01195	<.00423	<.00936
ASH12	72.449	<.02592	<.09397	<.04782	<.02710	<.00708	<.01904	<.01742	<.01814	<.02306	<.00572	<.01354
ASH13	77.1	<.00942	<.00616	<.01754	<.01418	<.00641	<.01060	<.00983	<.01204	<.01789	<.00624	<.00754
ASH15	71.272	<.01161	<.00775	<.00796	<.01905	<.01241	<.02908	<.00693	<.01122	<.02022	<.00905	<.02068
ASH17	78.341	<.01148	<.00616	<.00786	<.01248	<.00811	<.00687	<.00636	<.00624	<.01473	0.09402	<.00488
ASH18	79.908	<.00923	<.01792	<.02272	<.01697	<.00650	<.01173	<.00886	<.01395	<.03022	0.01384	<.00834
ASH19	77.492	<.01243	<.05045	<.04214	<.02169	<.00634	<.01195	<.01627	<.01006	<.02354	<.00542	<.00850
ASH20	92.285	<.01317	<.01980	<.01453	<.00983	<.00985	<.00825	<.01204	<.01167	<.01137	<.00369	<.00587

Appendix IV - Pesticide Analysis

Station_ID	DCAA-Surr. % recovery	3-5-Dichlorobenzoic_Acid *u* g/L	Dicamba *u* g/L	Dichlorprop *u* g/L	2-4-D *u* g/L	Pentachlorophenol *u* g/L	Silvex *u* g/L	2-4-5-T *u* g/L	Dinoseb *u* g/L	2-4-DB *u* g/L	Bentazon *u* g/L	Picloram *u* g/L
LIN04	82.846	<.01276	<.00995	<.02083	<.02299	<.01154	<.01401	<.00736	<.01311	<.08996	<.00709	<.01060
LIN05	102.89	<.00974	<.00807	<.04190	0.0246	<.01467	<.00960	<.00834	<.01581	<.04244	<.00624	<.00726
LIN06	62.375	<.03137	<.01867	<.04049	<.01943	<.04006	<.02454	<.01967	<.03625	<.09107	<.01748	<.01856
JEF01	90.177	<.02122	<.01199	<.04120	<.01298	<.02409	<.01591	<.01327	<.01818	<.06607	0.05844	<.01203
JEF02	98.789	<.01736	<.01068	<.03143	<.01777	<.02299	<.01769	<.01378	<.02102	<.07747	0.01726	<.01338
JEF03	92.836	<.00899	<.00642	<.01819	<.00967	<.01383	<.01594	<.00807	<.01774	<.04710	<.00615	<.01205
LIN07	72.487	<.01050	<.00847	<.01599	<.01151	<.01858	<.01529	<.00861	<.01665	<.05195	<.00698	<.01156
DESHA03	103.6	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00920	<0.00416	<0.00444
DREW07	105.07	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00920	<0.00416	<0.00444
DREW08	104.05	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00920	<0.00416	<0.00444
DREW09	72.93	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00920	<0.00416	<0.00444
DREW10	101.5	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00920	<0.00416	<0.00444
DREW11	86.06	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00920	<0.00416	<0.00444
DREW12	103.58	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00920	<0.00416	<0.00444
DREW13	94.15	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00920	<0.00416	<0.00444
DREW14	99.4	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00920	<0.00416	<0.00444
DREW15	102.4	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00920	<0.00416	<0.00444
JEF04	112.96	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
JEF05	97.03	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
JEF06	106.41	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
JEF07	83.95	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
JEF08	92.39	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
JEF09	45.53	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	0.03259	<0.00444
JEF10	102.95	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
JEF11	91.67	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
JEF12	92.5	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
JEF13	99.47	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	0.51917	<0.00444
LIN08	81.91	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	0.01762	<0.00444
LIN09	86.85	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
LIN10	93.97	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	0.06884	<0.00444
LIN11	94.47	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	0.0143	<0.00444
LIN12	98.95	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
LIN13	82.16	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444

Appendix IV - Pesticide Analysis

Station_ID	DCAA-Surr. % recovery	3-5-Dichlorobenzoic_Acid *u* g/L	Dicamba *u* g/L	Dichlorprop *u* g/L	2-4-D *u* g/L	Pentachlorophenol *u* g/L	Silvex *u* g/L	2-4-5-T *u* g/L	Dinoseb *u* g/L	2-4-DB *u* g/L	Bentazon *u* g/L	Picloram *u* g/L
LIN14	90.42	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
LIN15	96.9	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
LIN16	41.64	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	0.04351	<0.00444
LIN17	85.25	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	0.00611	<0.00444
DREW16	89.02	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	0.03477	<0.00444
DREW17	86.34	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
DREW18	85.08	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
DREW19	93.81	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
DREW20	93.94	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
DREW21	88.64	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
DREW22	92.96	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
DREW23	91.81	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
DREW24	67.09	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
DREW25	VOID	VOID	VOID	VOID	VOID	VOID	VOID	VOID	VOID	VOID	VOID	VOID
JEF0014	90.25	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
JEF0015	49.51	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
JEF0016	48.04	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
JEF0017	88.27	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
JEF0018	87.56	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
JEF0019	97.87	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
JEF0020	85.34	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
JEF0021	89.57	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
JEF0022	88.85	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	0.04044	<0.00444
JEF0023	76.02	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
LIN18	71.75	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
LIN19	58.46	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
LIN20	70.21	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
LIN21	73.88	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
DREW26	71.74	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
DREW27	65.49	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
DREW28	55.3	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
DREW29	71.17	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
DREW30	75.55	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444

Appendix IV - Pesticide Analysis

Station_ID	DCAA-Surr. % recovery	3-5-Dichlorobenzoic_Acid *u* g/L	Dicamba *u* g/L	Dichlorprop *u* g/L	2-4-D *u* g/L	Pentachlorophenol *u* g/L	Silvex *u* g/L	2-4-5-T *u* g/L	Dinoseb *u* g/L	2-4-DB *u* g/L	Bentazon *u* g/L	Picloram *u* g/L
DREW31	56.52	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
DREW32	66.98	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
DREW33	72.42	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
DREW34	76.43	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
DREW35	77.51	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
DREW36	<0.00323	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
DREW37	VOID	VOID	VOID	VOID	VOID	VOID	VOID	VOID	VOID	VOID	VOID	VOID
DREW38	61.94	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
LINC22	70.53	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	0.00652	<0.00444
LINC23	63.77	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	0.00871	<0.00444
LINC24	65.49	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
ASH0021	64.85	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
ASH0022	64.76	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
ASH0023	70.64	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
ASH0024	69.23	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
ASH0025	65.35	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
ASH0026	63.91	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
ASH0027	64.49	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
ASH0028	63.17	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
ASH0029	68.63	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444
ASH0030	61.69	<0.00402	<0.00453	<0.00954	<0.00622	<0.00388	<0.00567	<0.00312	<0.00714	<0.00921	<0.00416	<0.00444

Appendix IV - Pesticide Analysis

Station_ID	Acifluorfen *u* g/L	Nitrobenzene-d5 % recovery	2-Fluorobiphenyl % recovery	Terphenyl-d14 % recovery	Molinate *u* g/L	Propachlor *u* g/L	Trifluralin *u* g/L	Alpha-BHC *u* g/L	Atraton *u* g/L	Prometon *u* g/L	Simazine *u* g/L	Atrazine *u* g/L
DREW01	<.01494	78.267	90.408	88.999	<.00487	<.00853	<.00670	<.01505	0.0214	0.017	<.02658	<.00563
DREW02	<.01264	90.291	106.51	83.736	<.01513	<.00766	<.01015	<.00768	<.01020	<.01156	<.01133	<.00623
DREW03	<.02397	88.249	106.41	78.77	<.01488	<.01132	<.00477	<.00993	<.01601	<.00703	<.02230	<.01107
DREW04	<.01157	80.463	95.531	90.147	<.00762	<.00656	<.00991	<.00858	<.00968	<.00964	<.02917	<.00478
DESHA01	<.01811	75.234	93.221	84.346	<.01422	<.00527	<.01077	<.01129	<.00754	<.01045	<.03558	<.01501
DESHA02	<.02099	74.379	88.502	81.874	<.00537	<.00711	<.00995	<.00559	<.01619	<.01104	<.02099	<.01972
LINC01	<.01895	80.852	88.609	83.459	<.00983	<.00691	<.00420	<.00841	<.01139	<.01131	<.02845	<.02410
LINC02	<.33256	86.208	79.438	79.863	<.01025	<.00566	<.01004	<.00905	<.01532	<.01141	<.01917	<.01513
LINC03	<.03616	83.423	81.244	86.245	<.00663	<.00714	<.00650	<.01342	<.00983	<.00544	<.02834	<.00866
ASH01	<.01936	85.468	86.617	85.484	<.00715	<.01326	<.00541	<.07786	<.02085	<.02143	<.04318	<.01397
ASH02	<.01330	93.896	87.557	75.616	<.00322	<.00624	<.00534	<.01003	<.00637	<.00825	<.01917	<.00569
ASH03	<.01316	97.516	87.958	75.242	<.00448	<.00587	<.00666	<.06077	<.01028	<.03086	<.01571	<.00597
ASH04	<.01846	79.784	93.176	68.964	<.00811	<.00601	<.00415	<.04746	<.00610	<.01704	<.02583	<.00646
DREW05	<.01184	88.848	87.918	83.131	<.00544	<.00867	<.00518	<.07058	<.00682	<.02588	<.02373	<.00517
CHI01	<.01407	95.5	102.82	88.314	<.00675	<.01128	<.00469	<.09017	<.00976	<.03245	<.01835	<.00711
CHI02	<.02695	102.72	86.655	83.686	<.00583	<.00698	<.00378	<.07033	<.01071	<.02138	<.03183	<.00322
DREW06	<.28434	101.07	88.816	74.434	<.00679	<.00513	<.00621	<.06555	<.01095	<.03102	<.02532	<.00580
CHI03	<.02681	97.743	83.718	88.611	<.00494	<.00914	<.00842	<.07060	<.01879	<.03218	<.02174	<.01308
CHI04	<.03129	98.45	90.086	84.361	<.00448	<.00951	<.00699	<.05764	<.01075	<.02730	<.02217	<.01183
ASH05	<.01252	88.726	85.046	89.125	<.00490	<.03304	<.00203	<.01193	<.01728	<.01206	<.01839	<.00557
ASH06	<.01519	82.861	77.31	73.79	<.00436	<.03735	<.00077	<.00369	<.00374	<.00803	<.01231	<.00344
ASH07	<.02177	86.49	71.026	70.132	<.00460	<.03457	<.00143	<.00733	<.00909	<.00576	<.01039	<.00285
ASH08	<.02257	74.139	82.551	83.75	<.00160	<.02336	<.00100	<.00607	<.00645	<.00920	<.00936	<.00344
ASH09	<.01485	77.626	83.914	83.15	<.00371	<.01736	<.00132	<.00447	<.00603	<.00769	<.01204	<.00330
ASH10	<.01086	82.657	85.703	88.913	<.00435	<.01855	<.00103	<.02069	<.00874	<.00656	<.00972	<.00382
ASH11	<.01343	77.834	78.706	80.141	<.00400	<.01750	<.00113	<.00626	<.00911	<.00667	<.00881	<.00267
ASH12	<.01398	74.812	87.203	73.909	<.00479	<.02130	<.00101	<.00575	<.00635	<.00597	<.00845	<.00347
ASH13	<.01047	95.079	93.898	102.3	<.00291	<.00561	<.00042	<.01279	<.00623	<.00778	<.02063	<.00485
ASH15	<.01476	80.817	92.961	93.604	<.00480	<.00545	<.00036	<.01001	<.00627	<.00556	<.02434	<.00399
ASH17	<.00859	99.713	90.441	93.898	<.00435	<.00501	<.00047	<.01033	<.00544	<.00554	<.01422	<.00410
ASH18	<.01217	96.241	94.056	93.835	<.00382	<.00510	<.00048	<.01299	<.00689	<.00602	<.01439	<.00537
ASH19	<.01657	95.504	82.641	89.095	<.00360	<.00295	<.00057	<.00532	<.00305	<.00528	<.01078	<.00252
ASH20	<.01711	96.992	96.229	99.424	<.00276	<.00300	<.00042	<.00683	<.00402	<.00664	<.01300	<.00269

Appendix IV - Pesticide Analysis

Station_ID	Acifluorfen *u* g/L	Nitrobenzene-d5 % recovery	2-Fluorobiphenyl % recovery	Terphenyl-d14 % recovery	Molinate *u* g/L	Propachlor *u* g/L	Trifluralin *u* g/L	Alpha-BHC *u* g/L	Atraton *u* g/L	Prometon *u* g/L	Simazine *u* g/L	Atrazine *u* g/L
LIN04	<.01908	84.685	98.661	104.14	<.00405	<.00517	<.00104	<.00565	<.00257	<.00486	<.00983	<.00335
LIN05	<.02061	85.185	94.344	100.96	<.00309	<.00330	<.00108	<.00424	<.00371	<.00472	<.01202	<.00307
LIN06	<.04919	104.65	82.643	100.48	<.00367	<.00672	<.00188	<.00761	<.00523	<.00673	<.01839	<.00454
JEF01	<.02605	101.85	98.682	99.57	<.00366	<.00416	<.00153	<.00727	<.00417	<.00500	<.01360	<.00318
JEF02	<.03678	102.78	96.192	100.79	<.00263	<.00352	<.00114	<.00679	<.00358	<.00547	<.01213	<.00277
JEF03	<.01968	84.164	92.356	107.61	<.00353	<.00390	<.00113	<.00526	<.00319	<.00399	<.01260	<.00266
LIN07	<.02238	89.292	83.735	94.623	<.00264	<.00322	<.00138	<.00560	<.00375	<.00525	<.01191	<.00291
DESHA03	<0.01075	99.83	84.38	79.72	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
DREW07	<0.01075	83.19	70.43	84.76	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
DREW08	<0.01075	91.16	77	87.59	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
DREW09	<0.01075	89.9	76.82	83.36	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
DREW10	<0.01075	84.74	68.49	83.12	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
DREW11	<0.01075	85.9	73.33	78.8	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
DREW12	<0.01075	82.38	77.11	79.69	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
DREW13	<0.01075	91.4	77.01	83.05	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
DREW14	<0.01075	80.56	68.65	80.84	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
DREW15	<0.01075	82.33	73.11	77.54	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
JEF04	<0.01075	73.68	69.01	74.53	<0.00227	<0.00217	<0.00162	<0.00106	0.01883	0.02001	<0.00202	<0.0016
JEF05	<0.01075	80.05	75.94	73.72	<0.00227	<0.00217	<0.00162	<0.00106	0.01211	<0.00171	<0.00202	<0.0016
JEF06	<0.01075	88.64	77.17	62.65	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
JEF07	<0.01075	86.277	70.59	67.713	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
JEF08	<0.01075	81.81	75.9	77.91	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
JEF09	<0.01075	82.87	80.92	77.28	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
JEF10	<0.01075	76.98	70.06	81.95	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
JEF11	<0.01075	99.1	86.39	76.78	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
JEF12	<0.01075	81.98	77.01	78.42	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
JEF13	<0.01075	86.23	72.29	76.14	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
LIN08	<0.01075	82.78	90.48	81.51	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
LIN09	<0.01075	75.03	78	73.49	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
LIN10	<0.01075	71.84	81.43	79.87	0.04764	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
LIN11	<0.01075	72.54	69.94	67.85	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
LIN12	<0.01075	76.47	70.13	63.57	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
LIN13	<0.01075	87.49	90.18	80.33	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016

Appendix IV - Pesticide Analysis

Station_ID	Acifluorfen *u* g/L	Nitrobenzene-d5 % recovery	2-Fluorobiphenyl % recovery	Terphenyl-d14 % recovery	Molinate *u* g/L	Propachlor *u* g/L	Trifluralin *u* g/L	Alpha-BHC *u* g/L	Atraton *u* g/L	Prometon *u* g/L	Simazine *u* g/L	Atrazine *u* g/L
LIN14	<0.01075	65.69	65.44	75.3	0.48586	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
LIN15	<0.01075	86.96	85.41	75.41	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
LIN16	<0.01075	66.24	66.99	71.87	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
LIN17	<0.01075	76.02	78.74	75.44	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
DREW16	<0.01075	64.58	63.56	71.65	<0.00227	<0.00217	<0.00162	<0.00106	0.01116	0.02277	<0.00202	<0.0016
DREW17	<0.01075	61.76	57.38	68	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
DREW18	<0.01075	72.74	61.75	70.14	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
DREW19	<0.01075	79.44	77.61	79.59	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
DREW20	<0.01075	69.54	67.45	75.44	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
DREW21	<0.01075	69.94	58.01	68.79	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
DREW22	<0.01075	74.48	67.56	75.93	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
DREW23	<0.01075	64.63	58.07	71.13	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
DREW24	<0.01075	68.97	65.35	69.54	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
DREW25	VOID	77.23	78.07	68.15	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
JEF0014	<0.01075	61.17	66.81	67.07	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
JEF0015	<0.01075	67.97	66.45	70.66	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
JEF0016	<0.01075	69.22	65.9	65.98	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
JEF0017	<0.01075	70.34	63.85	63.92	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
JEF0018	<0.01075	68.42	67.53		<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
JEF0019	<0.01075	60.82	61.13	68.01	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
JEF0020	<0.01075	52.69	56.38	59.4	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
JEF0021	<0.01075	58.93	58.08	65.37	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
JEF0022	<0.01075	55.01	58.12	64.37	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
JEF0023	<0.01075	62.38	59.67	58.03	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
LIN18	<0.01075	73.9	76.59	60.42	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
LIN19	<0.01075	63.37	59.02	62.69	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
LIN20	<0.01075	61.75	63.48	61.1	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
LIN21	0.264731	74.86	66.01	64.93	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
DREW26	<0.01075	80.01	69.97	63.81	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
DREW27	<0.01075	59.49	54.82	62.91	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
DREW28	<0.01075	67.01	61.42	63.94	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
DREW29	<0.01075	51.34	56.13	61.7	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
DREW30	<0.01075	53.56	53.82	63.62	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016

Appendix IV - Pesticide Analysis

Station_ID	Acifluorfen *u* g/L	Nitrobenzene-d5 % recovery	2-Fluorobiphenyl % recovery	Terphenyl-d14 % recovery	Molinate *u* g/L	Propachlor *u* g/L	Trifluralin *u* g/L	Alpha-BHC *u* g/L	Atraton *u* g/L	Prometon *u* g/L	Simazine *u* g/L	Atrazine *u* g/L
DREW31	<0.01075	68.63	67.28	60.82	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	0.01511	<0.0016
DREW32	<0.01075	60.95	58.62	57.82	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
DREW33	<0.01075	54.4	60.26	64.62	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
DREW34	<0.01075	59.87	56.03	62.88	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
DREW35	<0.01075	61.55	69.03	56.19	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
DREW36	<0.01075	59.83	62.61	55.06	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
DREW37	VOID	55.44	58.58	60.36	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
DREW38	<0.01075	64.63	69.27	53.14	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
LINC22	<0.01075	63.69	70.61	57.65	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
LINC23	<0.01075	63.36	69.08	52.31	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
LINC24	<0.01075	58.76	60.63	56.9	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
ASH0021	<0.01075	37.78	40.46	55.92	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
ASH0022	<0.01075	59.24	64.18	56.59	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
ASH0023	<0.01075	49.34	53.43	58.08	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
ASH0024	<0.01075	46.28	49.98	56.11	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
ASH0025	<0.01075	50.73	56.96	56.01	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
ASH0026	<0.01075	61.48	62.31	58.84	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
ASH0027	<0.01075	49.01	53.24	55.05	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
ASH0028	<0.01075	0.3689	0.379992	0.396125	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
ASH0029	<0.01075	58.73	57.92	56.4	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016
ASH0030	<0.01075	57.29	58.86	56.18	<0.00227	<0.00217	<0.00162	<0.00106	<0.00318	<0.00171	<0.00202	<0.0016

Appendix IV - Pesticide Analysis

Station_ID	Propazine *u* g/L	Beta-BHC *u* g/L	Gamma-BHC *u* g/L	Terbuthylazine *u* g/L	Diazinon *u* g/L	Fluchloralin *u* g/L	Fonofos *u* g/L	Delta-BHC *u* g/L	Cyprazine *u* g/L	Metribuzin *u* g/L	Methyl-Parathion *u* g/L	Alachlor *u* g/L
DREW01	<.00548	<.01737	<.01479	<.06832	<.01483	<.00948	<.01143	<.01832	<.00723	<.00654	<.00521	<.00613
DREW02	<.00730	<.00887	<.00755	<.03375	<.01326	<.01150	<.01472	<.00936	<.00785	<.01248	<.00456	<.01017
DREW03	<.00950	<.01147	<.00976	<.08242	<.01752	<.00666	<.01320	<.01210	<.01002	<.01544	<.01575	<.01273
DREW04	<.01108	<.00991	<.00843	<.10152	<.00682	<.01419	<.01008	<.01045	<.01030	<.01245	<.01251	<.00580
DESHA01	<.00798	<.01303	<.01109	<.08281	<.01453	<.01696	<.00555	<.01374	<.01073	<.01272	<.01278	<.00612
DESHA02	<.01226	<.00646	<.00550	<.06997	<.01428	<.01554	<.01681	<.00681	<.00598	<.01270	<.01669	<.00915
LINC01	<.00928	<.00971	<.00827	<.07578	<.01358	<.00625	<.01844	<.01025	<.01161	<.01159	<.02013	<.00727
LINC02	<.01446	<.01045	<.00890	<.06259	<.01070	<.01606	<.00841	<.01102	<.00746	<.01566	<.01243	<.00760
LINC03	<.00501	<.01550	<.01319	<.06121	<.00985	<.01071	<.00700	<.01634	<.00758	<.01064	<.00927	<.00903
ASH01	<.01230	<.08037	<.08033	<.06352	<.01963	<.00693	<.01210	<.09499	<.00510	<.01140	<.01078	<.00864
ASH02	<.00392	<.01035	<.01034	<.02875	<.01715	<.00717	<.01073	<.01223	<.00307	<.00393	<.00911	<.00333
ASH03	<.00681	<.06272	<.06269	<.07098	<.01418	<.00969	<.01069	<.07414	<.00638	<.01087	<.00920	<.00579
ASH04	<.00582	<.04899	<.04897	<.02499	<.01381	<.00494	<.00866	<.05791	<.00409	<.00630	<.00489	<.00416
DREW05	<.00393	<.07285	<.07282	<.03986	<.01067	<.00738	<.00806	<.08611	<.00777	<.00571	<.00747	<.00481
CHI01	<.00908	<.09307	<.09303	<.02873	<.01834	<.00622	<.00968	<.11001	<.01113	<.00903	<.01179	<.00532
CHI02	<.00671	<.07260	<.07256	<.02736	<.01936	<.00521	<.00774	<.08581	<.00645	<.00767	<.00788	<.00520
DREW06	<.00709	<.06766	<.06762	<.03736	<.02014	<.00873	<.01233	<.07997	<.00747	<.00951	<.00566	<.00687
CHI03	<.00985	<.07287	<.07284	<.03605	<.01814	<.01327	<.00856	<.08613	<.00946	<.02198	<.01257	<.00880
CHI04	<.00705	<.05950	<.05947	<.04278	<.01470	<.01008	<.01320	<.07033	<.00726	<.01362	<.01028	<.00499
ASH05	<.00505	<.01514	<.01302	<.02552	<.01247	<.00435	<.00969	<.01710	<.00431	<.00577	<.00725	<.00605
ASH06	<.00178	<.00468	<.00403	<.01040	<.00786	<.00132	<.00551	<.00529	<.00295	<.00396	<.00401	<.00371
ASH07	<.00347	<.00931	<.00800	<.01507	<.00569	<.00229	<.00921	<.01051	<.00274	<.00414	<.00424	<.00361
ASH08	<.00385	<.00770	<.00663	<.02139	<.00836	<.00177	<.00801	<.00870	<.00219	<.00441	<.00390	<.00231
ASH09	<.00220	<.00567	<.00487	<.00983	<.00841	<.00228	<.00428	<.00640	<.00172	<.00420	<.00317	<.00440
ASH10	<.00143	<.02625	<.02257	<.01366	<.00831	<.00176	<.00410	<.02965	<.00290	<.00341	<.00387	<.00280
ASH11	<.00166	<.00795	<.00684	<.01007	<.00788	<.00209	<.00534	<.00898	<.00361	<.00461	<.00290	<.00217
ASH12	<.00246	<.00729	<.00627	<.00966	<.00651	<.00160	<.00418	<.00824	<.00231	<.00354	<.00352	<.00533
ASH13	<.00524	<.01452	<.01307	<.01735	<.01286	<.00071	<.00781	<.01504	<.00327	<.00546	<.00326	<.00557
ASH15	<.00480	<.01136	<.01023	<.02236	<.01591	<.00060	<.00618	<.01177	<.00397	<.00982	<.00468	<.00605
ASH17	<.00352	<.01173	<.01056	<.01936	<.00691	<.00074	<.00637	<.01215	<.00327	<.00446	<.00355	<.00455
ASH18	<.00459	<.01475	<.01328	<.02056	<.00964	<.00078	<.00549	<.01528	<.00334	<.05436	<.00311	<.00506
ASH19	<.00284	<.00604	<.00544	<.01263	<.00634	<.00100	<.00572	<.00625	<.00228	<.00535	<.00201	<.00563
ASH20	<.00323	<.00775	<.00698	<.01974	<.00921	<.00060	<.00522	<.00803	<.00200	<.00369	<.00320	<.00475

Appendix IV - Pesticide Analysis

Station_ID	Propazine *u* g/L	Beta-BHC *u* g/L	Gamma-BHC *u* g/L	Terbuthylazine *u* g/L	Diazinon *u* g/L	Fluchloralin *u* g/L	Fonofos *u* g/L	Delta-BHC *u* g/L	Cyprazine *u* g/L	Metribuzin *u* g/L	Methyl-Parathion *u* g/L	Alachlor *u* g/L
LIN04	<.00197	<.00577	<.00561	<.01238	<.00771	<.00174	<.00655	<.00707	<.00197	<.00628	<.00336	<.00233
LIN05	<.00304	<.00433	<.00421	<.01770	<.00869	<.00201	<.00845	<.00531	<.00254	<.00600	<.00303	<.00283
LIN06	<.00298	<.00777	<.00757	<.01692	<.00909	<.00343	<.00899	<.00953	<.00305	<.00524	<.00524	<.00348
JEF01	<.00256	<.00742	<.00722	<.02193	<.00857	<.00264	<.00608	<.00910	<.00323	<.00581	<.00562	<.00340
JEF02	<.00238	<.00691	<.00665	<.02079	<.00928	<.00188	<.00456	<.00850	<.00264	<.00465	<.00307	<.00235
JEF03	<.00212	<.00535	<.00515	<.02048	<.00648	<.00159	<.00514	<.00658	<.00272	<.00404	<.00303	<.00303
LIN07	<.00237	<.00570	<.00549	<.02209	<.00902	<.00215	<.00487	<.00702	<.00271	<.00502	<.00357	<.00317
DESHA03	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
DREW07	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
DREW08	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
DREW09	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
DREW10	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
DREW11	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
DREW12	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
DREW13	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
DREW14	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
DREW15	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
JEF04	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
JEF05	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
JEF06	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
JEF07	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
JEF08	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
JEF09	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
JEF10	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
JEF11	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
JEF12	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
JEF13	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
LIN08	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
LIN09	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
LIN10	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
LIN11	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
LIN12	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
LIN13	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018

Appendix IV - Pesticide Analysis

Station_ID	Propazine *u* g/L	Beta-BHC *u* g/L	Gamma-BHC *u* g/L	Terbuthylazine *u* g/L	Diazinon *u* g/L	Fluchloralin *u* g/L	Fonofos *u* g/L	Delta-BHC *u* g/L	Cyprazine *u* g/L	Metribuzin *u* g/L	Methyl-Parathion *u* g/L	Alachlor *u* g/L
LIN14	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
LIN15	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
LIN16	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
LIN17	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
DREW16	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
DREW17	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
DREW18	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
DREW19	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
DREW20	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
DREW21	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
DREW22	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
DREW23	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
DREW24	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
DREW25	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
JEF0014	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
JEF0015	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
JEF0016	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
JEF0017	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
JEF0018	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
JEF0019	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
JEF0020	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
JEF0021	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
JEF0022	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
JEF0023	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
LIN18	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
LIN19	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
LIN20	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
LIN21	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
DREW26	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
DREW27	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
DREW28	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
DREW29	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
DREW30	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018

Appendix IV - Pesticide Analysis

Station_ID	Propazine *u* g/L	Beta-BHC *u* g/L	Gamma-BHC *u* g/L	Terbuthylazine *u* g/L	Diazinon *u* g/L	Fluchloralin *u* g/L	Fonofos *u* g/L	Delta-BHC *u* g/L	Cyprazine *u* g/L	Metribuzin *u* g/L	Methyl-Parathion *u* g/L	Alachlor *u* g/L
DREW31	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
DREW32	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
DREW33	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
DREW34	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
DREW35	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
DREW36	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
DREW37	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
DREW38	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
LINC22	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
LINC23	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
LINC24	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
ASH0021	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
ASH0022	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
ASH0023	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
ASH0024	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
ASH0025	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
ASH0026	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
ASH0027	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
ASH0028	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
ASH0029	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018
ASH0030	<0.00179	<0.0034	<0.00072	<0.0042	<0.00343	<0.00172	<0.00181	<0.00252	<0.00132	<0.00298	<0.00174	<0.0018

Appendix IV - Pesticide Analysis

Station_ID	Ametryn *u* g/L	Prometryn *u* g/L	Heptachlor *u* g/L	Terbutryn *u* g/L	Metolachlor *u* g/L	Malathion *u* g/L	Dipropetryn *u* g/L	Chlorpyrifos *u* g/L	Cyanazine *u* g/L	Aldrin *u* g/L	Pendimethalin *u* g/L	Heptachlor-Epoxide *u* g/L
DREW01	<.00484	<.00676	<.00659	<.00365	<.00376	<.01631	<.00627	<.01651	<.01006	<.01232	<.00772	<.02526
DREW02	<.01442	<.01081	<.01177	<.00525	<.00533	<.01377	<.01460	<.01082	<.00718	<.01078	<.00597	<.02647
DREW03	<.01509	<.01173	<.01098	<.01245	<.00480	<.01934	<.01363	<.01537	<.02084	<.03722	0.01346	<.02549
DREW04	<.01343	<.00760	<.01106	<.01236	<.00582	<.02046	<.01457	<.03138	<.01928	<.02955	<.00776	<.02792
DESHA01	<.01756	<.01142	<.00873	<.01373	<.00322	<.02012	<.00804	<.03702	<.01398	<.03021	<.00990	<.04048
DESHA02	<.00625	<.00926	<.00991	<.01073	<.00747	<.01730	<.00658	<.01996	<.01687	<.03944	<.00448	<.03249
LINC01	<.01434	<.01724	<.00979	<.00874	<.00659	<.02624	<.01175	<.03041	<.01354	<.04757	<.01491	<.03097
LINC02	<.00979	<.01804	<.00929	<.01031	<.00310	<.01954	<.00593	<.03181	<.00981	<.02938	<.00371	<.03064
LINC03	<.00800	<.00772	<.00379	<.01075	<.00381	<.01267	<.01131	<.01530	<.01803	<.02189	<.00434	<.02207
ASH01	<.01032	<.00789	<.01460	<.00487	<.00568	0.04071	<.00533	<.01343	<.01227	<.02308	<.00634	<.02015
ASH02	<.00596	<.00462	<.00619	<.00420	<.00253	0.00939	<.00780	<.00450	<.01489	<.01951	<.00681	<.01054
ASH03	<.00556	<.01011	<.00629	<.00800	<.00250	<.01007	<.00709	<.01618	<.01673	<.01970	<.00501	<.02623
ASH04	<.00517	<.00502	<.00814	<.00405	<.00213	0.06224	<.00487	<.00624	<.00824	<.01048	<.00460	<.01032
DREW05	<.00681	<.00695	<.00529	<.00376	<.00233	0.06457	<.00501	<.01546	<.01519	<.01601	<.00670	<.00888
CHI01	<.01109	<.00957	<.01164	<.00555	<.00320	<.01804	<.00951	<.01348	<.01488	<.02525	<.00804	<.02022
CHI02	<.01435	<.00958	<.00468	<.00385	<.00358	0.0846	<.00579	<.01192	<.00709	<.01688	<.00801	<.01163
DREW06	<.00924	<.00660	<.00938	<.00552	<.00277	<.01298	<.01231	<.01284	<.00945	<.01212	<.00807	<.01330
CHI03	<.00583	<.00809	<.00970	<.00703	<.00407	0.04759	<.00782	<.02567	<.01067	<.02693	<.00910	<.02606
CHI04	<.01133	<.00912	<.01108	<.00759	<.00372	<.00984	<.00907	<.02076	<.01636	<.02201	<.00719	<.02646
ASH05	<.00662	<.00480	<.01727	<.00657	<.00403	0.05268	<.01054	<.01077	<.02009	<.01398	<.00589	<.00814
ASH06	<.00241	<.00282	<.00703	<.00402	<.00301	<.01420	<.00378	<.00311	<.00870	<.00774	<.00302	<.00388
ASH07	<.00366	<.00197	<.00525	<.00296	<.00439	<.01149	<.00365	<.00458	<.01040	<.00817	<.00188	<.00272
ASH08	<.00337	<.00349	<.00799	<.00433	<.00445	<.01482	<.00795	<.00518	<.01022	<.00751	<.00277	<.00497
ASH09	<.00335	0.44015	<.00662	<.00304	<.00245	0.0112	<.00397	<.00523	<.00804	<.00610	<.00200	<.00355
ASH10	<.00211	0.04956	<.01799	<.00313	<.00306	<.01086	<.00459	<.00393	<.01354	<.00746	<.00254	<.00412
ASH11	<.00200	0.01099	<.00376	<.00241	<.00301	<.01222	<.00505	<.00430	<.00842	<.00558	<.00240	<.00351
ASH12	<.00256	<.00284	<.00818	<.00249	<.00237	0.05092	<.00451	<.00523	<.00808	<.00678	<.00261	<.00412
ASH13	<.00560	<.00349	<.00677	<.00328	<.00169	0.09814	<.00624	<.00710	<.01118	<.00761	<.00262	<.00263
ASH15	<.00433	<.00448	<.00489	<.00281	<.00139	<.00837	<.00464	<.00513	<.01174	<.01092	<.00256	<.00148
ASH17	<.00617	<.00301	<.00398	<.00212	<.00224	<.00580	<.00368	<.00740	<.00635	<.00829	<.00173	<.00137
ASH18	<.00364	<.00280	<.00614	0.12721	<.00213	<.01163	<.00403	<.00628	<.00871	<.00727	<.00270	<.00109
ASH19	<.00360	<.00436	<.00236	<.00128	<.00157	<.00374	<.00320	<.00450	<.00431	<.00470	<.00267	<.00260
ASH20	<.00250	<.00274	<.00474	<.00206	<.00114	<.00762	<.00294	<.00549	<.00549	<.00748	<.00358	<.00187

Appendix IV - Pesticide Analysis

Station_ID	Ametryn *u* g/L	Prometryn *u* g/L	Heptachlor *u* g/L	Terbutryn *u* g/L	Metolachlor *u* g/L	Malathion *u* g/L	Dipropetryn *u* g/L	Chlorpyrifos *u* g/L	Cyanazine *u* g/L	Aldrin *u* g/L	Pendimethalin *u* g/L	Heptachlor-Epoxide *u* g/L
LIN04	<.00248	<.00270	<.00569	<.00209	<.00158	<.00535	<.00345	<.00581	<.00580	<.00599	<.00233	<.00487
LIN05	<.00317	<.00200	<.00442	<.00395	<.00124	<.00515	<.00484	<.00565	<.00613	<.00541	<.00360	<.00473
LIN06	<.00392	<.00388	<.00554	<.00410	<.00277	<.01622	<.00615	<.00887	<.00820	<.00935	<.00443	<.00826
JEF01	<.00354	<.00390	<.00594	<.00305	<.00220	<.00530	<.00437	<.00734	<.00524	<.01003	<.00293	<.00846
JEF02	<.00261	<.00357	<.00460	<.00226	<.00149	<.00409	<.00648	<.00516	0.00998	<.00574	<.00242	<.00318
JEF03	<.00208	<.00285	<.00490	<.00257	<.00159	<.00453	<.00401	<.00434	<.00631	<.00568	<.00268	<.00495
LIN07	<.00287	<.00385	<.00499	<.00207	<.00200	<.00373	<.00395	<.00630	<.00453	<.00669	<.00310	<.00615
DESHA03	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
DREW07	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
DREW08	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	0.05373	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
DREW09	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	0.06117	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
DREW10	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	0.049034	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
DREW11	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
DREW12	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
DREW13	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
DREW14	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
DREW15	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
JEF04	0.01604	0.01226	<0.00309	0.00807	<0.00126	<0.00179	0.021726	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
JEF05	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
JEF06	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
JEF07	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
JEF08	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
JEF09	<0.0014	<0.00157	<0.00309	<0.00176	0.007314	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
JEF10	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
JEF11	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
JEF12	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	
JEF13	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
LIN08	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
LIN09	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
LIN10	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
LIN11	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
LIN12	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
LIN13	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274

Appendix IV - Pesticide Analysis

Station_ID	Ametryn *u* g/L	Prometryn *u* g/L	Heptachlor *u* g/L	Terbutryn *u* g/L	Metolachlor *u* g/L	Malathion *u* g/L	Dipropetryn *u* g/L	Chlorpyrifos *u* g/L	Cyanazine *u* g/L	Aldrin *u* g/L	Pendimethalin *u* g/L	Heptachlor-Epoxide *u* g/L
LIN14	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
LIN15	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
LIN16	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
LIN17	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
DREW16	<0.0014	0.004102	<0.00309	<0.00176	<0.00126	<0.00179	0.017112	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
DREW17	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
DREW18	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
DREW19	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
DREW20	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
DREW21	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
DREW22	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
DREW23	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
DREW24	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
DREW25	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
JEF0014	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
JEF0015	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
JEF0016	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
JEF0017	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
JEF0018	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
JEF0019	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
JEF0020	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	0.011311	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
JEF0021	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
JEF0022	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
JEF0023	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	0.00971	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
LIN18	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
LIN19	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
LIN20	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
LIN21	<0.0014	<0.00157	<0.00309	<0.00176	0.111891	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
DREW26	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
DREW27	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
DREW28	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
DREW29	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
DREW30	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274

Appendix IV - Pesticide Analysis

Station_ID	Ametryn *u* g/L	Prometryn *u* g/L	Heptachlor *u* g/L	Terbutryn *u* g/L	Metolachlor *u* g/L	Malathion *u* g/L	Dipropetryn *u* g/L	Chlorpyrifos *u* g/L	Cyanazine *u* g/L	Aldrin *u* g/L	Pendimethalin *u* g/L	Heptachlor-Epoxide *u* g/L
DREW31	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
DREW32	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
DREW33	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
DREW34	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
DREW35	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
DREW36	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
DREW37	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
DREW38	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
LINC22	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
LINC23	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
LINC24	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	0.013383	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
ASH0021	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
ASH0022	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
ASH0023	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
ASH0024	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
ASH0025	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
ASH0026	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
ASH0027	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
ASH0028	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
ASH0029	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274
ASH0030	<0.0014	<0.00157	<0.00309	<0.00176	<0.00126	<0.00179	<0.00176	<0.00298	<0.00445	<0.00314	<0.00195	<0.00274

Appendix IV - Pesticide Analysis

Station_ID	Endosulfan-I *u* g/L	p-p'-DDE *u* g/L	Dieldrin *u* g/L	Endrin *u* g/L	Endosulfan-II *u* g/L	p-p'-DDD *u* g/L	Endosulfan-Sulfate *u* g/L	p-p'-DDT *u* g/L	Hexazinone *u* g/L	Methoxychlor *u* g/L	PCB-as-AR1221 *u* g/L
DREW01	<.10733	<.01314	<.03568	<.01762	<.12648	<.00196	<.02066	<.00267	<.00323	<.00210	<.01699
DREW02	<.22245	<.00518	<.03260	<.01559	<.06815	<.00304	<.02576	<.00413	<.00554	<.00632	<.02819
DREW03	<.18727	<.01485	<.04745	<.04972	<.22926	<.00317	<.02845	<.00431	<.00595	<.00611	<.03531
DREW04	<.18192	<.01072	<.04468	<.03954	<.07016	<.00687	<.03743	<.00933	<.00320	<.00545	<.01609
DESHA01	<.07722	<.01309	<.04477	<.04228	<.02738	<.00245	<.03007	<.00332	<.00526	<.00745	<.01696
DESHA02	<.10933	<.01032	<.06244	<.05093	<.04850	<.00622	<.02828	<.00846	<.00789	<.00245	<.02537
LINC01	<.15602	<.00591	<.03806	<.06349	<.10278	<.00471	<.04282	<.00640	<.01269	<.00580	<.02016
LINC02	<.16322	<.01173	<.04825	<.03676	<.05222	<.00369	<.03794	<.00502	<.00425	<.00371	<.02109
LINC03	<.18642	<.00959	<.03165	<.02879	<.04302	<.00273	<.01991	<.00371	<.00534	<.00319	<.02504
ASH01	<.13581	<.00500	<.04332	<.03864	<.15916	<.00503	<.01775	<.00639	<.00945	<.00404	<.02548
ASH02	<.14515	<.00324	<.02196	<.02815	<.10304	<.00238	<.01155	<.00303	<.00286	<.00201	<.00982
ASH03	<.10337	<.00746	<.02152	<.02931	<.10909	<.00249	<.01136	<.00316	<.00565	<.00193	<.01707
ASH04	<.08247	<.00247	<.03108	<.01657	<.11537	<.00255	<.00995	<.00324	<.00460	<.00191	<.01227
DREW05	<.14137	<.00449	<.03250	<.02785	<.13209	<.00455	<.01156	<.00578	<.00582	<.00277	<.01418
CHI01	<.09624	<.01002	<.06081	<.04190	<.12549	<.00187	<.01556	<.00238	<.00637	<.00430	<.01570
CHI02	<.14874	<.00660	<.03051	<.02802	<.13542	<.00275	<.01091	<.00349	<.00974	<.00557	<.01533
DREW06	<.16882	<.00811	<.04494	<.01983	<.11182	<.00381	<.01188	<.00484	<.00399	<.00353	<.02025
CHI03	<.23500	<.00920	<.04943	<.04136	<.12505	<.00576	<.01491	<.00732	<.00944	<.00209	<.02595
CHI04	<.10722	<.01228	<.03438	<.03372	<.09222	<.00412	<.01268	<.00523	<.00917	<.00406	<.01472
ASH05	<.18188	<.00316	<.09063	<.07359	<.13256	<.00490	<.01715	<.00437	<.02679	<.00287	<.01231
ASH06	<.07744	<.00087	<.02639	<.02904	<.03555	<.00095	<.00232	<.00084	<.00940	<.00075	<.00755
ASH07	<.10020	<.00151	<.03423	<.03258	<.05433	<.00126	<.00427	<.00112	<.00882	<.00121	<.00735
ASH08	<.13174	<.00146	<.03080	<.02956	<.05841	<.00295	<.00571	<.00263	<.00881	<.00109	<.00470
ASH09	<.11841	<.00088	<.03005	<.02550	<.03505	<.00156	<.00557	<.00139	<.00633	<.00115	<.00895
ASH10	<.08883	<.00145	<.02424	<.03232	<.05080	<.00187	<.00535	<.00167	<.01165	<.00076	<.00570
ASH11	<.07830	<.00151	<.02344	<.02243	<.04338	<.00112	<.00392	<.00100	<.01114	<.00066	<.00442
ASH12	<.09918	<.00092	<.02094	<.02957	<.07302	<.00163	<.00490	<.00146	<.00973	<.00092	<.01084
ASH13	<.05139	<.00034	<.01862	<.02140	<.06445	<.00226	<.00409	<.00182	<.01083	<.00174	<.01309
ASH15	<.05796	?.00910	<.01995	<.03201	<.06167	<.00331	<.00148	<.00265	<.01272	<.00140	<.01423
ASH17	<.07441	<.00047	<.01785	<.02353	<.04647	<.00157	<.00562	<.00126	<.00960	<.00194	<.01071
ASH18	<.07347	<.00037	<.01743	<.02207	<.04617	<.00330	<.00563	<.00264	<.00938	<.00122	<.01189
ASH19	<.07521	<.00063	<.01695	<.01369	<.03456	<.00168	<.00369	<.00135	<.00722	<.00116	<.01323
ASH20	<.05561	<.00038	<.01483	<.02389	<.02737	<.00193	<.00610	<.00155	<.00851	<.00088	<.01117

Appendix IV - Pesticide Analysis

Station_ID	Endosulfan-I *u* g/L	p-p'-DDE *u* g/L	Dieldrin *u* g/L	Endrin *u* g/L	Endosulfan-II *u* g/L	p-p'-DDD *u* g/L	Endosulfan-Sulfate *u* g/L	p-p'-DDT *u* g/L	Hexazinone *u* g/L	Methoxychlor *u* g/L	PCB-as-AR1221 *u* g/L
LIN04	<.18087	<.00135	<.02674	<.01084	<.03839	<.00193	<.00515	<.00149	<.00197	<.00054	<.00630
LIN05	<.07331	<.00094	<.10912	<.00958	<.05029	<.00212	<.00590	<.00164	<.00358	<.00067	<.00765
LIN06	<.16955	<.00175	<.18796	<.01558	<.07075	<.00209	<.00546	<.00162	<.00376	<.00078	<.00940
JEF01	<.12898	<.00183	<.02465	<.01767	<.03722	<.00209	<.00803	<.00161	<.00317	<.00075	<.00918
JEF02	<.08998	<.00099	<.02633	<.01065	<.04473	<.00136	<.00490	<.00101	<.00310	0.00187	<.00625
JEF03	<.09918	<.00099	<.02225	<.01116	<.04408	<.00157	<.00526	<.00116	<.00219	<.00050	<.00807
LIN07	<.12892	<.00105	<.02657	<.01178	<.03345	<.00149	<.00497	<.00110	<.00227	<.00062	<.00843
DESHA03	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	0.01496	<0.00203	<0.00451
DREW07	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	0.00381	<0.00203	<0.00451
DREW08	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
DREW09	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	0.00347	<0.00208	<0.00203	<0.00451
DREW10	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
DREW11	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
DREW12	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027		<0.00106	<0.00208	<0.00203	<0.00451
DREW13	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
DREW14	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
DREW15	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
JEF04	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	0.0048	0.02609	<0.00203	<0.00451
JEF05	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	0.00948	<0.00203	<0.00451
JEF06	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	0.00584	<0.00208	<0.00203	<0.00451
JEF07	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
JEF08	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
JEF09	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
JEF10	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
JEF11	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	0.00255	<0.00208	<0.00203	<0.00451
JEF12	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
JEF13	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
LIN08	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	0.0167	0.023296	<0.00203	<0.00451
LIN09	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	0.028362	<0.00203	<0.00451
LIN10	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	0.017132	<0.00203	<0.00451
LIN11	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
LIN12	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
LIN13	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451

Appendix IV - Pesticide Analysis

Station_ID	Endosulfan-I *u* g/L	p-p'-DDE *u* g/L	Dieldrin *u* g/L	Endrin *u* g/L	Endosulfan-II *u* g/L	p-p'-DDD *u* g/L	Endosulfan-Sulfate *u* g/L	p-p'-DDT *u* g/L	Hexazinone *u* g/L	Methoxychlor *u* g/L	PCB-as-AR1221 *u* g/L
LIN14	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
LIN15	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	0.01441	<0.00208	<0.00203	<0.00451
LIN16	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
LIN17	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
DREW16	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	0.03524	<0.00203	<0.00451
DREW17	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	0.016586	<0.00203	<0.00451
DREW18	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
DREW19	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
DREW20	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
DREW21	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
DREW22	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
DREW23	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
DREW24	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
DREW25	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
JEF0014	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
JEF0015	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
JEF0016	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
JEF0017	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
JEF0018	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
JEF0019	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
JEF0020	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
JEF0021	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
JEF0022	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
JEF0023	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	0.01382	<0.00208	<0.00203	<0.00451
LIN18	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	0.01664	<0.00203	<0.00451
LIN19	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	0.008014	<0.00203	<0.00451
LIN20	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
LIN21	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	0.0019	<0.00208	<0.00203	<0.00451
DREW26	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
DREW27	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
DREW28	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
DREW29	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
DREW30	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451

Appendix IV - Pesticide Analysis

Station_ID	Endosulfan-I *u* g/L	p-p'-DDE *u* g/L	Dieldrin *u* g/L	Endrin *u* g/L	Endosulfan-II *u* g/L	p-p'-DDD *u* g/L	Endosulfan-Sulfate *u* g/L	p-p'-DDT *u* g/L	Hexazinone *u* g/L	Methoxychlor *u* g/L	PCB-as-AR1221 *u* g/L
DREW31	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
DREW32	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	0.010401	<0.00203	<0.00451
DREW33	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
DREW34	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
DREW35	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
DREW36	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
DREW37	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
DREW38	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
LINC22	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
LINC23	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
LINC24	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
ASH0021	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
ASH0022	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
ASH0023	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
ASH0024	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
ASH0025	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
ASH0026	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
ASH0027	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
ASH0028	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
ASH0029	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451
ASH0030	<0.00892	<0.00192	<0.00818	<0.00646	<0.00674	<0.0027	<0.00357	<0.00106	<0.00208	<0.00203	<0.00451

Appendix IV - Pesticide Analysis

Station_ID	PCB-as-AR1232 *u* g/L	PCB-as-AR1242 *u* g/L	PCB-as-AR1248 *u* g/L	PCB-as-AR1254 *u* g/L	PCB-as-AR1260 *u* g/L	Technical-Chlordane *u* g/L
DREW01	<.03513	<.13364	<.36898	<.19052	<.07999	<.04890
DREW02	<.05828	<.13111	<.36200	<.27558	<.11571	<.06766
DREW03	<.07300	<.20056	<.55374	<.31350	<.13163	<.15020
DREW04	<.03326	<.19858	<.54827	<.36018	<.15123	<.11894
DESHA01	<.03506	<.11994	<.33114	<.37860	<.15896	<.10658
DESHA02	<.05246	<.26421	<.72946	<.30957	<.12998	<.16995
LINC01	<.04167	<.17880	<.49365	<.49066	<.20601	<.16573
LINC02	<.04359	<.26935	<.74365	<.28665	<.12035	<.06844
LINC03	<.05176	<.19965	<.55123	<.30584	<.12841	<.08330
ASH01	<.05274	<.11298	<.31147	<.17102	<.07181	<.07752
ASH02	<.02032	<.08104	<.22341	<.10262	<.04309	<.05589
ASH03	<.03533	<.17606	<.48539	<.22199	<.09321	<.08106
ASH04	<.02539	<.06841	<.18860	<.14438	<.06062	<.03686
DREW05	<.02935	<.06501	<.17924	<.12742	<.05350	<.05605
CHI01	<.03250	<.19975	<.55069	<.27347	<.11482	<.13090
CHI02	<.03172	<.08225	<.22676	<.19530	<.08200	<.05817
DREW06	<.04190	<.09944	<.27415	<.23130	<.09712	<.06062
CHI03	<.05372	<.12666	<.34918	<.30725	<.12901	<.07817
CHI04	<.03047	<.11387	<.31395	<.26553	<.11149	<.09981
ASH05	<.02547	<.06869	<.18929	<.04918	<.02065	<.04400
ASH06	<.01563	<.02182	<.06012	<.04685	<.01967	<.02858
ASH07	<.01522	<.02627	<.07239	<.06111	<.02566	<.02554
ASH08	<.00972	<.03029	<.08346	<.05504	<.02311	<.02078
ASH09	<.01853	<.02798	<.07712	<.05581	<.02343	<.02606
ASH10	<.01180	<.02315	<.06380	<.07458	<.03131	<.01906
ASH11	<.00915	<.02195	<.06048	<.06599	<.02771	<.02259
ASH12	<.02244	<.02105	<.05800	<.03616	<.01518	<.03755
ASH13	<.02709	<.06113	<.16852	<.01139	<.00478	<.01391
ASH15	<.02946	<.06004	<.16553	<.02141	<.00899	<.01141
ASH17	<.02217	<.03080	<.08493	<.01978	<.00830	<.02108
ASH18	<.02461	<.03926	<.10822	<.02940	<.01234	<.01119
ASH19	<.02738	<.04688	<.12924	<.01290	<.00542	<.02148
ASH20	<.02311	<.02692	<.07421	<.02160	<.00907	<.02015

Appendix IV - Pesticide Analysis

Station_ID	PCB-as-AR1232 *u* g/L	PCB-as-AR1242 *u* g/L	PCB-as-AR1248 *u* g/L	PCB-as-AR1254 *u* g/L	PCB-as-AR1260 *u* g/L	Technical-Chlordane *u* g/L
LIN04	<.01304	<.03406	<.09391	<.06115	<.02568	<.03617
LIN05	<.01584	<.05791	<.15964	<.08801	<.03695	<.02420
LIN06	<.01945	<.05359	<.14773	<.07601	<.03192	<.04495
JEF01	<.01901	<.05257	<.14492	<.08855	<.03718	<.04548
JEF02	<.01294	<.04023	<.11090	<.05010	<.02104	<.04007
JEF03	<.01671	<.04507	<.12425	<.05166	<.02169	<.03727
LIN07	<.01744	<.03888	<.10720	<.07638	<.03207	<.03113
DESHA03	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
DREW07	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
DREW08	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
DREW09	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
DREW10	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
DREW11	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
DREW12	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
DREW13	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
DREW14	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
DREW15	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
JEF04	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
JEF05	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
JEF06	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
JEF07	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
JEF08	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
JEF09	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
JEF10	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
JEF11	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
JEF12	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
JEF13	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
LIN08	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
LIN09	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
LIN10	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
LIN11	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
LIN12	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
LIN13	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876

Appendix IV - Pesticide Analysis

Station_ID	PCB-as-AR1232 *u* g/L	PCB-as-AR1242 *u* g/L	PCB-as-AR1248 *u* g/L	PCB-as-AR1254 *u* g/L	PCB-as-AR1260 *u* g/L	Technical-Chlordane *u* g/L
LIN14	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
LIN15	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
LIN16	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
LIN17	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
DREW16	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
DREW17	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
DREW18	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
DREW19	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
DREW20	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
DREW21	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
DREW22	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
DREW23	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
DREW24	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
DREW25	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
JEF0014	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
JEF0015	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
JEF0016	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
JEF0017	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
JEF0018	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
JEF0019	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
JEF0020	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
JEF0021	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
JEF0022	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
JEF0023	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
LIN18	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
LIN19	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
LIN20	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
LIN21	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
DREW26	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
DREW27	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
DREW28	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
DREW29	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
DREW30	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876

Appendix IV - Pesticide Analysis

Station_ID	PCB-as-AR1232 ***u*** **g/L**	PCB-as-AR1242 ***u*** **g/L**	PCB-as-AR1248 ***u*** **g/L**	PCB-as-AR1254 ***u*** **g/L**	PCB-as-AR1260 ***u*** **g/L**	Technical-Chlordane ***u*** **g/L**
DREW31	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
DREW32	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
DREW33	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
DREW34	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
DREW35	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
DREW36	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
DREW37	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
DREW38	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
LINC22	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
LINC23	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
LINC24	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
ASH0021	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
ASH0022	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
ASH0023	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
ASH0024	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
ASH0025	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
ASH0026	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
ASH0027	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
ASH0028	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
ASH0029	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876
ASH0030	<0.00932	<0.01795	<0.0492	<0.05302	<0.02222	<0.00876