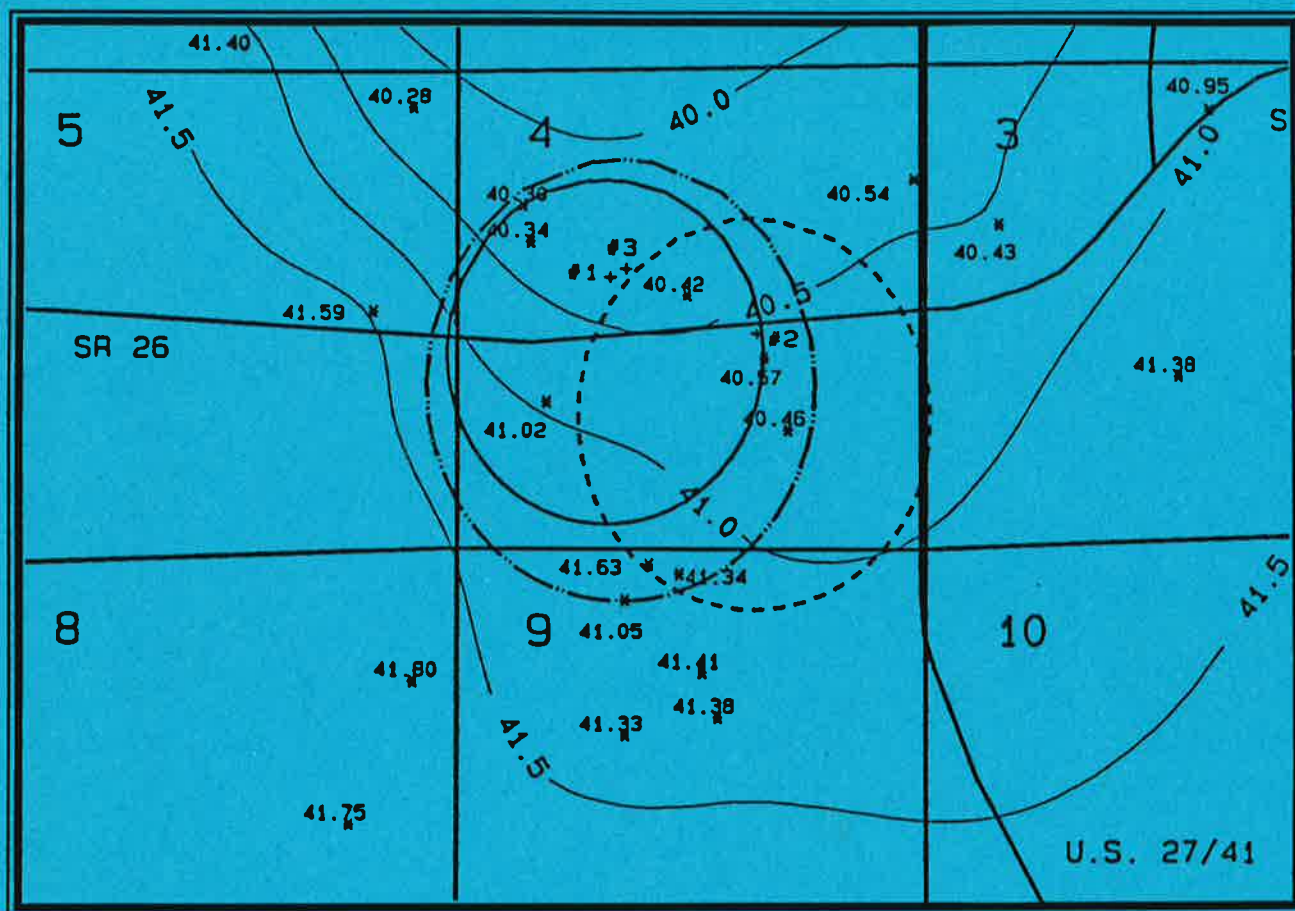


Hydrogeologic Investigation of Newberry, Florida and Model Wellhead Protection Plan

Volume One



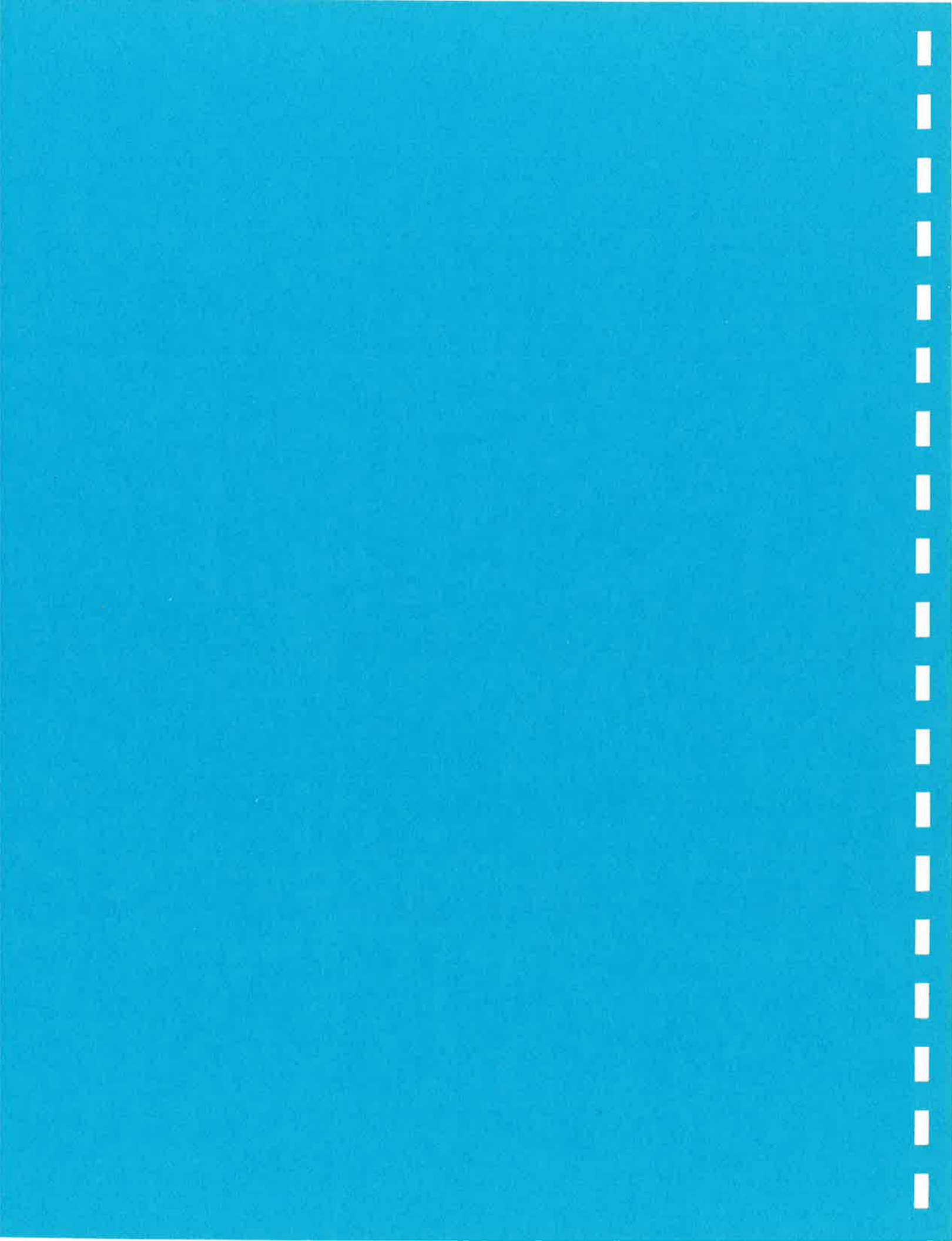
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Ground-Water Protection Branch
U.S. Environmental Protection Agency, Region IV

December 1994
(Revised August 1996)



ALACHUA COUNTY WELLHEAD PROTECTION DEMONSTRATION PROJECT
(COOPERATIVE AGREEMENT NO. S004891-91-0)

FINAL REPORT

HYDROGEOLOGIC INVESTIGATION OF NEWBERRY, FLORIDA
AND
MODEL WELLHEAD PROTECTION PLAN

VOLUME ONE

Prepared For

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EXECUTIVE SUMMARY

The primary source of potable, industrial and agricultural water in Alachua County is the groundwater of the Floridan aquifer system. In the western portion of Alachua County the Floridan aquifer system is unconfined and susceptible to contamination. In 1991, Alachua County entered into a cooperative agreement with the United States Environmental Protection Agency (EPA) to conduct a wellhead protection demonstration project. The purpose of the demonstration project (Cooperative Agreement No. S004891-91-0) was to conduct an investigation and prepare a model wellhead protection plan for a small municipality.

The project was conducted in two phases: Phase 1, Hydrogeologic Investigation, and Phase 2, Design of a Wellhead Protection Plan. The Hydrogeologic Investigation included 11 tasks: selecting a study area, conducting a land use inventory, completing a facilities inventory, computerizing land use and facilities data, obtaining available data on the public supply wells, conducting a well inventory and potentiometric surface mapping, aquifer testing, fracture trace analysis, determining the cone of depression for the public supply wells, modeling wellhead protection zones, and locating sites for future wellhead development. The project began October 29, 1991 and was completed September 15, 1993.

Wellhead protection in Alachua County is complicated by the presence of carbonate rocks and the karstification of these strata. The carbonate rocks of the Floridan aquifer system are composed of limestone and dolomite and have been highly altered by weathering processes. In western Alachua County, the dominant underlying structural feature is the Ocala Uplift. Due to the uplift, the Ocala Formation is present at land surface, covered with only a thin veneer of sands and re-worked deposits. Also present are landform and drainage characteristics that are distinctive of karst geology. Karst features in western Alachua County include sinkholes or closed depressions, springs, swallow holes (in streams), prairies, sinkhole lakes, and an absence of surface streams and rivers.

The first task was to select a small municipality for the study. Based on available well construction information, depth to groundwater, location and number of wells, and the interest in participation, the City of Newberry was selected for the demonstration project. The City of Newberry is located in the west central portion of western Alachua County where the Floridan aquifer system is under unconfined conditions.

A land use inventory was conducted within a one-mile radius of the municipal supply wells. Fifty-five percent of the land use was found to be residential, forty percent of the land use was agricultural, and approximately five percent of the land use was commercial, industrial, and institutional/government.

An inventory of facilities that use or store hazardous materials or petroleum products within a one-mile radius of the municipal supply wells was conducted. Twenty-six facilities were located. Thirteen of the facilities currently use or store (or have used or stored) petroleum products. Gasoline and diesel fuel were the most common product types reported.

The City of Newberry has three municipal supply wells. The wells range in depth from 142 to 200 feet. All three wells are located in the urban area of Newberry. Wells #1 and #3 are approximately 200 feet apart. Both of these wells are more than one-quarter of a mile from well #2. All three of the wells are open to the Ocala Formation in the upper portion of the Floridan aquifer system. Well #1 is deeper and may extend into the Avon Park Formation.

A field inventory was conducted to locate existing wells for Floridan aquifer system potentiometric surface mapping. Thirty-four wells were located and used in the potentiometric surface mapping. Water level measurements were conducted three times during this study.

Potentiometric surface mapping of the upper portion of the Floridan aquifer system consistently showed a north to northwesterly groundwater flow direction in the Newberry area. The gradient, 0.00019, approximately one foot per mile, is low.

A constant rate aquifer test was conducted using an existing irrigation well approximately 1.5 miles northwest of the City wells. Analysis of the test data showed transmissivities of 69,000 to 190,000 gpd/ft. The existing irrigation well was 10-inches in diameter and 117 feet deep with 77 feet of casing. Two 4-inch monitoring wells were constructed at a distance of 40 and 100 feet for the purpose of water level data collection.

High specific capacities, 190 to 400 gallons per minute per foot of drawdown (gpm/ft), were measured during testing conducted on the supply wells. These results indicate the high productivity of the Floridan aquifer system in this area. Estimates of transmissivity based on specific capacity data ranged from 380,000 to 720,000 gallons per day per foot (gpd/ft). The highest estimated values of transmissivity may be a function of well depth and/or the presence of highly weathered or fractured rock. The Avon Park Formation that occurs below the Ocala Formation has been reported to have higher transmissivities. The wide range of transmissivities may have been the result of a number of factors: the heterogeneous and anisotropic nature of the aquifer; the varying depth of the wells tested; the short duration of the test pumping; the discharge of the pumped water to a depression southwest of the well; and the partial penetration of the wells.

The storativity values determined from the constant rate aquifer test ranged from 0.0006 to 0.0013. The presence of re-worked deposits overlying the limestone and the highly mineralized nature of the top of the formation may have caused the Floridan aquifer system in this area to respond more like a semi-confined unit in terms of storativity.

Fracture traces, in this case, the alignment of sinkholes or closed depressions, may provide evidence of subsurface cavern development. Numerous fracture traces, or lineaments, were mapped within a five-mile radius of the City of Newberry's municipal wells. One fracture trace, in particular, was mapped within immediate proximity to the City of Newberry municipal wells.

The Multiple Well Capture Zone Module (MWCAP) of the "EPA Modular Semi-analytical Model for the Delineation of Wellhead Protection Areas" was chosen to delineate travel times associated with the three City of Newberry municipal supply wells. Initially, capture zones were plotted based on two scenarios, an average pumping rate of 500 gallons per minute (gpm) distributed evenly among the three wells and a maximum pumping rate of 500 gpm for each of the three wells, assuming 10 percent porosity and transmissivity of 105,000 gpd/ft. Additional

scenarios for the ten year capture zones were modeled for porosity values of 10, 15 and 20 percent at the transmissivities of 105,000 and 400,000 gpd/ft.

A model wellhead protection ordinance with two wellhead protection areas or zones is presented. The wellhead protection ordinance provides for permitting, containment standards, exemptions, water conservation, and protection of future water supply areas. Section seven defines the wellhead protection area as two zones. Zone one (1) is the land area between the well(s) and a 500-foot radius contour. Zone two (2) is the land situated between the 500-foot contour and the 10-year travel time contour. The wellhead protection areas were consistent with those proposed in the state-wide wellhead protection rule, Chapter 62-521, Florida Administrative Code (August 29, 1994 Draft). Land use and hazardous materials are regulated within the wellhead protection zones.

The ten year capture zones for both the average pumped and the fully pumped scenarios, using an assumed transmissivity of 105,000 gpd/ft, are circular. By changing the transmissivity to 400,000 gpd/ft the capture zones become more elliptical with a greater portion of the zone being in the upgradient direction.

Sites for future wellhead development are limited to the northwest area of the city. This is due to two reasons, the existing infrastructure and the presence of potential pollution sources.

ACKNOWLEDGMENTS

The author wishes to thank Ms. Eve Zimmerman and Mr. Dale Froneberger, U.S. Environmental Protection Agency and Dr. Rodney DeHan, Florida Department of Environmental Protection who made this project possible and provided technical comments and assistance during the study. Thanks are also extended to the Alachua County Commission for their approval and support of this project.

Special thanks are given to the Newberry City Commission for their approval to use Newberry for the demonstration project site. Mr. Blaine Suggs, Utilities Director for the City of Newberry was helpful by supplying information on the municipal wells and cooperating with our field efforts in data collection.

The author wishes to thank the following Alachua County Environmental Protection Department employees, former employees and temporary staff for their contribution to the project. Ms. Libby Schmidt and Mr. Jim Trifilio initiated the project and were responsible for much of the original concept of the study. Mr. Randy Chambers was responsible for collection of all field data. Ms. Janet Lowe collected data for the facilities inventory and conducted much of the initial mapping. Mr. Joe Dertien conducted the initial analysis of the aquifer test data and researched and prepared the model ordinance. Ms. Jori Sculc compiled data and prepared tables. Ms. Terry Ohberg drafted a number of the figures and plates and assisted in preparation of the tables and text. Ms. Amy Sung was responsible for revisions to the ordinance and preparation of the final text, tables and figures.

Thanks are also extended to water management district and Florida Department of Environmental Protection staff. Mr. Ron Ceryak and Mr. Nolan Col provided assistance in obtaining geologic and hydrogeologic data and gave many helpful suggestions that enabled us to conduct the project. Mr. Col also reviewed and provided comments on a draft of the report. Ms. Koren Taylor and Mr. John Passehl also reviewed and commented on the report draft.

The author would also like to thank several other individuals who made completion of this project possible. Dr. Roger Williams allowed us use of his irrigation well for aquifer testing purposes. Clyatt Well Drilling installed and developed two monitoring wells for the purpose of aquifer testing. Eng, Denman & Associates conducted the elevation surveys of the water wells used in potentiometric surface mapping. Layne-Atlantic Company set the test pump and collected water level data during aquifer testing. Mr. Rand Edelstein of GeoSolutions performed the aquifer test analysis. Dr. Bob Lindquist of GeoSys prepared potentiometric surface maps, modeled the wellhead protection areas, conducted the final fracture trace analysis, and offered technical guidance. Mr. C. Ross Sproul of CH2M Hill provided technical assistance and information on the local hydrogeology and aquifer parameters. Special thanks is extended to all the individuals in the Newberry area who allowed us to use their wells for water level measurements.

1.0 INTRODUCTION

1.1 BACKGROUND

The 1986 Amendments to the Safe Drinking Water Act (SDWA) established the Wellhead Protection (WHP) Program to protect groundwaters that supply wells used for public water supply systems (USEPA, 1991). The increased management of activities in the vicinity of public water supply wells through the WHP Program may provide significant gains in human health protection.

The United States Environmental Protection Agency (EPA) determined that local governments play an important part in the implementation of a State WHP Program because of their responsibility for delineation and management of the Wellhead Protection Area(s) (WHPA) in their communities. The implementation of WHP programs include delineating the WHPA, locating the sources of contamination, assessing management options, and preparing for the effects of a contaminant release or spill.

In fiscal year 1991 Congress appropriated \$1,500,000 to the EPA for grants to local communities to demonstrate implementation of WHP Programs (USEPA, 1991). It was the intent of EPA's Office of Ground-Water Protection (OGWP) to fund a total of between 30 and 60 projects, with awards up to \$50,000. Wellhead Protection Program Demonstration Project funds were awarded through cooperative agreements under the authority of Section 1442(b) (3) (C) of the SDWA (SDWA, 1974, as amended June 1986). Any municipality, as defined in the SDWA, Section 1401(10), was eligible to apply for WHP Program Demonstration Project funds.

The SDWA Amendments of 1986 require States to establish and submit a State WHP Program to EPA for approval (USEPA, 1991). Each State Program must contain the seven elements stated in Section 1428(a) of the Amendments (USEPA, 1991). Each State's WHP plan must:

1. Specify duties of State agencies and local government entities;
2. Determine wellhead protection areas;
3. Identify potential sources of contamination;
4. Specify management approaches;
5. Include contingency plan;
6. Describe a process for siting new (future) wells; and
7. Be publicly reviewed.

The seven elements required in a State Wellhead Protection Program may help to identify local WHP issues which, in turn, may lend themselves to projects.

The State of Florida, through its administrative code, is currently undergoing rule making on Wellhead Protection. The intent of the proposed rule, Chapter 62-521, is to provide protection to potable water wells by establishing a statewide WHP Program (Chapter 62-521, Workshop Draft, August 29, 1994). Specific facilities or activities are being evaluated for regulation within the WHP zone(s). These facilities or activities include: industrial waste water facilities, domestic waste water facilities, hazardous waste, pesticide application and mixing/loading areas, solid waste facilities, Class V injection wells, storage tank systems, stormwater, underground facilities for the transportation of products or pollutants, and water use permitting. The Florida Department of Environmental Protection (FDEP) proposes to map and delineate WHPAs for all potable water wells that supply water for human consumption to a Community Water System, as defined in Section 403.852(3), Florida Statutes (Florida Statutes, 1993) . The State proposes to present criteria for determining equivalency of a local government's WHP Program.

1.2 PURPOSE AND SCOPE

The purpose of these cooperative agreements is to design, demonstrate, and document for general use activities undertaken by local communities in the development and implementation of their WHP Program. Activities include delineation of WHPAs, identification of sources of contamination, and development of management techniques. The EPA awards these funds to local municipalities to assist states in developing or implementing effective WHP Programs because local governments can serve as sites to test approaches. The information gained in this process also serves to assist local governments in the implementation of wellhead protection in their communities and, from information acquired through these demonstration projects, help implement wellhead protection throughout the United States.

The purpose of the Alachua County Wellhead Protection Demonstration Project (Cooperative Agreement No. S004891-91-0) was to conduct an investigation and prepare a model wellhead protection plan for a small municipality in Alachua County. A condition for selection of the municipality was that it be located in an area where the Floridan aquifer system is unconfined. The project was conducted in two phases: Phase 1, Hydrogeologic Investigation and Phase 2, Design of a Wellhead Protection Plan. The Hydrogeologic Investigation included 11 tasks: selecting a study area, conducting a land use inventory, completing a facilities inventory, computerizing land use and facilities data, obtaining available data on the public supply wells, conducting a well inventory and potentiometric surface mapping, aquifer testing, fracture trace analysis, determining the cone of depression for the public supply wells, modeling wellhead protection zones, and locating sites for future wellhead development. The project began October 29, 1991 and was completed September 15, 1993.

This report is a final project summary describing the work conducted as part of the scope of services under Wellhead Demonstration Projects Program (Cooperative Agreement No. S004891-91-0). Brief descriptions of the geology and hydrogeology of Alachua County are included to assist in the understanding of the emphasis placed on wellhead protection in areas where the Floridan aquifer system is unconfined.

2.0 ALACHUA COUNTY PHYSIOGRAPHY, GEOLOGY, AND WATER RESOURCES

2.1 PHYSIOGRAPHY

Alachua County lies in the north-central portion of the Florida peninsula. Alachua County is part of the Central Highlands or Central Florida Ridge of the Atlantic Coastal Plain (Spangler, 1985). The county is comprised of approximately 892 square miles and consists of a low, flat, karst limestone plain in the west, bounded by a west-facing escarpment, and a flat upland plateau in the east (Williams *et al.*, 1977). Elevations in the county range from approximately 25 feet above National Geodetic Vertical Datum of 1929 (NGVD) near the Santa Fe River, to over 195 feet northwest of Gainesville. The topographic relief can be identified in Figure 1a, a digitized image of the topographic contours of the United States Geological Survey, 1:24,000 scale quadrangle maps of Alachua County (Lindquist and Arrington, 1987).

Alachua County lies along the boundary of two major geomorphic divisions of the Florida peninsula, the northern, or proximal, zone and the central, or mid-peninsula, zone (White, 1970). Features characteristic of the northern zone include dry, steep walled sinks; abandoned spring heads; dry stream courses; and intermittent lakes and prairies that were formerly broad shallow lakes. The central zone is comprised of broad valleys containing large, shallow lakes and of ridges. Within these divisions are three physiographic regions (White, 1970) that, in western Alachua County, have been further divided into seven physiographic zones (Williams *et al.*, 1977, Figure 1b). In western Alachua County the dominant underlying structural feature is the Ocala Uplift (Figure 1c).

The Northern Highlands Plateau (Williams *et al.*, 1977) is an area of low relief. Elevations above NGVD generally range from slightly under 200 feet on the western edge to approximately 145 feet on the eastern side. The plateau extends north and east from Gainesville and is continuous into southeastern Georgia. In this area of the county, the Ocala Formation is encountered at depths greater than 100 to 150 feet below land surface (Figure 1d). The Hawthorn Group (Scott, 1988) consists of varying amounts of sands, clayey sands, clays, carbonates, and phosphates. It overlies the Ocala Formation and confines the Floridan aquifer system. The Hawthorn Group sediments support an intermediate aquifer system under confined conditions within permeable beds. Above the Hawthorn Group lie 0 to 30 feet of sands and clayey sands which contain the surficial aquifer system. The plateau is characterized by cypress hammocks and poorly drained, swampy areas. Drainage is generally to the north, towards the Santa Fe River, or to the east and south, toward Newnan's Lake (Williams *et al.*, 1977).

The Northern Highlands Marginal Zone (Williams *et al.*, 1977) lies between the Northern Highlands Plateau and the Western Valley. Elevations range from over 190 feet NGVD in the east to approximately 75 feet NGVD in the west, where the Northern Highlands Marginal Zone adjoins the Western Valley. The Northern Highlands Marginal Zone extends from the Santa Fe River on the north to south of Gainesville. Relief in this area is the greatest found in Alachua County (Figure 1a). This relief is partially caused by erosion of streams cutting into the plateau. Many of these streams terminate in sinks or swallow holes when they reach the limestones of the Western Valley.

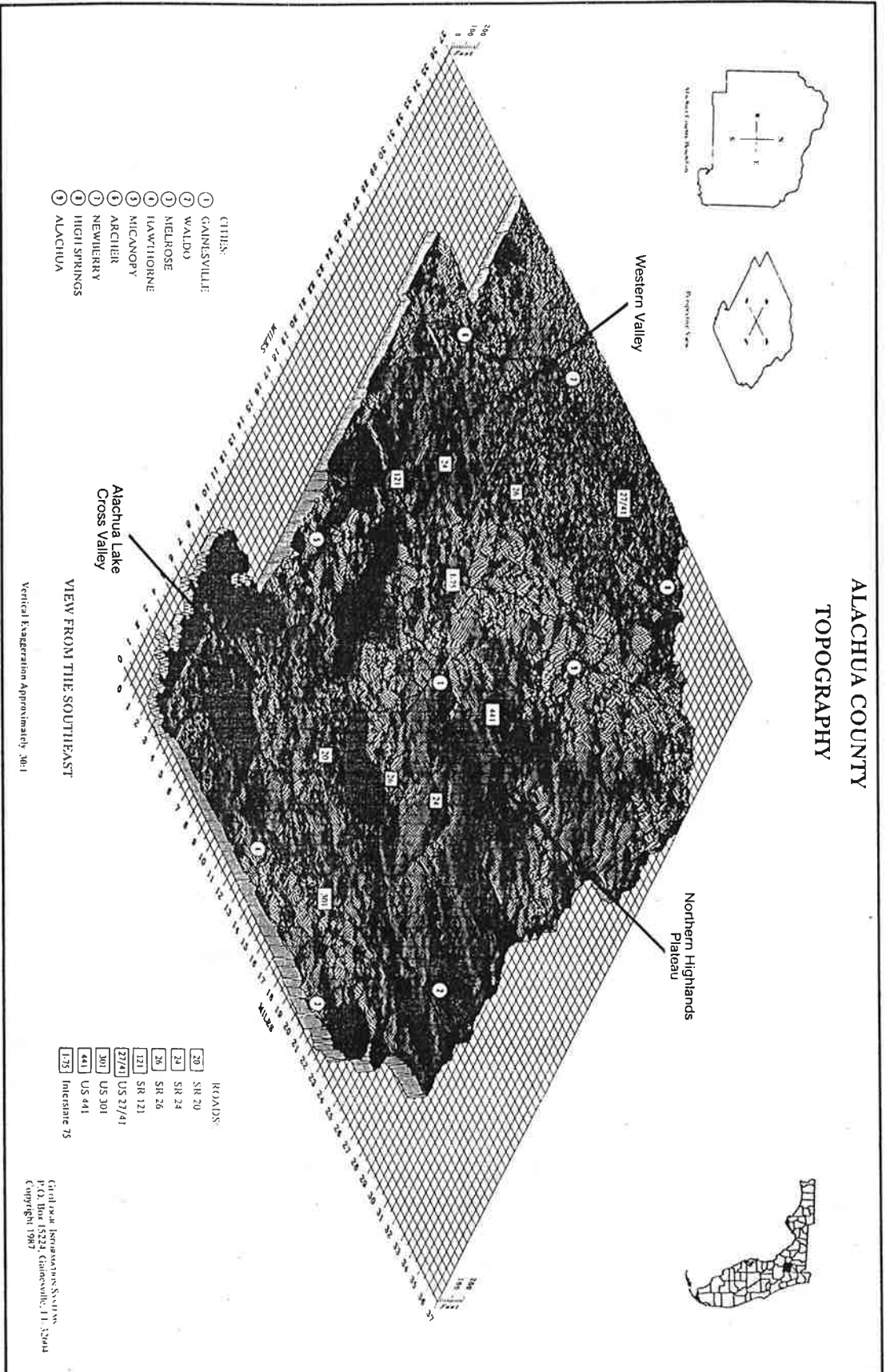


Figure 1a Digitized Image of the United States Geological Survey 7.5' Quadrangle Maps for Alachua County, Florida

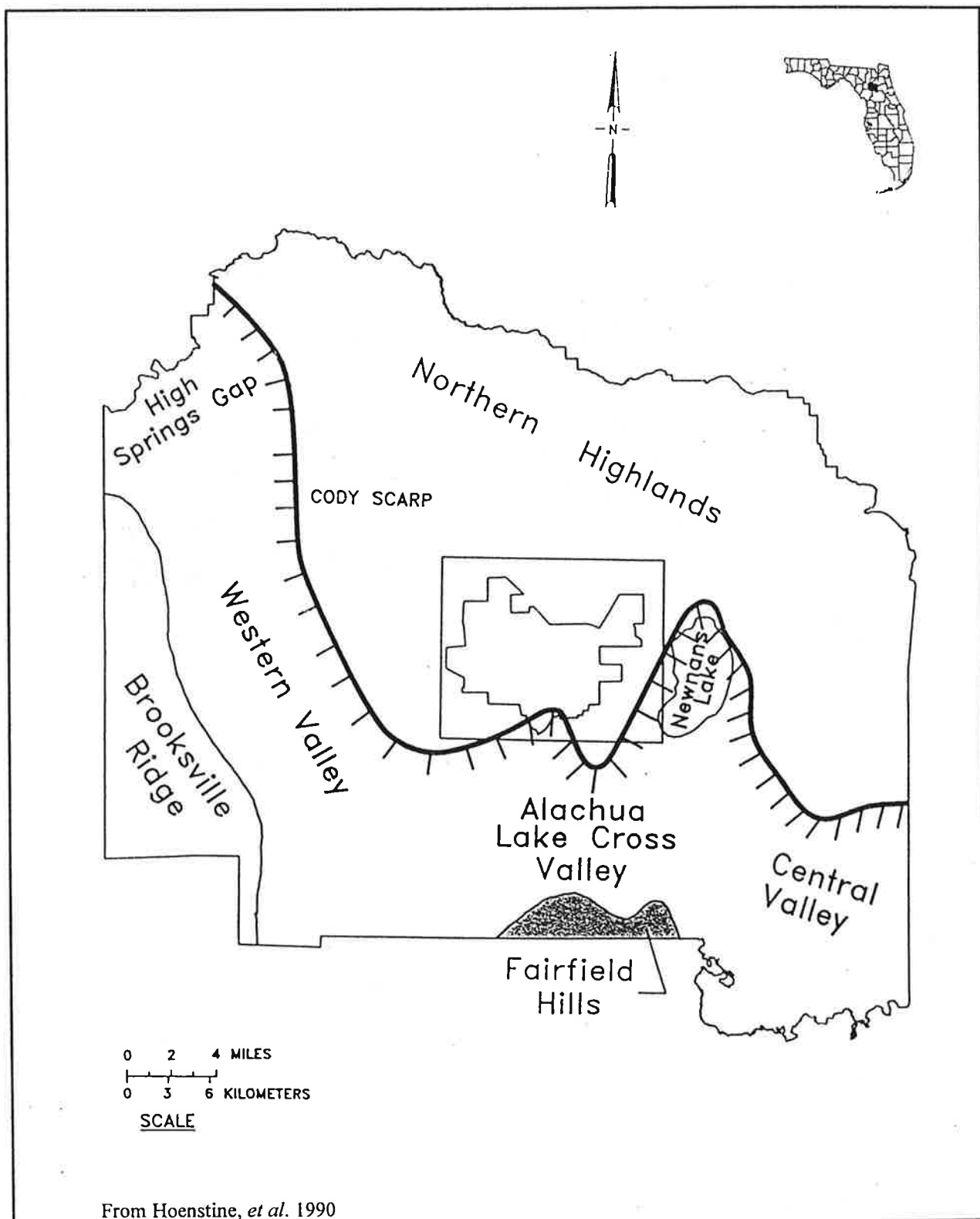


Figure 1b Physiographic Provinces of Alachua County, Florida

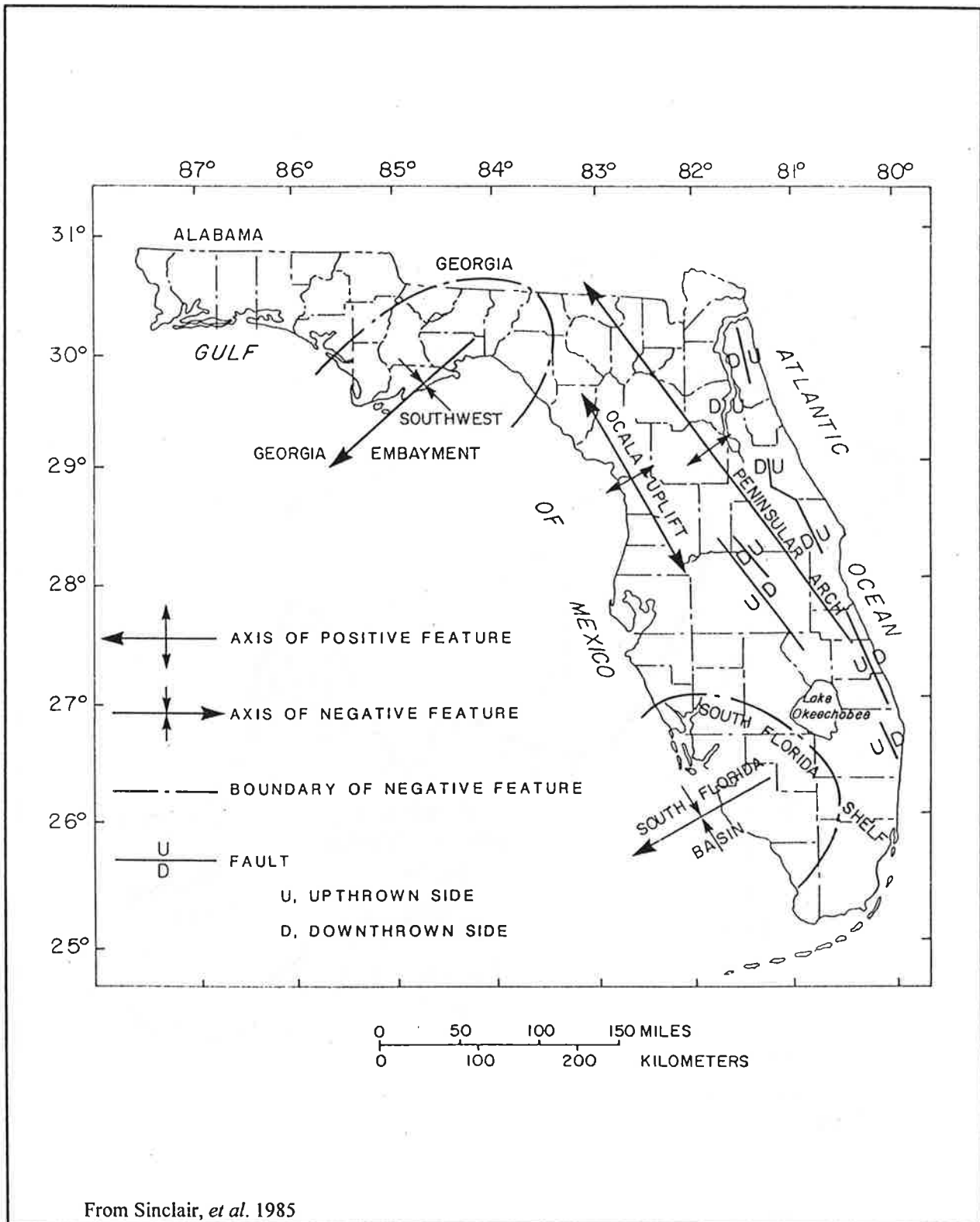


Figure 1c Structural Features of Florida

NORTH FLORIDA STRATIGRAPHY

MILLION YEARS	SERIES	FORMATION	HYDROSTRATIGRAPHIC UNIT
5.3	RECENT, PLEISTOCENE, PLIOCENE	TERRACE MARINE AND FLUVIAL DEPOSITS	SURFICIAL AQUIFER SYSTEM
10.8	MIOCENE UPPER	REWORKED SEDIMENTS	
17	MIDDLE	STATENVILLE	INTERMEDIATE AQUIFER SYSTEM OR INTERMEDIATE CONFINING UNIT
		COOSAWHATCHEE	
		MARKS HEAD PENNY FARMS	
25	LOWER	HAWTHORN GROUP	FLORIDAN AQUIFER SYSTEM
38	OLIGOCENE	SUWANNEE LIMESTONE	
55	EOCENE	ABSENT	SUB-FLORIDAN CONFINING UNIT
		CRYSTAL RIVER WILLISTON INGLIS	
		OCALA FORMATION	
		AVON PARK FORMATION	
	PALEOCENE	OLDSMAR LIMESTONE	
		CEDAR KEY LIMESTONE	

After SEGS, 1986 and Scott, 1988

Figure 1d Generalized Stratigraphic Cross Section of North Florida

Much of the topographic relief found in the Northern Highlands Marginal Zone is caused by the Hawthorn Group sediments and the underlying Ocala Formation. Clayey units in the Hawthorn Group produce lenses of perched water which, in some areas, may be expressed as small ponds. There are also many small springs associated with the surficial sediments contacting the clayey sediments of the Hawthorn Group (Williams *et al.*, 1977). The small springs around the sides of Devil's Mill Hopper, Glenn Springs, and Boulware Springs are examples of these springs. The influence of the Ocala Formation in the region is demonstrated by the presence of sinkholes, sinkhole ponds, and caves.

The Alachua Stream System is an example of the underlying control of the Ocala Formation on the topography (Williams *et al.*, 1977). This stream basin drains over 70 square miles and is intersected by 10 sinks, or swallow holes, that divert water underground. The system includes Townsend Branch, Mill Creek, the streams flowing into Burnetts Lake, Turkey Creek, Blues Creek, and Sanchez Prairie.

The Fairfield Hills (Williams *et al.*, 1977) meet the Alachua Lake Cross Valley and the Western Valley just north of the Marion County line. Land surface elevations range from 60 to 160 feet NGVD. Relief and topography are similar to that found in the Northern Highlands Marginal Zone. Williams *et al.* (1977) concluded that the Fairfield Hills and the Northern Highlands once formed a continuous highland across Alachua County.

The Western Valley (Williams *et al.*, 1977) is a limestone plain covered by a thin veneer of sands and residual sediments of the Hawthorn Group. The first limestone unit encountered below land surface is the Ocala Formation. Elevations above NGVD of this region average 70 feet. Generally flat, the sinkholes, quarries, low hills, and erosional remnants of the Northern Highlands provide topographic relief. The Western Valley is bounded on the east by the Northern Highlands Marginal Zone and on the west by the Brooksville Ridge and the Brooksville Ridge Marginal Zone.

The origin of the essentially flat surface of the Western Valley limestone plain has been described by several authors as a marine terrace. Others consider it to be the result of a karst cycle of erosion. Evidence suggests that both processes have influenced this area (Williams *et al.*, 1977; Scott, 1988).

Drainage in the Western Valley is vertical, there are very few surface water bodies present. The Santa Fe River flows across the limestone plain in the northern part of the county but is diverted underground for several miles. There are many sinkholes in the Western Valley, often occurring along linear trends. These sinkholes are a surface reflection of the control of solution by jointing in the Ocala Limestone. Over 100 caves are known to exist in Alachua County. Most are short in length, one exception is Warrens Cave which has a mapped length of over 3 3/4 miles (Williams *et al.*, 1977).

The Alachua Lake Cross Valley (Williams *et al.*, 1977) is a low area in the southern and southeastern part of the county characterized by prairies and large flat bottom lakes. Relief is low. Elevations range from 50 to 75 feet NGVD. The northern and southern boundaries of the

Alachua Lake Cross Valley are defined by the erosional scarp of the Northern Highlands Marginal Zone and the Fairfield Hills.

The lake region is underlain by the eroded surface of the Ocala Formation (Williams *et al.*, 1977). Erosional remnants of the Hawthorn Group and limestone ridges separate the basins. Origins of the large shallow lake basins have been attributed to solution. At the present time, many of the of the basins have floors that are below the potentiometric surface of the Floridan or intermediate, aquifer systems.

Only a small portion of the Brooksville Ridge (Williams *et al.*, 1977) is present in the southwest corner of Alachua County. Relief on the ridge is high. Elevations, above NGVD, range from 55 to 135 feet. The ridge itself consists of a thick mantle of Pleistocene sands overlying residual re-worked deposits and the Ocala Formation. All drainage is internal and the dissolution of the underlying limestone controls the topographic features present in this area.

The Brooksville Ridge Marginal Zone (Williams *et al.*, 1977) is basically an extension of the Western Valley. The major difference is the presence of re-worked sediments and the absence of the thick sand cover on the Brooksville Ridge. Drainage is internal. The open pit phosphate mining that occurred in this area in the early 1900's was due to the presence of the re-worked sediments and the thin sand cover (Williams *et al.*, 1977; Hoenstine *et al.*, 1990). In Newberry, there are still pits from these early mining operations.

2.2 GEOLOGY

There are four major geologic groups, or formations, (Figure 1d) that occur at or near the land surface in Alachua County (Spangler, 1985). These units, in order of decreasing age, are the Ocala Formation, the Hawthorn Group, reworked sediment (formerly the Alachua Formation), and the Plio-Pleistocene Terrace Deposits (Spangler, 1985; Scott, 1988). The western part of Alachua County is comprised of a relatively flat limestone plain underlain by the Ocala Formation (Williams *et al.*, 1977). This limestone is typically overlain by a thin mantle of sandy soils and some re-worked sediments. In the eastern part of the county, a sequence of Hawthorn Group sediments overlie the Ocala Formation.

The oldest formation penetrated by water wells in Alachua County is the Avon Park Formation. The Avon Park Formation is typically a hard, dense, tan to dark brown dolostone or dolomitic limestone. This formation may exceed 500 feet in thickness in eastern Alachua County (Clark *et al.*, 1964). Lying unconformably above the Avon Park Formation are a series of Upper Eocene age limestones, called the Ocala Formation, formerly the Ocala Group. The Ocala Formation is approximately 200 feet thick in the county and constitutes a major component of the Floridan aquifer system.

The Ocala Formation is the oldest formation to outcrop at land surface in Alachua County (Clark *et al.*, 1964; Williams *et al.*, 1977). This formation underlies the entire county, but occurs only at land surface in the western portion of the county. The elevation of the top of the Ocala Formation in Alachua County is shown in Figure 2 (Lindquist, 1992). The surface of the Ocala

Formation slopes towards the east. Elevations range from 0 feet NGVD in the northeastern part of the county to 60 feet above NGVD in western Alachua County (Figure 2). Limestone of the Ocala Formation is quarried in Alachua County, primarily in areas north and east of Newberry (Hoenstine *et al.*, 1990). This formation is white to cream colored, soft, granular, fossiliferous limestone (Williams *et al.*, 1977). Portions of this formation have been replaced by silica. Large boulders of chert remain as residual remnants of the re-worked limestone. They were formed by the in-situ replacement of the carbonate by silica, possibly from the clay overlying the limestone. Chert is also common along fractures or joints in the limestones and more common on the erosional surface or in close proximity to the silicious beds of the Hawthorn Group (Williams *et al.*, 1977).

Sediments of the Oligocene age are represented by silicified boulders of the Suwannee Limestone. This limestone formation is also reported in well logs from the vicinity of the Gainesville Municipal Airport (Clark *et al.*, 1964). This marine limestone may have been deposited unconformably on the sediments of the Ocala Formation in most of the county. Erosion has removed almost all traces of this unit. Residual boulders of Suwannee Limestone (containing molds of an echinoid, Rhyncholampus gouldii) are very common around High Springs, can be seen along the Santa Fe River, and have been found in areas near Newberry and Arredondo (Williams *et al.*, 1977).

Clastic sediments of the Miocene Series Hawthorn Group unconformably overlie the Ocala Formation sediments in central and eastern Alachua County. The Hawthorn Group is a complex unit comprised of interbedded and intermixed carbonate and clastic sediments containing varying percentages of phosphate (Scott, 1988). The Hawthorn Group in northern Florida is made up of four formations: the Penny Farms, the Marks Head, the Coosawhatchie, and the Statenville. Lithologically, the Hawthorn Group in northern Florida is comprised of a basal carbonate containing interbedded clastics (Scott, 1988).

There are few locations in Alachua County where sediments of the Hawthorn Group are exposed (Scott, 1988). These locations include some small creek banks north and east of Alachua, the eroded banks of Hogtown Creek in the Gainesville area, and the Devil's Mill Hopper. The extensive sections visible at the Devil's Mill Hopper are the best location in the county to view the Hawthorn sediments, although they are somewhat obscured by surficial sands and vegetation. Differentiation of the units at this location are difficult. Sections of the Hawthorn visible at Brooks Sink, north of Brooker, in Bradford County, give some indication of what Hawthorn sediments would be present in the northern part of Alachua County (Scott, 1988).

The Hawthorn Group (Figure 3, Lindquist and Arrington, 1989a) sediments are absent in west-central Alachua County. In north-eastern Alachua County they are present in thickness approaching 150 feet. The green, blue, or gray clays and sandy clays present in sediments of the Hawthorn Group provide a separation of the geologic units into distinct aquifer systems in the eastern portion of the county, (Dames & Moore, 1983). In the eastern portion of the county sediments of the Hawthorn Group confine the Floridan aquifer system.

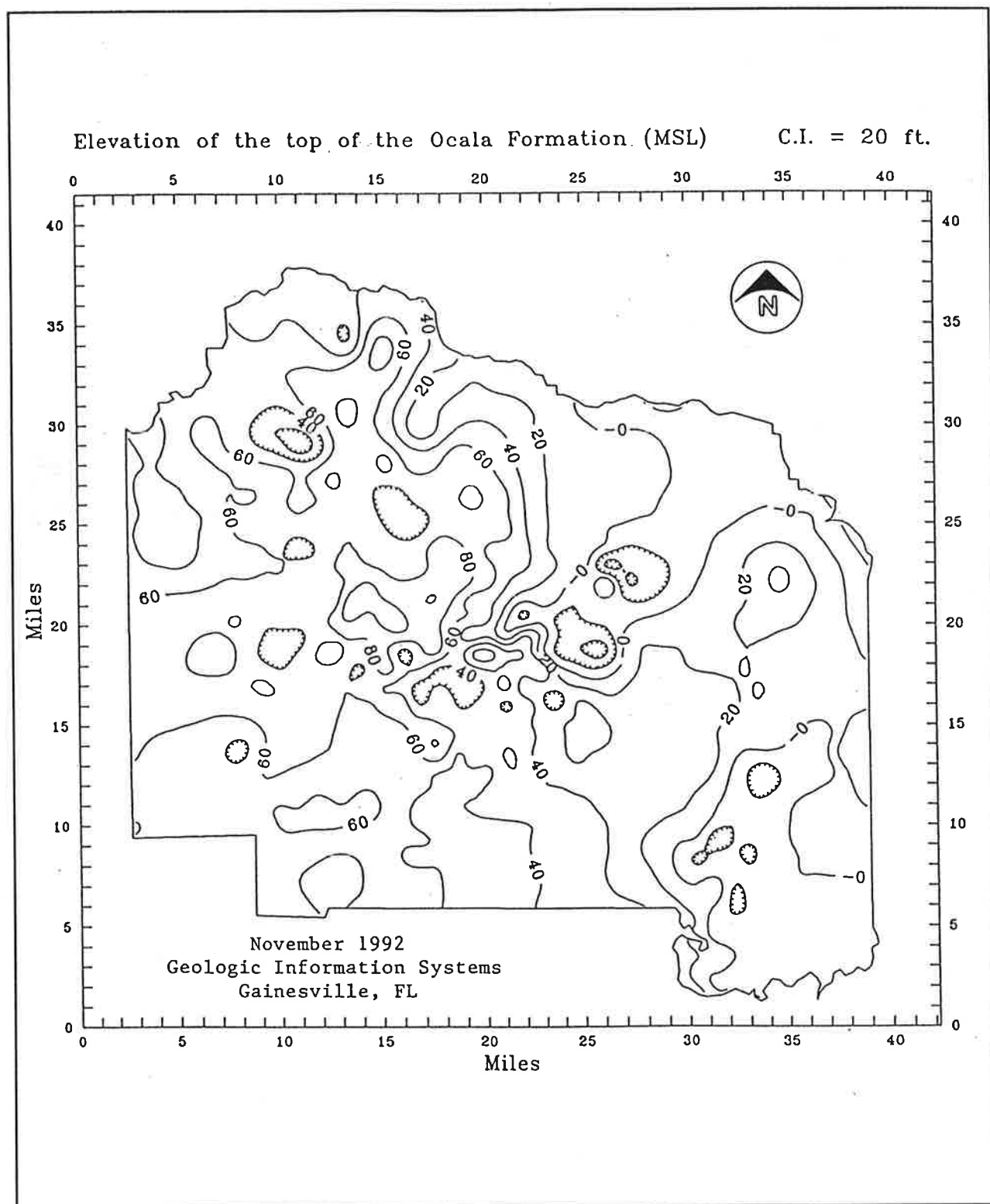


Figure 2 Elevation of the Top of the Ocala Formation, Alachua County, Florida

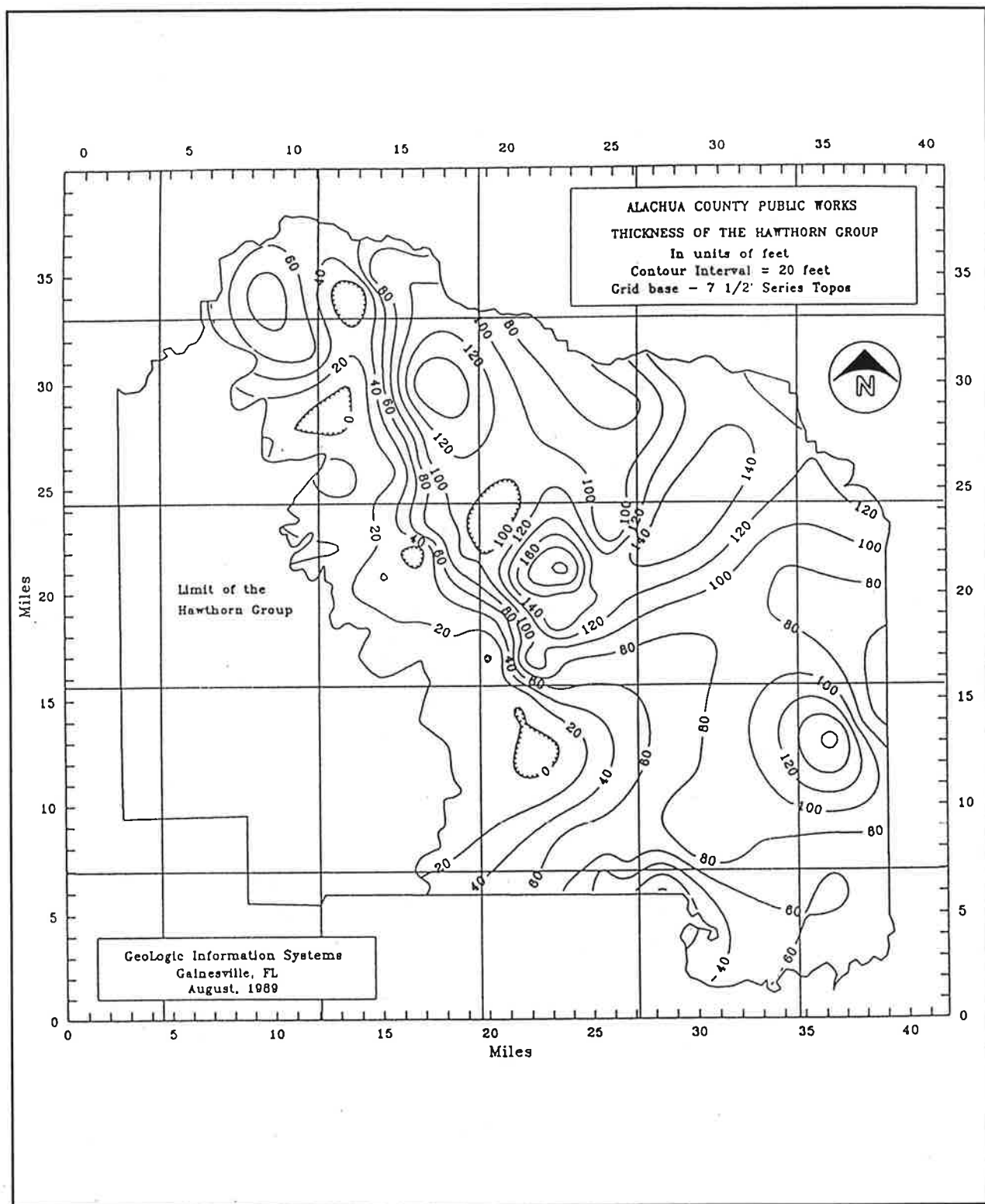


Figure 3 Thickness of the Hawthorne Group in Alachua County, Florida

In small areas of the southwestern corner of Alachua County sinkhole and channel fill deposits occur as Re-worked deposits (Williams *et al.*, 1977; Scott, 1988). These sediments lie directly on the Ocala Formation and are comprised of white, gray or buff sands, frequently containing clays, phosphate pebbles, and vertebrate fossils. The origin of these sediments appears to be the Hawthorn Group. As erosion of the Hawthorn sediments occurred in the western portion of the county, small solution features were filled with these re-worked deposits (Williams *et al.*, 1977; Scott, 1988).

A blanket of undifferentiated sands and clayey sands of Pliocene to Recent age form a thin veneer over most of Alachua County (Williams *et al.*, 1977). In the western part of the county these sediments directly overlie the Ocala Formation. In the central and eastern portion of the county these sands overlie the Hawthorn Group sediments. Figure 4 shows the thickness of these sediments throughout Alachua County (Lindquist and Arrington, 1989b).

2.3 WATER RESOURCES

There are three aquifer systems present in Alachua County: the surficial aquifer system, the intermediate aquifer system, and the Floridan aquifer system (SEGS, 1986). Aquifer system occurrence is caused by the geologic units present. The Floridan aquifer system underlies the entire county. The surficial and intermediate aquifer systems are present only in the eastern portion of the county where sediments of the Hawthorn Group are present. The Florida Hydrogeologic Units are defined by the Southeastern Geological Society Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition (SEGS, 1986).

The surficial aquifer system is defined as the permeable hydrogeologic unit encountered at land surface that contains unconsolidated to poorly indurated clastic deposits. It may be made up of carbonate rocks, other than those of the Floridan aquifer system. Materials of the surficial aquifer system belong to all or part of the upper Miocene to Holocene Series. The surficial aquifer system contains the water table, and the water within it is usually unconfined. The lower boundary of the surficial aquifer system is extensive and has vertically persistent beds of much lower permeability, such as the Hawthorn Group (SEGS, 1986).

The intermediate aquifer system, or intermediate confining unit, includes all rocks that lie between, and collectively retard the exchange of water between, the overlying surficial aquifer system and the underlying Floridan aquifer system (SEGS, 1986). In general, these deposits consist of fine grained clastic deposits, interlayered with carbonate rocks belonging to all or parts of the Miocene and younger series. The term "intermediate confining unit" applies to those places where there is poorly-yielding to non-yielding strata. The aquifers in the intermediate system contain water under confined conditions. The top of the intermediate aquifer system, or the intermediate confining unit, coincides with the base of the surficial aquifer system. The base of the intermediate aquifer is at the top of the permeable carbonates of the Floridan aquifer system (SEGS, 1986).

The Floridan aquifer system is a thick, carbonate sequence which includes all or part of the Paleocene to early Miocene Series and functions regionally as a water-yielding hydraulic unit

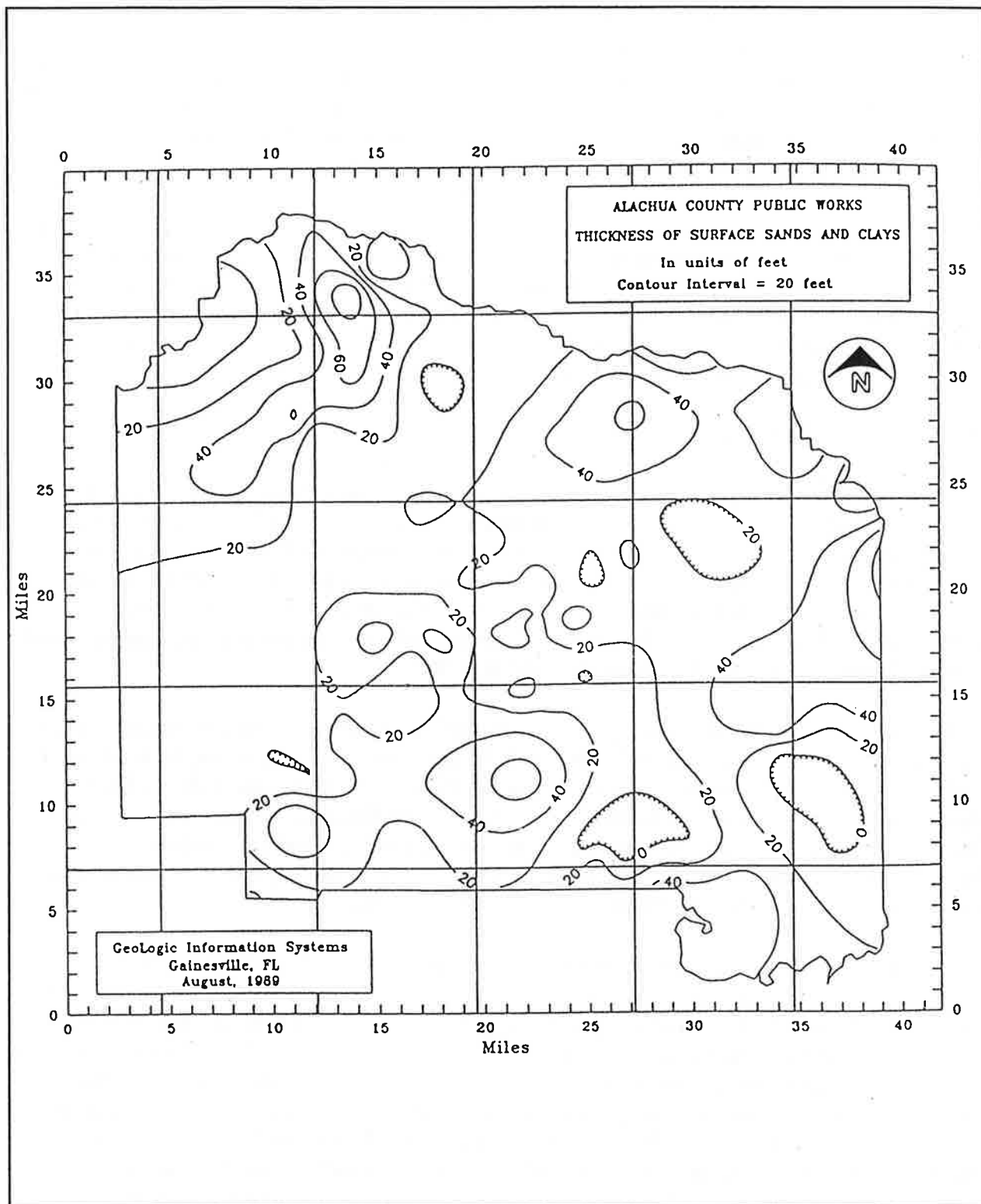


Figure 4 Thickness of the Surface Sands and Clays in Alachua County, Florida

(SEGS, 1986). Where overlain by either the intermediate aquifer system or the intermediate confining unit, the Floridan contains water under confined conditions. The base of the aquifer system in Alachua County coincides with the appearance of anhydrite beds that lie near the top of the Cedar Keys Limestone (SEGS, 1986).

Figure 5, which shows the degree of confinement of the Floridan aquifer system (Macesich, 1987) also illustrates areas where the Hawthorn Group sediments are present in the county. These sediments serve to confine the Floridan aquifer system. In western Alachua County the Floridan aquifer system is unconfined and sediments of the Ocala Formation are overlain by porous sand. In the central portion of the county, sediments of the Hawthorn Group overlie the Eocene limestones, but these sediments are perforated by sinkholes, providing a direct connection to the Floridan aquifer system. In the eastern portion of Alachua County, sediments of the Hawthorn Group overlie the Floridan aquifer system.

Figures 6 and 7 show the potentiometric surface of the Floridan aquifer system in Alachua County in 1992 and 1993, respectively. Measurements are made semi-annually to correspond with those made by the St. Johns River Water Management District for the U.S. Geological Survey. Both data sets are merged and the data plotted. The regional groundwater flow direction is from the east, a potentiometric high, to the west and northwest. The Floridan aquifer system discharges to springs along the Santa Fe River along the northern boundary of Alachua County. It should be noted that the area of influence of pumpage at the Murphree Well Field (center of the maps) appears larger in 1992 due to a lack of data points in the vicinity of the well field.

3.0 SUMMARY OF COOPERATIVE AGREEMENT # S004891-91-0 SPECIFIC OBJECTIVES

3.1 SELECTION OF A STUDY AREA

In Alachua County there are three municipalities with public supply wells located in areas where the Floridan aquifer system is under unconfined conditions (Table 1, Figures 5 and 8). These municipalities are Archer, High Springs, and Newberry.

Based on available well construction information, depth to groundwater, location and number of wells, and the interest in participation in the project, the City of Newberry was selected for the demonstration project (Figure 8). The City of Newberry staff reported a population of approximately 4,000 and a land area within the city limits of 14.5 square miles. The community is served by a single public water system comprised of three wells.

3.2 LAND USE INVENTORY

Existing land use within a one-mile radius of the public supply wells located in the City of Newberry was conducted using available data from the Alachua County Property Appraisers Office. Land use in six major categories (residential, commercial, industrial, institutional/government, and agricultural) is shown on Figure 9. Table 2 presents the estimated area of each of the six land use categories. A table of the data collected as part of the inventory is presented

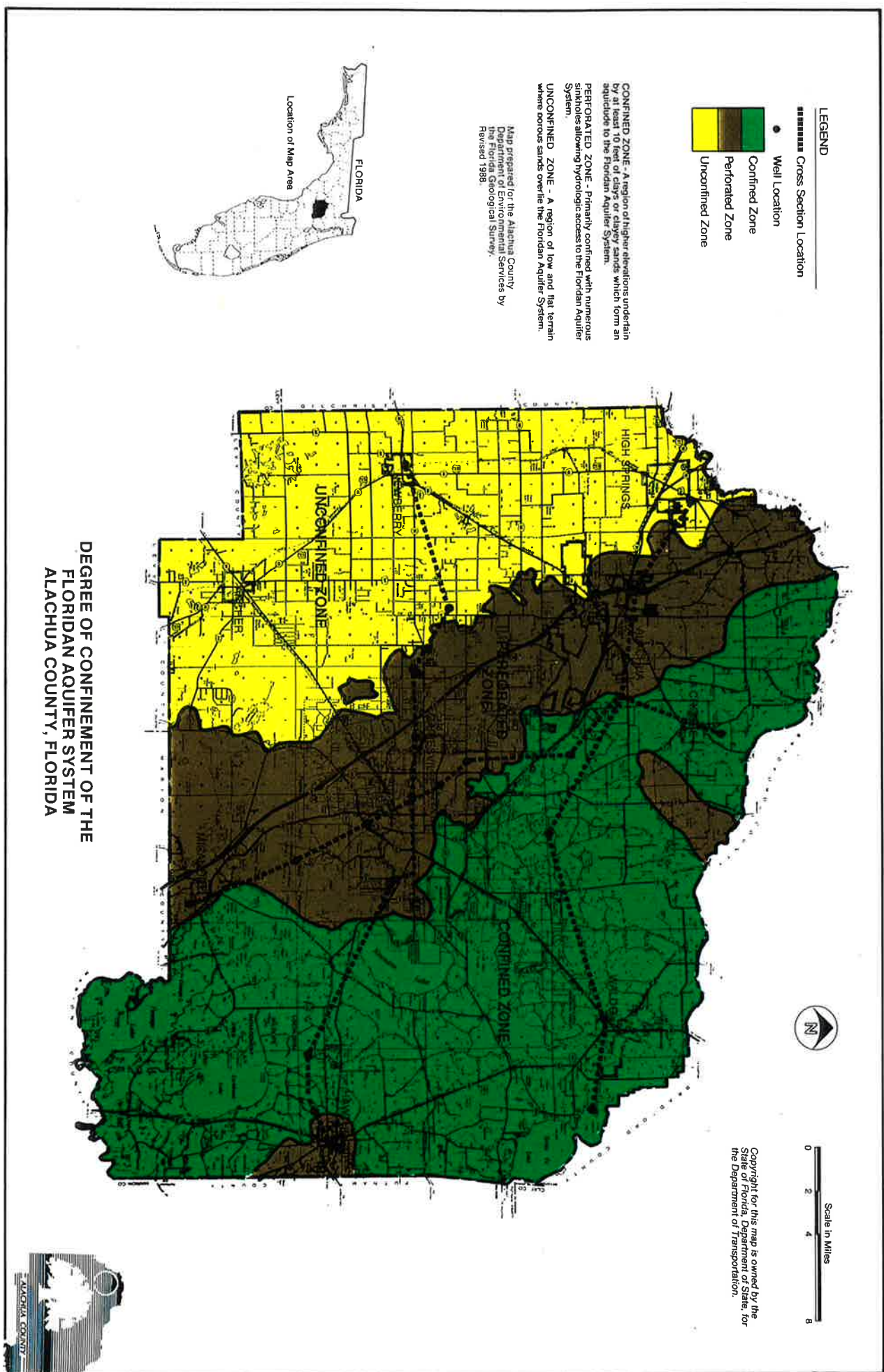


Figure 5 Degree of Confinement of the Floridan Aquifer System Alachua County, Florida

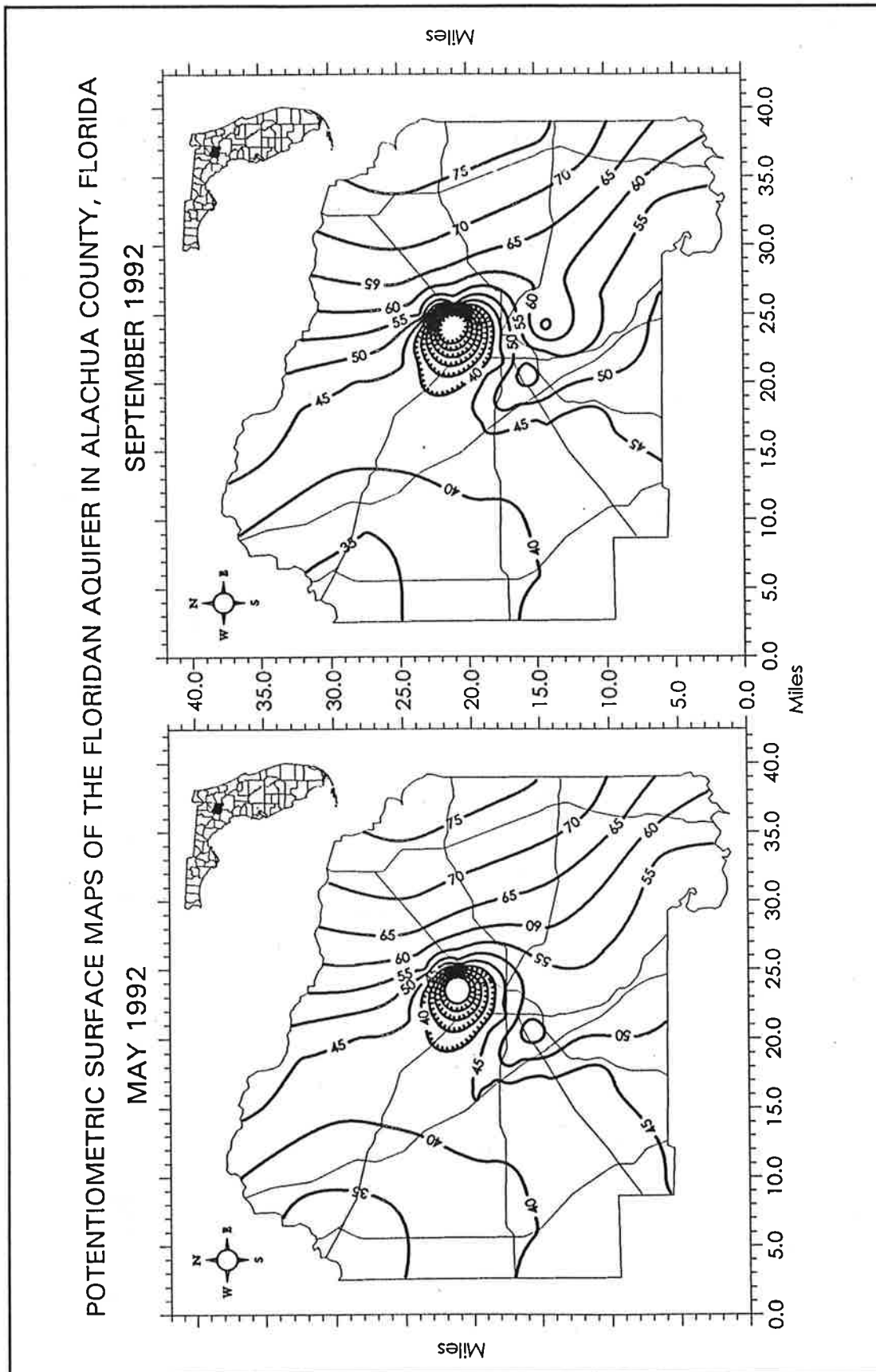


Figure 6 Potentiometric Surface Maps of the Floridan Aquifer System in Alachua County, Florida, May and September 1992

POTENTIOMETRIC SURFACE MAPS OF THE FLORIDAN AQUIFER IN ALACHUA COUNTY, FLORIDA MAY 1993 SEPTEMBER 1993

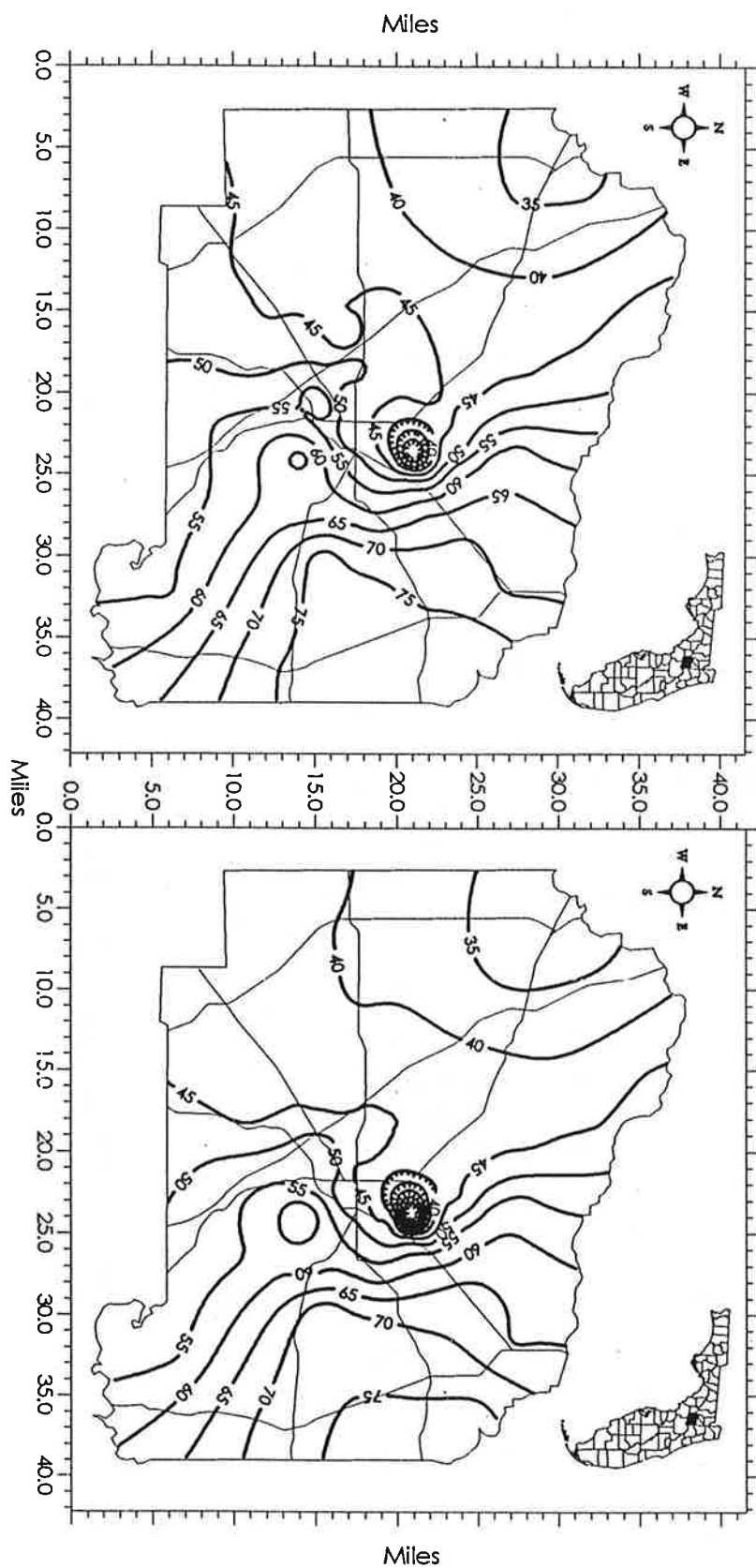


Figure 7 Potentiometric Surface Maps of the Floridan Aquifer System in Alachua County, Florida, May and September 1993

Table 1 Municipalities with Public Water Systems in Alachua County, Florida

Municipality	Water Supply Source	Aquifer System	Degree of Confinement*
Alachua	Groundwater	Floridan	Perforated
Archer	Groundwater	Floridan	Unconfined
Gainesville	Groundwater	Floridan	Confined
Hawthorne	Groundwater	Floridan	Perforated
High Springs	Groundwater	Floridan	Unconfined
Micanopy	Groundwater	Floridan	Perforated
Newberry	Groundwater	Floridan	Unconfined
Waldo	Groundwater	Floridan	Confined

* See Figure 5

Table 2 Existing Land Use of Parcels Located Within a One-Mile Radius of the Public Supply Wells in Newberry, Florida

Type of Land Use	Estimated Area (percent)
Residential	55
Commercial	2
Industrial	0.5
Institutional/Government	3.5
Agricultural	40

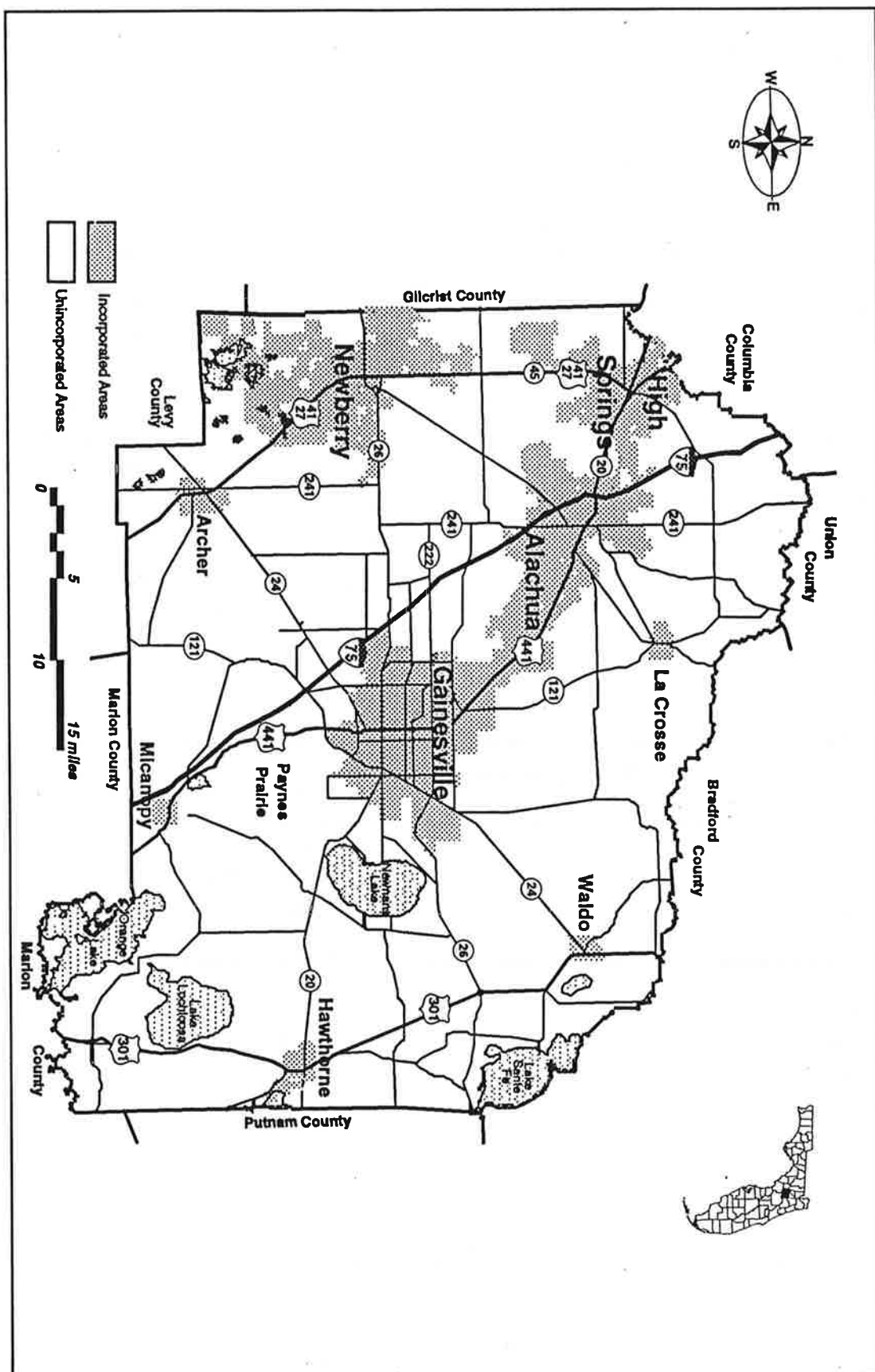


Figure 8 Locations of Municipalities in Alachua County, Florida

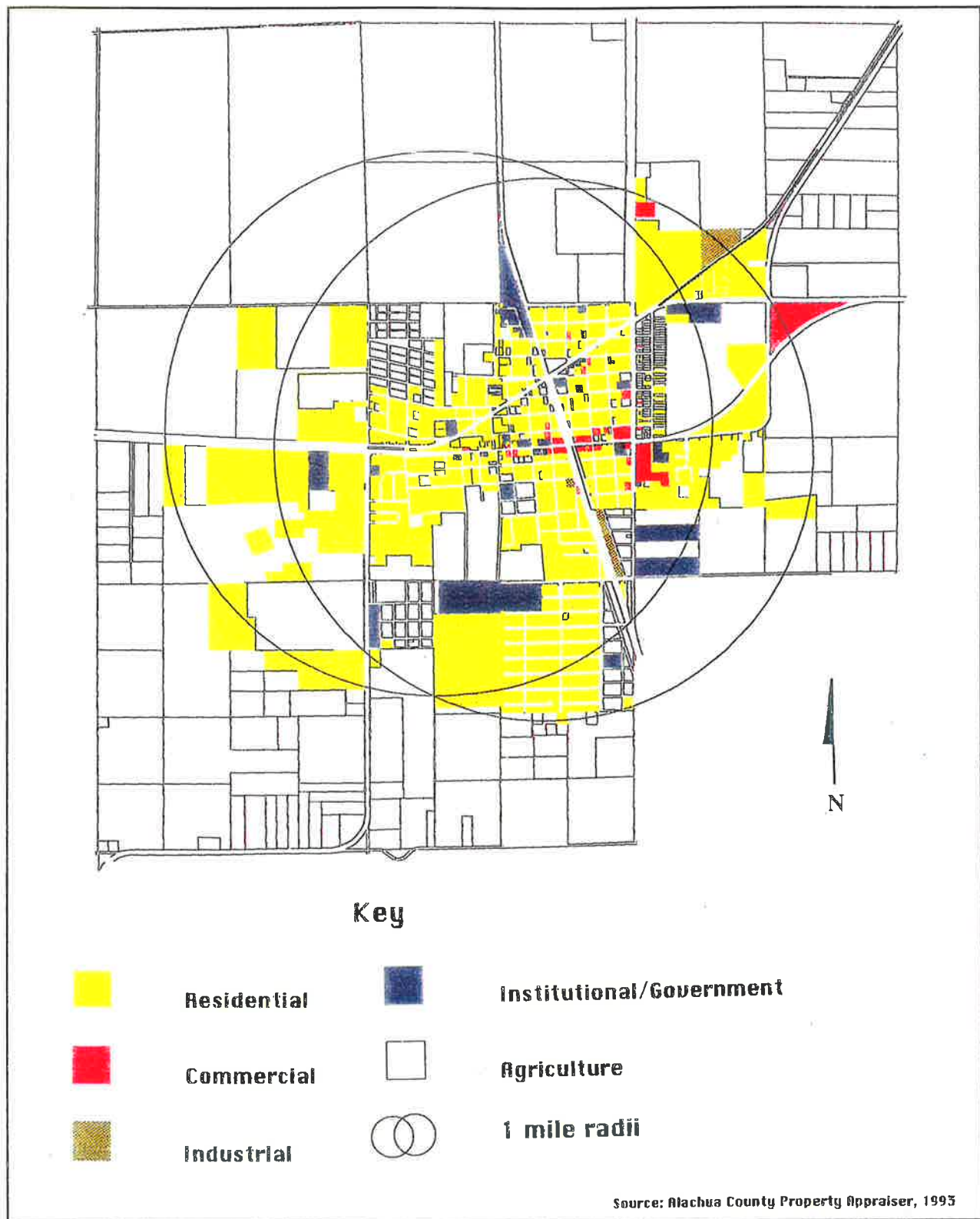


Figure 9 Existing Land Use of Parcels Located Within a One-Mile Radius of Newberry's Public Supply Wells

in Appendix A. Data in the table include: the Alachua County tax parcel number; section, township, and range; landuse category; owner name and address; and acreage. At the time the inventory was conducted, the data for Section 10 were not available.

3.3 FACILITIES INVENTORY

An inventory of potential point sources of groundwater pollution within a 1-mile radius of the City of Newberry public supply wells was conducted. Twenty-six facilities, or sites, that used or stored petroleum products or hazardous materials were inventoried. The inventory was based on information in the Alachua County Environmental Protection Department (ACEPD) files. The inventoried facilities were then inspected. Copies of the most recent inspection forms are presented in Appendix B. Table 3 presents a list of the sites, including: facility name, owner/operator, facility address, ACEPD facility number, the FDEP facility number, latitude, longitude, Alachua County tax parcel number, section, township, and range. The type of product stored, storage tank size, contaminant type, violations, and a brief history for each facility or site are presented in Tables 4a and 4b. Locations of the facilities or sites are shown in Figure 10 and on Plates I through IX (Volume Two).

Staff from our office conducted an inspection of the Newberry Public Works facility for compliance with Alachua County Ordinance 91-6 (Hazardous Materials Management Code) and Florida Statutes Chapter 403.7234. No major violations were noted. Our staff requested that the secondary containment waste area and secondary containment for the fuel storage area be coated with an impervious coating; oil contaminated soils be excavated and the areas filled with clean soils; and that all materials be stored on impervious surfaces. A copy of the inspection letter and photographs of the site are presented in Appendix C.

One facility not presented in the tables is the Newberry Wastewater Treatment Plant. This facility is located approximately 0.5 to 0.75 miles southeast of the Newberry public supply wells. The effluent disposal method at the facility is land application. The site has groundwater monitoring wells and quarterly compliance monitoring is conducted as a requirement of the FDEP operating permit.

3.4 HYDROGEOLOGIC DATA FOR PUBLIC SUPPLY WELLS

3.4.1. Available Data

The City of Newberry has three potable supply wells, #1, #2 and #3 (Figure 11). Copies of water management district water use permits and well construction reports can be found in Appendix D. All wells are constructed with steel casing and are completed "open hole". Well #1 is a 10-inch diameter well with 100 feet of casing and a total depth of 200 feet. Well #2 is a 12-inch diameter well with 90 feet of casing and a total depth of 167 feet. Well #3 is a 10-inch diameter well with 84 feet of casing and a total depth of 142 feet. All three wells are open to the Ocala Formation in the upper portion of the Floridan aquifer system. Well #1 may extend into the Avon Park Formation.

Table 3 An Inventory of Facilities that Use or Store Hazardous Materials or Petroleum Products Within
a One-Mile Radius of the City of Newberry/ Public Supply Wells, Alachua County, Florida

Facility	Owner/Operator	Address	ACDEP #	FDEP #	Latitude	Longitude	Tax Parcel #	Sect.	Twn	Rng	Map #
ABC Automotive	--	255 W. Central	9114	--	--	--	2208-003-000	3	10S	17E	1
Newberry High School	AC School Board	SW 9th Street	0263	18518897	293838	823651	1988-000-000	4	10S	17E	2
Auto Service Paint & Body	Chris Wood	175 S. Main	0026-01	--	293912	825925	1951-000-000	3	10S	17E	3
Ben's Trucking	Hayward McCoy	US 27	0633	--	--	--	1908-002-000	34	9S	17E	4
Bounds Heating & AC	Robert Bounds	595 W. Central	1512	--	--	--	2230-000-000	4	10S	17E	5
Newberry BP	Richardson Oil	20 E. Central	0188	18518077	293858	823642	2199-000-000	4	10S	17E	6
Brooker's Tractor Corp.	Loren Brooker	645 N. Main	0638-10	--	293947	823623	1961-000-000	4	10S	17E	7
Buddy's Custom Airboats	Buddy Jeffcoat	175 S. Main	0026	18500041	293912	825935	1951-000-000	3	10S	17E	8
Durst Auto & Truck	H. Farnsworth	230 N. Main	1575	--	--	--	2118-000-000	4	10S	17E	9
Farnsworth Oil Co.	H. Farnsworth	21 NW 2nd Ave.	0059	18500103	293858	823627	2118-000-000	4	10S	17E	10
A.M. Green Property	A.M. Green	SR 26	0738	19200104	293808	823623	2544-000-000	10	10S	17E	11
Holt's Brake & Tire	Charles Holt	90 NW 3rd Street	1608	--	--	--	2136-000-000	4	10S	17E	12
Hunt Funeral Home	Brooker T. Hunt	506 NE 7th Avenue	1188	--	--	--	1899-001-000	34	9S	17E	13
Jiffy #161	Marcia Click	90 S. Main	0089	18500162	293856	823628	1948-000-000	3	10S	17E	14
J & M Manufacturing	--	730 S. Main	0273-10	18520102	293805	823642	2530-000-000	9	10S	17E	15
Larry's Paint & Body	Larry Trotter	52 N. Main	0689	19047257	293925	823642	2195-000-000	4	10S	17E	16
Louis's Body Shop	Louis Toombs	198 N. Main	1576	--	--	--	2121-000-000	4	10S	17E	17
Mac Johnson's Roofing	Mac Johnson	390 SW Seaboard	1554	--	--	--	1989-000-000	4	10S	17E	18
Newberry Airstrip	D. Crocker	Rt. 337 South	0530	--	--	--	2538-008-000	9	10S	17E	19
Newberry Animal Hospital	J.A. Philpot	380 S. Main	1244	--	--	--	2263-003-000	4	10S	17E	20
Newberry Equipment Co.	Richard Yoh	633 N. Main	0638-00	19047246	293947	823643	1961-001-000	4	10S	17E	21
Newberry Public Works	Blaine Suggs	145 NW 9th Street	0454	18737201	293901	823654	2465-000-000	4	10S	17E	22
Nubby's Bait & Tackle	Evelyn McKoy	35 SW 1st Avenue	0588	18942976	293843	823626	2252-004-000	4	10S	17E	23
R.J.'s Lucky Seven	Robert Valdes	20 E. Central	0017	18500026	293841	823623	1967-001-000	3	10S	17E	24
Santa Fe Feed & Fertilizer	J.S. Clardy, Jr.	US 27 & SR 26A	0334	18626858	293942	823629	1915-001-000	34	9S	17E	25
Whittle's Roofing	O.D. Whittle	SR 26	9637	--	--	--	2512-001-016	5	10S	17E	26

-- No data available

Table 4a The Status of Facilities that Use or Store Hazardous Materials or Petroleum Products Within a One-Mile Radius of the City of Newberry Public Supply Wells, Alachua County, Florida

Facility	Owner/Operator	Address	Product Type	Tank Size (gallons)	Containment Type	Violations	History
ABC Automotive	-	255 W. Central	-	-	-	-	Never Inspected
Newberry High School	AC School Board	SW 9th Street	Gasoline Diesel Fuel Oil	2,000 15,000 1,000	Primary Primary Secondary	None	1989: Secondary containment installed
Auto Service Paint & Body	Chris Wood	175 S. Main	Used oil Thinner	55 55	Drum Drum	No secondary containment	1993: Out of business
Bert's Trucking	Hayward McCoy	US 27	Gasoline	2,000	Primary	Improperly abandoned*	-
Bounds Heating & AC	Robert Bounds	595 W. Central	-	-	-	-	-
Newberry BP	Richardson Oil	20 E. Central	Gasoline Gasoline Gasoline Diesel Cleaner Used oil	8,000 8,000 8,000 4,000 55 55	Secondary Secondary Secondary Secondary Drum Drum	1993: Piping sumps and dispensers improperly installed No secondary containment; soil contamination	1990: Used oil and kerosene tanks removed
Brooker's Tractor Corp.	Loren Brooker	645 N. Main	Diesel	900	Primary	1992, 1993: Improperly abandoned*	FKA Newberry Equip. Co.
Buddy's Custom Airboats	Buddy Jeffcoat	175 S. Main	Gasoline Gasoline Gasoline Gasoline Diesel	1,000 2,000 2,000 3,000 1,000	Primary Primary Primary Primary Primary	1992, 1993: Improperly abandoned*	FKA Buddy's Phillips 66
Durst Auto & Truck	H. Farnsworth	230 N. Main	Thinner	Unknown	Unknown	Unknown	-
Farnsworth Oil Co.	H. Farnsworth	21 NW 2nd Ave.	None	None	-	None	Before 1989: 5 gasoline, diesel, & kerosene

Table 4a The Status of Facilities that Use or Store Hazardous Materials or Petroleum Products Within
a One-Mile Radius of the City of Newberry Public Supply Wells, Alachua County, Florida (continued)

Facility	Owner/Operator	Address	Product Type	Tank Size (gallons)	Containment Type	Violations	History
A.M. Green Property	A.M. Green	SR 26	Gasoline	550	Steel	None	1989: Diesel tank removed
Holt's Brake & Tire	Charles Holt	90 NW 3rd Street	Used oil	25	Drum	No secondary containment; open containers	--
Hunt Funeral Home	Brooker T. Hunt	506 NE 7th Avenue	Formaldehyde	Varies	Sharp's container	None	--
Jiffy #161	Marcia Glick	90 S. Main	Gasoline Gasoline Gasoline Diesel	10,000 10,000 10,000 4,000	Primary (tanks) Secondary (piping)	None	1991: Leak detection not working
J & M Manufacturing	--	730 S. Main	Gasoline Diesel Diesel Unknown	1,000 550 550 55	Steel (Primary, aboveground) Drum	No secondary containment No secondary containment	FKA Winnebago Drainage Systems & County Plastics
Larry's Paint & Body	Larry Trotter	52 N. Main	Gasoline Gasoline Used oil Thinner	2,000 2,000 5,000 <10	Primary Steel	1991, 1992: Improperly abandoned*	--
Louis' Body Shop	Lotis Toombs	198 N. Main	Thinner	<10	Primary	None	--
Mac Johnson's Roofing	Mac Johnson	390 SW Seaboard	Used oil	55	Drum	Open container	--
Newberry Airstrip	D. Crocker	Rt. 337 South	Pesticide	--	--	--	1991: FDEP site closure
Newberry Animal Hospital	J.A. Philpot	380 S. Main	Photo-waste	40	Small containers	None	--
Newberry Equipment Co.	Richard Yoh	633 N. Main	Diesel	900	Primary	1992, 1993: Improperly abandoned*	--

Table 4a. The Status of Facilities that Use or Store Hazardous Materials or Petroleum Products Within
a One-Mile Radius of the City of Newberry Public Supply Wells, Alachua County, Florida (continued)

Facility	Owner/Operator	Address	Product Type	Tank Size (gallons)	Containment Type	Violations	History
Newberry Public Works	Blaine Suggs	145 NW 9th Street	Gasoline Diesel	1,000 1,000	Primary (aboveground)	Soil contamination	1990: Gasoline and diesel tanks removed
Nubby's Bar & Tackle	Evelyn McKay	35 SW 1st Avenue	Gasoline Gasoline Gasoline Gasoline	3,000 3,000 500 500	Primary Primary Primary Primary	Improperly abandoned*	-
R.J.'s Lucky Seven	Robert Valdes	20 E. Cental	Gasoline Gasoline Gasoline Gasoline Diesel	4,000 4,000 4,000 4,000 1,000	Primary Primary Primary Primary Primary (aboveground)	None	1990: Began "Monitoring Only" following contamination assessment
Santa Fe Feed & Fertilizer	J.S. Clardy, Jr.	US 27 & SR 26A	None	None	-	None	Before 1989: Gasoline tank removed
Whittle's Roofing	O.D. Whittle	SR 26	-	-	-	-	

- No data available

FKA = Formerly Known As

* Tanks are no longer used, but have exceeded allowable time for proper removal or replacement.

TABLE 4b Historical Summary of Petroleum and Hazardous Materials Facilities Near the City of Newberry, Florida

Facility	History
ABC AUTOMOTIVE	(HM) This facility has been determined to be a potential site for regulation under the Hazardous Management Code (HMMC) due to the possible presence of used oil and thinner. This facility has never been inspected.
ACSB - NEWBERRY H.S.	(PETROLEUM) A 1,000 gal. fuel oil UST was abandoned in place 987. A 2,000 gal. gasoline UST was removed in 1987. There was a spill in 1990 of <5 gal., during the installation a 15,000 gal. diesel UST. This facility appears to be in compliance with 62-761, F.A.C.
AUTO SERVICE PAINT & BODY	(HM) This facility was closed in 9/93. No violations were noted.
BP - NEWBERRY	(HM) The presence of soil contamination from used oil drums has been detected at this facility. No secondary containment has been provided for drums containing parts cleaner*. Further action is to be taken, pending disposition instructions from the FDEP. (PETROLEUM) This facility is out of compliance with 62-761.500(3): USTs were not installed by a certified contractor, according to manufacturer's instructions. The secondary containment is neither product nor water tight.
BEN'S TRUCKING	(PETROLEUM) This facility is in violation of 62-761, F.A.C.: one UST was improperly removed. No closure assessment has been performed to date.
BROOKER'S TRACTOR CORP.	(HM) This facility appears to be in compliance with the HMMC.
BUDDY'S AIRBOATS	(PETROLEUM) This facility is in violation of 62-761.800, F.A.C.: improper abandonment of all USTs. Facility was formerly a gas station (Buddy's '66). There has been no change of ownership.
DURST AUTO & TRUCK	(HM) This facility appears to be in violation of the HMMC: no secondary containment for thinner*; floor drains are unsealed. This facility has been in operation for three years with the existing violations.
FARNSWORTH OIL	(PETROLEUM) This facility has been out of service since 1980. All USTs were removed prior to 1989.
A.M. GREEN PROP.	(PETROLEUM) This site appears to be in compliance with 62-761. A gasoline leak, due to tank corrosion, was discovered in 1992. At that time, 12" of product was removed by the United Fuels Corporation.

TABLE 4b Historical Summary of Petroleum and Hazardous Materials Facilities Near the City of Newberry, Florida (continued)

Facility	History
HOLT'S BRAKE & TIRE	(HM) This facility appears to be in violation of the HMMC: no secondary containment*; open containers. This facility has been in operation since 11/92 with the existing violations.
HUNT FUNERAL HOME	(HM) This facility has been determined to be a potential site for regulation under the HMMC, due to the possible presence of formaldehyde. This facility has never been inspected.
JIFFY #161	(PETROLEUM) This facility appears to be in compliance with 17-761. The leak detection system was found to be functioning improperly in both 1991 and 1993, and was repaired both times.
J.M. MANUFACTURING	(HM) This facility was originally known as Winnebago Drainage Systems, then as Country Plastics. It was purchased in 8/92 by J.M. Manufacturing. This facility appears to be in violation of the HMMC: the drum storage area has a cracked secondary containment structure; two existing diesel AST's have cracked secondary containment structures; and surface run-off is directed towards a nearby sink hole.
LARRY'S PAINT & BODY	(HM) This facility appears to be in violation of the HMMC due to no secondary containment*; open containers; and rainwater accumulation (which can lead to corrosion of containers).
LOUIS' BODY SHOP	(HM) This facility appears to be in violation of the HMMC: no secondary containment*; open containers.
MAC JOHNSON'S	(HM) This facility appears to be in violation of the HMMC: open containers.
NEWBERRY AIRSTRIP	(PETROLEUM) This facility is out of service. An FDEP site closure was performed in 1991.
NEWBERRY ANIMAL HOSPITAL	(HM) This facility appears to be in violation of the HMMC: open containers; suspected photo waste discharges to sewer.
NEWBERRY EQUIPMENT CO.	(PETROLEUM) This facility appears to be out of compliance with 62-761.800, F.A.C.: improperly abandoned UST. To date, no closure assessment has been performed.
NEWBERRY PUBLIC WORKS	(PETROLEUM) This facility has been out of service since 1990. Prior to removal, USTs were operated without secondary containment. During removal, soil contamination was discovered within 100' of a currently operational city well facility. No Containment Assessment Report has been performed to date.

TABLE 4b Historical Summary of Petroleum and Hazardous Materials Facilities Near the City of Newberry, Florida (continued)

Facility	History
NUBBY'S BAIT & TACKLE	(PETROLEUM) This facility appears to be out of compliance with 62-761. The tanks were improperly abandoned and have now exceeded the allowable time for proper removal and replacement. This site is ineligible for EDI due to the lack of evidence of contamination.
R.J.'S LUCKY SEVEN QUICK MART	(PETROLEUM) This facility was placed on "Monitoring Only" status under the EDI program, following a contamination assessment.
SANTA FE FEED & FERTILIZER	(PETROLEUM) All USTs were removed prior to 1989.
WHITTLE'S ROOFING	(HM) This facility has been determined to be a site for regulation under the HMMC, due to the possible presence of sealants, adhesives, and tar. No inspection has been performed to date.

* (HM) Facilities that are required to install an approved secondary containment system by 1/1/95.

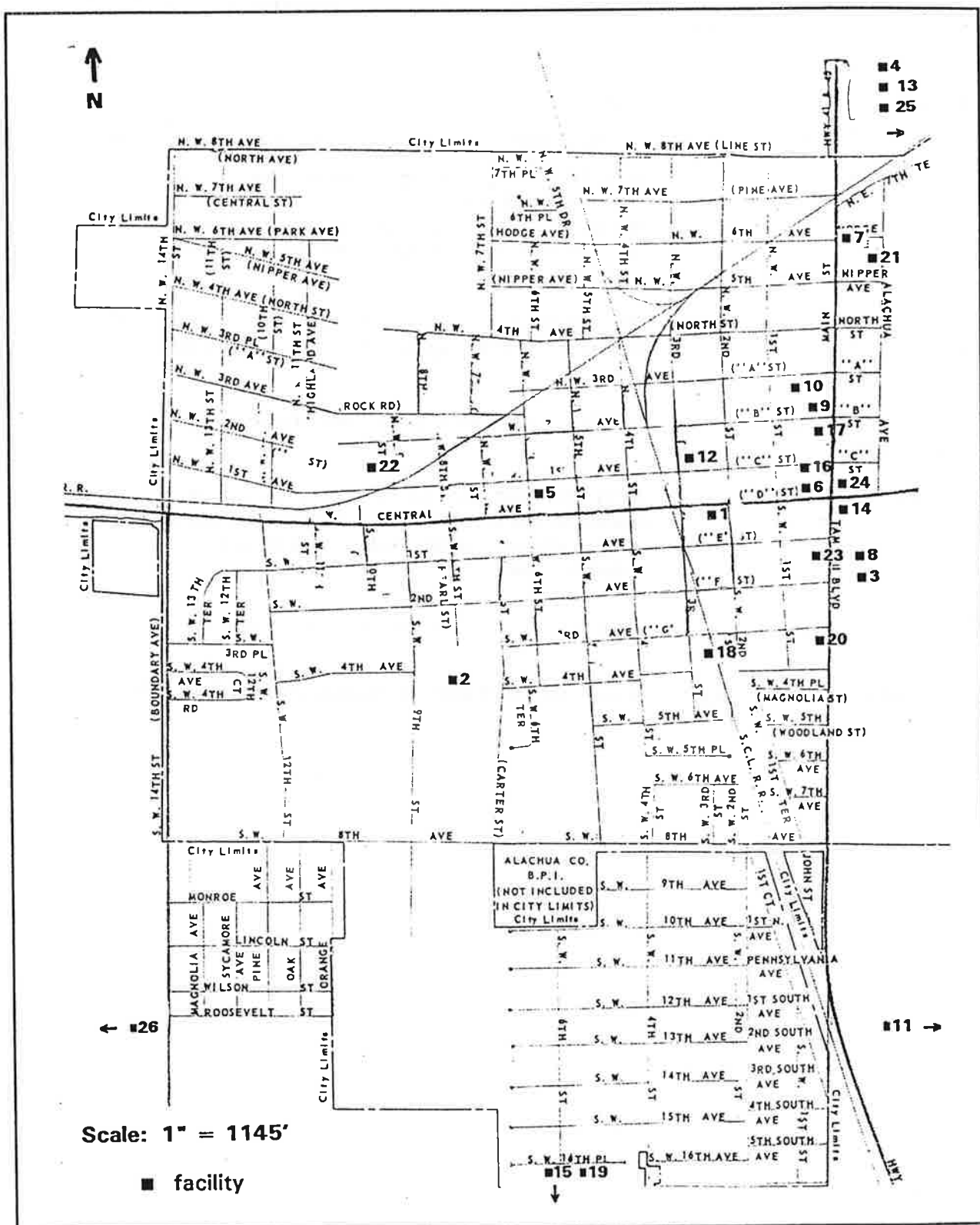


Figure 10 Locations of Facilities that Use or Store Hazardous Materials or Petroleum Products Within a One-Mile Radius of the City of Newberry Public Supply Wells, Alachua County, Florida

3.4.2 Cone of Depression and Pump Influence

To determine the influence of pumping, water level measurements were made in adjacent wells. All three public supply wells are pumped on a rotating schedule. Wells #1 and #3 are located closest together (Figure 11). They are approximately 200 feet apart. Static water level measurements were made in both wells on October 13, 1992 when neither well was being pumped. Drawdown was then measured in well #3 when well #1 was pumping. Discharge rate from well #1 was 575 gallons per minute (gpm). At this pumping rate less than 0.02 feet of drawdown was measured in well #3. Measurements made when well #3 was pumped at 450 gpm confirmed the relatively small drawdown. These small drawdowns can be attributed to the high productivity of the aquifer system.

3.5 WELL INVENTORY AND POTENTIOMETRIC SURFACE MAPPING

3.5.1 Well Inventory from Available Data

Data for permitted and located wells were obtained from the Suwannee River Water Management District (SRWMD). A list of these wells is presented in Table 5. The wells are listed by SRWMD record number. The table contains information on location, well use, casing diameter, casing depth, and total depth. Selected wells from this list were used for potentiometric mapping.

3.5.2 Field Well Inventory

In an effort to locate additional wells for potentiometric surface mapping throughout the Newberry area, a field inventory was conducted. Table 6 presents a list of the inventoried wells used for potentiometric surface mapping. A permission to enter property form, well data sheet, photographs, and well completion reports (where available) for the wells are presented in Appendix E.

3.5.3 Measuring Point Elevation Survey

For the purpose of producing a potentiometric surface map of the upper portion of the Floridan aquifer system the elevation of the measuring-point at each well was established. The firm of Eng, Denman & Associates conducted the survey. The measuring point elevations, relative to NGVD, for each well are presented in Table 6 and Appendix F.

3.5.4. Potentiometric Surface Mapping

Water level data from over thirty wells were collected three times during the project for the purpose of constructing potentiometric maps of the upper portion of the Floridan aquifer system in the vicinity of Newberry. Data were collected on May 22, 1992; September 17, 1992; and May 13, 1993. Water surface elevations, in reference to NGVD, are presented in Table 6. The raw data are presented in Appendix G.

Table 5 An Inventory of Water Management District Permitted and Located Wells in the Vicinity of Newberry, Florida

SRWMD Record Number	Township Range Section	SRWMD Site ID Number	SRWMD DPERMIT Number	Latitude	Longitude	Owner	Well Use	Casing Diameter (inches)	Casing Depth (feet)	Total Depth (feet)
289	091732	-	383	-	-	R D WILLIAMS	RESIDENTIAL	4	73.6	82
442	091732	-	8989	-	-	ROGER D WILLIAMS	RESIDENTIAL	4	69	120
443	091732	-	9198	-	-	JOHN CATCHES	RESIDENTIAL	4	63	80
444	091732	-	11419	-	-	JAMES RUMMELL	RESIDENTIAL	4	-	84
688	091733	-1091733002	10879	-	-	RUFUS H ROLAND	IRRIGATION	10	-	166
694	091734	-	2816	-	-	CHARLES DGWINKLER	RESIDENTIAL	4	-	-
741	091734	-	2817	-	-	CHARLES DGWINKLER	RESIDENTIAL	4	-	-
753	091734	-	2818	-	-	CHARLES DGWINKLER	RESIDENTIAL	4	-	-
755	091734	-	423	-	-	CHARLES DGWINKLER	RESIDENTIAL	4	-	-
782	091734	-	1016	-	-	RALPH SHEFFIELD	RESIDENTIAL	4	70	90
788	091734	-	9159	-	-	NEWBERRY CABINET	RESIDENTIAL	2	-	-
837	091734	-	9160	-	-	LEON HADSOCK	RESIDENTIAL	4	63.5	100
1027	101703	-	5669	-	-	LEON HADSOCK	RESIDENTIAL	4	-	-
1116	101703	-	8136	-	-	FLETCHER FARM EQUIP CO	RESIDENTIAL	4	-	-
1259	101703	-	8346	-	-	ROBERT MCKENZIE	RESIDENTIAL	4	94	100
1281	101703	-	8467	-	-	MICHAEL LIDDLETON	RESIDENTIAL	4	65	100
1337	101704	-	907	-	-	J W MCAFEE	RESIDENTIAL	4	63	105
1425	101704	-	4528	-	-	TOM APARCIO	RESIDENTIAL	4	75	85
1445	101704	-	4856	-	-	BOBBY LITTLE	IRRIGATION	4	63	87
1595	101704	-	5500	-	-	PAUL NORFLEET	RESIDENTIAL	4	45	85
1616	101704	-	6645	-	-	PAUL ROBERT	IRRIGATION	4	-	-
1633	101704	-	8587	-	-	RODNEY BARBER	RESIDENTIAL	4	120	135
1756	101704	-	11425	-	-	CARROLL COMBEE	RESIDENTIAL	4	65	97
1790	101705	-	1020	-	-	CITY OF NEWBERRY	PUBLIC SUPPLY	10	-	-
1824	101705	-	1226	-	-	TIMOTHY MUSSEY	RESIDENTIAL	4	-	-
1851	101705	-	1277	-	-	HELEN MELTON	RESIDENTIAL	4	100	100
1868	101705	-	1598	-	-	ERIC C BOWMAN	RESIDENTIAL	4	84	107
1889	101705	-	2960	-	-	HAROLD DICK	RESIDENTIAL	4	96	138
1945	101705	-	6757	-	-	R L SULLIVAN	RESIDENTIAL	4	63	100
1968	101705	-	6863	-	-	KENNETH HEASLETT	RESIDENTIAL	4	90	95
1969	101708	-	3485	-	-	JEFF SNYDER	RESIDENTIAL	4	57	80
1974	101708	-	10664	-	-	SYLVESTER BASS	RESIDENTIAL	4	63	93
2113	101708	-	10742	-	-	THOMAS CAMPBELL	RESIDENTIAL	4	-	-
2176	101708	-	11430	-	-	ED COMPELL	RESIDENTIAL	4	63	98
2191	101708	-	11939	-	-	C R KARIPOTT	RESIDENTIAL	4	74	100
		-		-	-	DAVID MARTINEAU	RESIDENTIAL	4	87	115

Table 5 An Inventory of Water Management District Permitted and Located Wells in the Vicinity of Newberry, Florida (continued)

SRWMD Record Number	Township Range Section	SRWMD Site ID Number	SRWMD DPERMIT Number	Latitude	Longitude	Owner	Well Use	Casing Diameter (inches)	Casing Depth (feet)	Total Depth (feet)
2205	101709	-	7677	-	-	GLEN MCELROY	RESIDENTIAL	4	63	85
2216	101709	-	10163	-	-	SHERRY COOK	RESIDENTIAL	4	80	104
2276	101709	-	10812	-	-	LUCILLE M KING	RESIDENTIAL	4	100	120
2277	101710	-	1050	-	-	M S BASS	RESIDENTIAL	4	78	128
2278	101710	-	4407	-	-	CHARLIE L FUTCH	IRRIGATION	10	-	-
2335	101710	-101710001	7913	-	-	A M GREEN	IRRIGATION	10	118	160
7839	091732	-091732001	15344	293927	823808	E D NORFLEET	IRRIGATION	12	-	-
7840	091732	-091732002	-	293925	823809	R D WILLIAMS	IRRIGATION	10	-	-
7841	091732	-091732004	35959	293942	823810	E D NORFLEET	IRRIGATION	12	-	-
7842	091733	-091733001	18924	293928	823710	RUFUS H ROLAND	RESIDENTIAL	4	-	-
7843	091733	-091733002	10879	293950	823640	RUFUS H ROLAND	IRRIGATION	10	-	-
7844	091734	-091734001	-	293918	823552	MRS MAYWELL	RESIDENTIAL	4	-	-
7845	091734	-091734002	39223	293942	823623	PERCY MCGHEE	RESIDENTIAL	4	-	-
8678	101703	-101703001	-	293833	823554	E H GRAVELY	IRRIGATION	8	-	-
8679	101704	-101704001	-	293838	823644	CITY OF NEWBERRY	PUBLIC SUPPLY	10	-	-
8680	101704	-101704002	-	293844	823645	CITY OF NEWBERRY	PUBLIC SUPPLY	10	-	-
8681	101704	-101704003	-	293848	823705	CITY OF NEWBERRY	PUBLIC SUPPLY	10	-	-
8682	101704	-101704005	-	293849	823705	CITY OF NEWBERRY	PUBLIC SUPPLY	12	-	-
8683	101704	-101704006	18621	293859	823628	MAXIE PERKINS	RESIDENTIAL	4	-	-
8684	101704	-101704007	17500	293822	823629	WINNEBAGO DRAINAGE SYS	COMMERCIAL	6	-	-
8685	101704	-101704008	24647	293820	823719	MEL VIN COLOMAN	RESIDENTIAL	2	-	-
8686	101704	-101704009	27875	293846	823719	SAM GETZEN	RESIDENTIAL	4	-	-
8687	101704	-101704010	27545	293814	823702	CITY OF NEWBERRY	IRRIGATION	4	-	-
8688	101704	-101704011	28142	293817	823649	MIKE HARTEOS	RESIDENTIAL	1	-	-
8689	101704	-101704012	27681	293842	823635	R C BRANK	RESIDENTIAL	4	-	-
8690	101704	-101704013	30449	293843	823630	R C BRANK	RESIDENTIAL	4	-	-
8691	101704	-101704014	36641	293848	823705	CITY OF NEWBERRY	PUBLIC SUPPLY	10	-	-
8692	101705	-101705002	37103	293843	823740	KEN HORNBY	RESIDENTIAL	4	-	-
8695	101708	-101708001	-	293727	823757	JOYCE BEHRENS	RESIDENTIAL	4	-	-
8696	101708	-101708002	16638	293729	823729	HERBERT MARLOWE JR.	RESIDENTIAL	4	-	-
8697	101708	-101708003	30360	293753	823742	MIKE MCDANIELS	RESIDENTIAL	4	-	-
8698	101709	-101709001	-	293817	823722	NORTH FL CROP DUST	RESIDENTIAL	-	-	-
8699	101709	-101709002	19811	293728	823708	SHERMAN WATERS	RESIDENTIAL	-	-	-
8700	101709	-101709003	30453	-	-	UNKNOWN	RESIDENTIAL	-	-	-
8701	101710	-101710001	7913	293755	823609	A M GREEN	IRRIGATION	10	-	-

Table 5 An Inventory of Water Management District Permitted and Located Wells in the Vicinity of Newberry, Florida (continued)

SRWMD Record Number	Township Range Section	SRWMD Site ID Number	SRWMD DPERMIT Number	Latitude	Longitude	Owner	Well Use	Casing Diameter (inches)	Casing Depth (feet)	Total Depth (feet)
324	091732	-091732001	15344	-	-	E D NORFLEET	IRRIGATION	12	200	409
440	091732	-091732004	35959	-	-	E D NORFLEET	IRRIGATION	12	59	150
858	091732	-	17755	-	-	ROGER D WILLIAMS	RESIDENTIAL	4	63	100
924	091734	-	14438	-	-	STANLEY C MCKAY	RESIDENTIAL	4	63	80
1284	091734	-091734002	39223	-	-	PERCY MCGHEE	RESIDENTIAL	4	80	100
1707	091734	-	17160	-	-	TOMMY HINES	RESIDENTIAL	2	60	90
1744	091734	-	18099	-	-	DAVID WOODCOCK	RESIDENTIAL	4	42	70
1745	091734	-	34492	-	-	D W BROWN	RESIDENTIAL	4	42	78
1746	091734	-	35645	-	-	WYVIS HUNT	RESIDENTIAL	4	69	84
1893	091734	-	35714	-	-	A D WOODCOCK	RESIDENTIAL	4	63	90
2203	091734	-	36221	-	-	JOE CRENSHAW	RESIDENTIAL	4	72	90
2225	101703	-101703002	13477	-	-	JIM DURRANCE	RESIDENTIAL	4	-	120
3496	101703	-	15366	-	-	JAMES DUBOIS	RESIDENTIAL	4	63	85
3732	101703	-	17545	-	-	NEWBERRY BK (SHORE BLDs	IRRIGATION	4	90	100
4017	101703	-	20340	-	-	DORSEY GALLAGHER	RESIDENTIAL	4	70	90
4357	101703	-	20578	-	-	BURNELL PARKER	RESIDENTIAL	4	60	100
4402	101703	-	23076	-	-	JAMES RICHARDSON	MONITOR	2	10	25
4433	101703	-	23077	-	-	JAMES RICHARDSON	MONITOR	2	10	25
4612	101703	-	23078	-	-	JAMES RICHARDSON	MONITOR	2	10	25
4956	101703	-	23079	-	-	JAMES RICHARDSON	MONITOR	2	10	25
5478	101703	-	24840	-	-	MCB OIL COMPANY	MONITOR	2	2	10
5728	101703	-	25021	-	-	MCB OIL COMPANY	MONITOR	2	2	10
6668	101703	-	25022	-	-	MCB OIL COMPANY	MONITOR	2	2	10
7197	101703	-	25023	-	-	MCB OIL COMPANY	MONITOR	2	2	10
7435	101703	-	29725	-	-	HUNTLEY JIFFY STORES	MONITOR	4	18	20
7627	101703	-	29727	-	-	HUNTLEY JIFFY STORES	MONITOR	4	18	20
8395	101703	-	29728	-	-	HUNTLEY JIFFY STORES	MONITOR	4	18	20
8474	101703	-	29730	-	-	HUNTLEY JIFFY STORES	MONITOR	4	18	25
8767	101703	-	41031	-	-	GREG SPEARS	RESIDENTIAL	4	77	91
8768	101703	-	41190	-	-	FL DER	MONITOR	4	84	120
8769	101703	-	41626	-	-	FL DER	MONITOR	4	35	50
8770	101704	-	14848	-	-	R HOOLE	RESIDENTIAL	4	63	100
8908	101704	-	16874	-	-	LOUISE ROLAND	RESIDENTIAL	4	-	35
8979	101704	-	17576	-	-	CECIL W MCCOMB	RESIDENTIAL	4	42	95
9507	101704	-101704004	15034	-	-	C G BOYD	RESIDENTIAL	4	41	60

Table 5 An Inventory of Water Management District Permitted and Located Wells in the Vicinity of Newberry, Florida (continued)

SRWMD Record Number	Township Range Section	SRWMD Site ID Number	SRWMD DPERMIT Number	Latitude	Longitude	Owner	Well Use	Casing Diameter (inches)	Casing Depth (feet)	Total Depth (feet)
9571	101704	-101704006	18621	-	-	MAXIE PERKINS	IRRIGATION	4	63	86
9700	101704	-	27426	-	-	GRADY HARTZOG	RESIDENTIAL	4	158	175
9701	101704	-101704007	17500	-	-	WINNEBAGO DRAINAGE INC	COMMERCIAL	6	95	115
9702	101704	-	27680	-	-	J W (TOMMY) CARLISLE	H	2	58	88
9929	101704	-101704008	24647	-	-	MELVIN COLEMAN	RESIDENTIAL	2	-	-
9930	101704	-101704009	27875	-	-	SAM P. GETZEN	IRRIGATION	4	69	110
9931	101704	-101704010	27545	-	-	CITY OF NEWBERRY	IRRIGATION	4	63	106
9932	101704	-	28590	-	-	JIM DURANCE	RESIDENTIAL	2	60	95
11431	101704	-	29752	-	-	ALACHUA CO SCHOOL BD	MONITOR	4	15	15
11605	101704	-	29753	-	-	ALACHUA CO SCHOOL BD	MONITOR	4	25	25
11773	101704	-	29754	-	-	ALACHUA CO SCHOOL BD	MONITOR	4	15	15
11774	101704	-	29755	-	-	ALACHUA CO SCHOOL BD	MONITOR	4	15	15
11775	101704	-101704011	28142	-	-	MIKE HARTZOG	IRRIGATION	4	63	95
13699	101704	-	31777	-	-	MELVIN BARBER	RESIDENTIAL	2	63	65
13350	101704	-101704012	27681	-	-	R C BRANK	H	4	42	55
13929	101704	-	41632	-	-	CITY OF NEWBERRY	A	4	-	58
14048	101704	-101704013	30449	-	-	R C BRANK	RESIDENTIAL	4	147	151
14054	101704	-101704014	36641	-	-	CITY OF NEWBERRY	PUBLIC SUPPLY	10	84	142
14183	101705	-	14012	-	-	MR SIMPSON	RESIDENTIAL	4	-	100
14184	101705	-	14885	-	-	RUDY NAPIER	RESIDENTIAL	4	60	80
14378	101705	-	14886	-	-	RUDY NAPIER	RESIDENTIAL	4	60	80
14645	101705	-	14887	-	-	RUDY NAPIER	RESIDENTIAL	4	60	80
13096	101705	-	18871	-	-	CHUCK CLOCKER	RESIDENTIAL	4	841	105
15365	101705	-	21911	-	-	FLORIDA DER	MONITOR	4	73	90
15487	101705	-	21912	-	-	FLORIDA DER	MONITOR	4	40	62
16232	101705	-	21913	-	-	FLORIDA DER	MONITOR	4	60	80
16234	101705	-	21914	-	-	FLORIDA DER	MONITOR	4	64	80
16235	101705	-	22052	-	-	DER	MONITOR	4	59	80
16237	101705	-	22654	-	-	CLARENCE GRUBB	RESIDENTIAL	4	75	85
16259	101705	-	33450	-	-	FL DEPT ENVIRON REG	MONITOR	4	35	50
16260	101705	-	33451	-	-	FL DEPT ENVIRON REG	MONITOR	4	35	50
16261	101705	-	33452	-	-	FL DEPT ENVIRON REG	MONITOR	4	40	55
16262	101705	-	33453	-	-	FL DEPT ENVIRON REG	MONITOR	4	35	50
16337	101705	-	38243	-	-	TIM MCCUTCHEON	RESIDENTIAL	4	76	80

Table 5 An Inventory of Water Management District Permitted and Located Wells in the Vicinity of Newberry, Florida (continued)

SRWMD Record Number	Township Range Section	SRWMD Site ID Number	SRWMD DPERMIT Number	Latitude	Longitude	Owner	Well Use	Casing Diameter (inches)	Casing Depth (feet)	Total Depth (feet)
16867	101705	-101705001	14078	-	-	JAY FOWLER	RESIDENTIAL	4	-	77
16956	101705	-101705002	37103	-	-	KEN HORNBY	RESIDENTIAL	4	70	99
16960	101708	-	20770	-	-	WILLIAM ELLIS	RESIDENTIAL	4	84	103
18267	101708	-	21538	-	-	LEON BENTON	RESIDENTIAL	4	57	80
18283	101708	-	22718	-	-	DER	MONITOR	2	77	77
18325	101708	-	27197	-	-	JOANNE M BUKAS	RESIDENTIAL	4	80	100
19943	101708	-	27347	-	-	MIKE HALL	RESIDENTIAL	4	61	98
19944	101708	-	28859	-	-	TED MAY	RESIDENTIAL	4	80	100
19945	101708	-	28981	-	-	ED NORFLEET	RESIDENTIAL	4	69	96
19946	101708	-	29830	-	-	HARRY D PONS	RESIDENTIAL	2	69	75
20986	101708	-101708002	16638	-	-	HERBERT A MARLOW	RESIDENTIAL	4	63	100
21132	101708	-	31761	-	-	CHUCH TEWKSBURY	RESIDENTIAL	4	68.3	90
22135	101708	-	31819	-	-	HERB MARLO	RESIDENTIAL	4	130	120
22204	101708	-	34638	-	-	JAMES R LEE	RESIDENTIAL	4	71.4	90
22450	101708	-	37063	-	-	PETER LIEFFERS	RESIDENTIAL	4	76	93
22711	101708	-	37652	-	-	TERRY STEEN	RESIDENTIAL	4	69	95
23131	101708	-101708003	30360	-	-	MIKE MCDANIELS	RESIDENTIAL	4	68	85
23555	101708	-	38515	-	-	DON HOLT	RESIDENTIAL	4	71	95
23595	101708	-	41830	-	-	MARK ROSS	RESIDENTIAL	4	63	90
24140	101709	-101709002	19811	-	-	SHERMAN WATERS	RESIDENTIAL	4	88.5	105
24728	101709	-	22123	-	-	CLYMAG BROOKER	RESIDENTIAL	4	51	64
24899	101709	-	22847	-	-	CITY OF NEWBERRY	MONITOR	4	54	51
24998	101709	-	22848	-	-	CITY OF NEWBERRY	MONITOR	4	50	47
27154	101709	-	22849	-	-	CITY OF NEWBERRY	MONITOR	4	58	55
27400	101709	-	27551	-	-	HERBERT MARLOWE JR	RESIDENTIAL	4	100	120
27539	101709	-	38413	-	-	LARRY HARRISON	RESIDENTIAL	4	101	110
27925	101709	-	40759	-	-	CITY OF NEWBERRY	MONITOR	4	43	53
27931	101710	-	13594	-	-	D E POLK	RESIDENTIAL	4	60	90
28103	101710	-	21617	-	-	TOM MEHL	RESIDENTIAL	4	71.9	85

- No data available

Table 6 Potentiometric Surface Data for Selected Wells in the Vicinity of Newberry, Florida

Well Name	Latitude	Longitude	Measuring Point	5/22/92	9/17/92	Water Level	5/13/93	Water Level
			Elevation (feet, NGVD)	Water Surface Elevation (feet, NGVD)	Water Surface Elevation (feet, NGVD)	Decrease* (feet)	Water Surface Elevation (feet, NGVD)	Increase** (feet)
Coleman, Willem	293845	823737	83.26	39.10	38.94	0.16	41.59	2.49
Hartzog, Grady	293835	823715	92.98	38.78	38.68	0.10	41.02	2.24
Holder, W.M.	293855	823617	66.77	38.22	38.15	0.07	40.43	2.21
Hooie, Robert	293857	823718	79.48	38.14	38.08	0.06	40.30	2.16
Karales, Andy	293908	823550	69.65	38.72	38.62	0.10	40.95	2.23
Marchant	293725	823626	93.45	—	39.21	—	41.70	—
Marlow "A"	293734	823735	87.56	39.63	39.45	0.18	41.98	2.35
Marlow "B"	293748	823740	88.54	39.42	39.25	0.17	41.75	2.33
Marlow "C"	293804	823732	81.68	39.46	39.30	0.16	41.80	2.34
Marlow, Herbert	293720	823641	84.43	39.74	39.64	0.10	42.20	2.46
McClanahan, Mary	293908	823732	76.90	38.10	38.03	0.07	40.28	2.18
McDilda, Edna	293847	823657	77.04	38.15	38.11	0.04	40.42	2.27
Newberry #1	293849	823705	81.11	38.09	38.02	0.07	40.29	2.20
Newberry #2 - Four-inch	293844	823646	78.14	38.33	38.29	0.04	40.54	2.21
Newberry #3	293850	823703	79.33	37.77	37.72	0.05	—	—
Newberry Cemetery	293817	823702	81.54	39.31	39.17	0.14	41.63	2.32
Newberry STP MW-1A	293800	823653	87.30	39.03	38.87	0.16	41.38	2.35
Newberry STP MW-2	293805	823705	74.62	39.00	—	—	—	—
Newberry STP MW-3	293816	823658	84.12	39.02	—	—	41.34	2.32
Newberry STP MW-4	293805	823655	80.64	39.02	—	—	41.41	2.39
Newberry STP MW-5	293758	823705	90.48	39.01	38.87	0.14	41.33	2.32
Newberry STP MW-6	293813	823654	95.91	37.10	—	—	—	—
Newberry STP MW-7	293813	823705	81.08	38.86	—	—	41.05	2.19
Parker, Larry	293838	823554	86.80	39.12	38.97	0.15	41.38	2.26
Perkins, Maxie	293900	823628	76.15	38.31	38.20	0.11	40.54	2.23
Rogers, Jimmy	293832	823644	77.07	38.51	38.55	-0.04	40.46	1.95
Roland, Louise	293841	823647	76.46	38.34	38.29	0.05	40.57	2.23
Roland, R. Harold	293948	823625	76.66	37.21	37.21	0.00	39.28	2.07
Roland, Rufus H.	293941	823715	88.13	37.21	37.25	0.04	39.34	2.13
Sloan, Marie	293934	823547	79.16	38.54	38.39	0.15	40.72	2.18
Smith, J.B.	293853	823717	82.06	38.22	38.16	0.06	40.34	2.12
Williams 10-inch	293940	823742	78.01	—	37.21	—	39.20	—
Williams 4-inch PVC	293926	823744	83.33	—	37.80	—	39.99	—
Williams, Roger	293918	823755	86.69	38.99	38.80	0.19	41.40	2.41

* Decrease in water levels between measurements made 5/22/92 and 9/17/92

** Increase in water levels between measurements made 5/22/92 and 5/13/93

Water surface elevations showed little variation over the measurement period. Water surface elevations for May 1992 ranged from approximately 37.10 feet to 39.74 feet NGVD. Water surface elevations for September 1992 were 0.04 feet higher to 0.19 feet lower. Data collected in May 1993 indicated increased water surface elevations of 1.95 to 2.49 feet.

Potentiometric surface maps for the water surface elevation data are presented in Figures 12, 13, and 14. The groundwater flow direction is towards the north, or somewhat northwesterly. The gradient is relatively low, 0.00019, approximately one foot per mile. The low gradient is a function of the relatively flat topography and the high transmissivities of the aquifer.

3.6 AQUIFER TESTING

To determine Floridan Aquifer system hydraulic properties in the vicinity of Newberry, two types of tests were conducted; tests for specific capacity and a constant rate test.

Specific capacity was calculated from water level measurements during the testing conducted on October 13, 1992 (see Section 3.4.2). In addition, the specific capacity for well #3 was calculated based on data supplied by the driller on the well completion report (November 30, 1990). Specific capacities ranged from 190 to 400 gpm/ft. See Table 7a.

Due to the lack of available data on aquifer hydraulic properties in the Newberry area and the inability to conduct a constant rate test using the City of Newberry supply well, a constant rate aquifer test was conducted at a nearby location. A test site was chosen approximately one to 1.5 miles northwest of the Newberry public supply wells (Figure 15). An existing irrigation well was used for the test well. The test well was 10-inches in diameter with 77 feet of casing and a total depth of 117 feet, providing approximately 40 feet of open hole. Conducting the constant rate aquifer test using the existing irrigation well involved construction of two observation wells, setting a test pump and collecting the water level data during testing.

3.6.1 Monitoring Well Construction

Two four-inch monitoring wells were constructed for the purpose of collecting water level data during aquifer testing. Based on the small amount of drawdown measured during the testing of the City of Newberry wells, observations wells #1 and #2 were constructed close to the test well. The wells were constructed with the same amount of casing and open hole section as the test well. Observation well #1 (or "A") was installed 40 feet south of the test well. Observation well #2 (or "B") was installed 100 feet south of the test well. The wells were installed and developed by Clyatt Well Drilling.

On April 21, 1994, during development of the two observation wells, drawdown was measured and specific capacity was calculated. Observation well #1 was pumped at 30 gpm for one hour with a maximum drawdown of 0.36 feet and a calculated specific capacity of 80 gpm/ft. Observation well #2 was pumped at 30 gpm for an hour with a maximum drawdown of 7.07 feet and a calculated specific capacity of 4.2 gpm/ft. The differences in the specific capacity are indicative of the variability of the Ocala Formation hydraulic properties in this area.

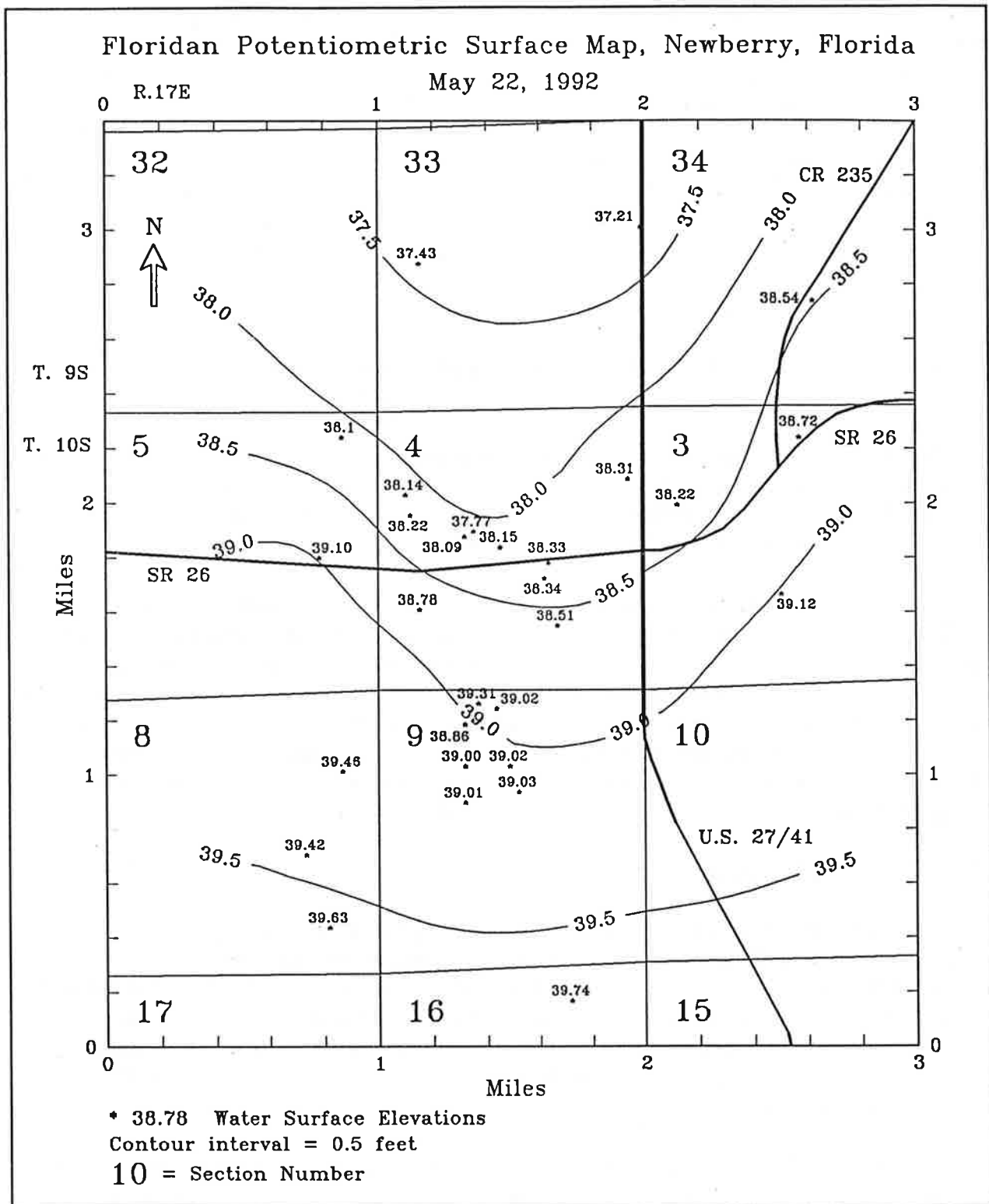


Figure 12 Floridan Aquifer System Potentiometric Surface in the Vicinity of Newberry, Florida, May 22, 1992

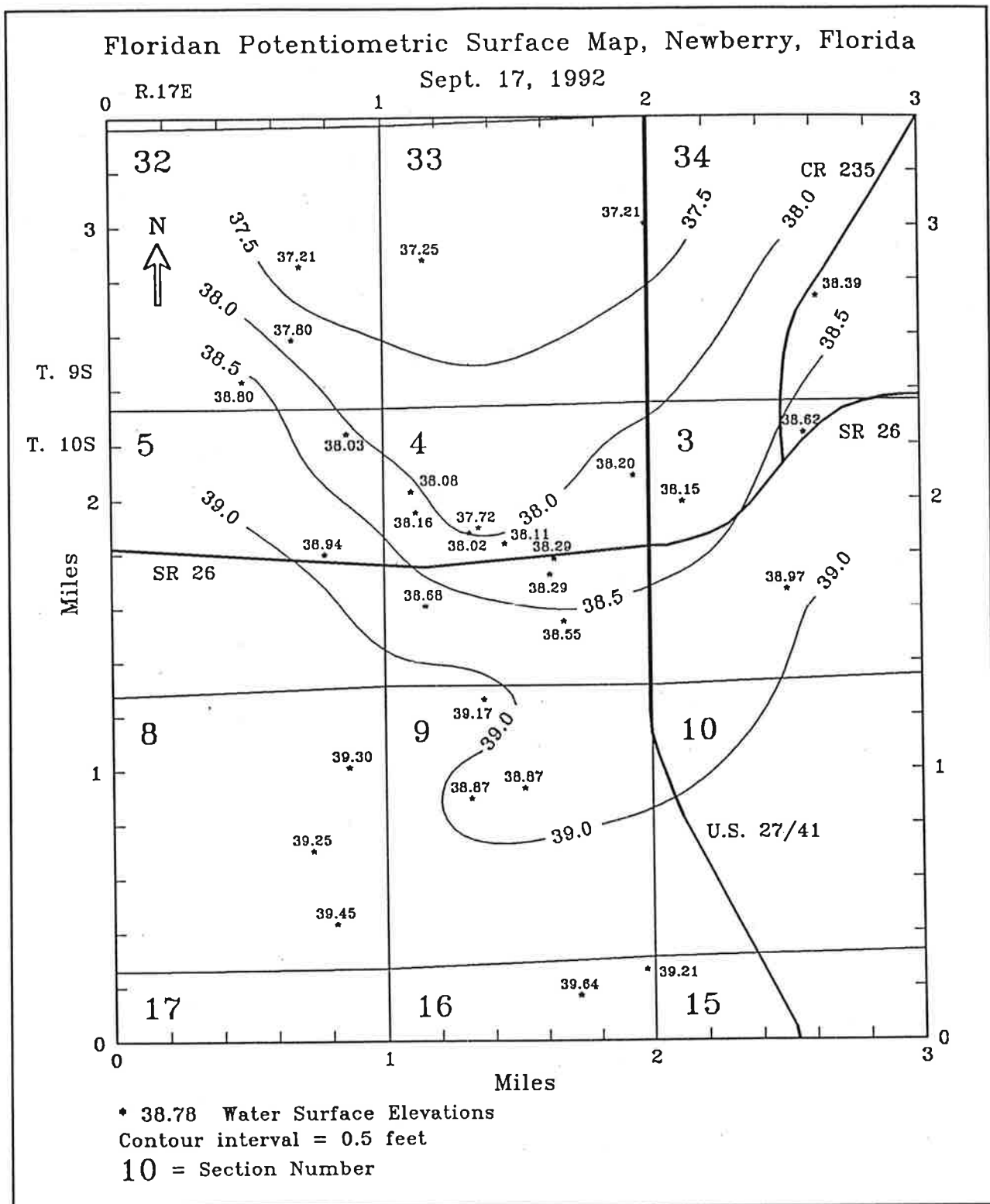


Figure 13 Floridan Aquifer System Potentiometric Surface in the Vicinity of Newberry, Florida, September 17, 1992

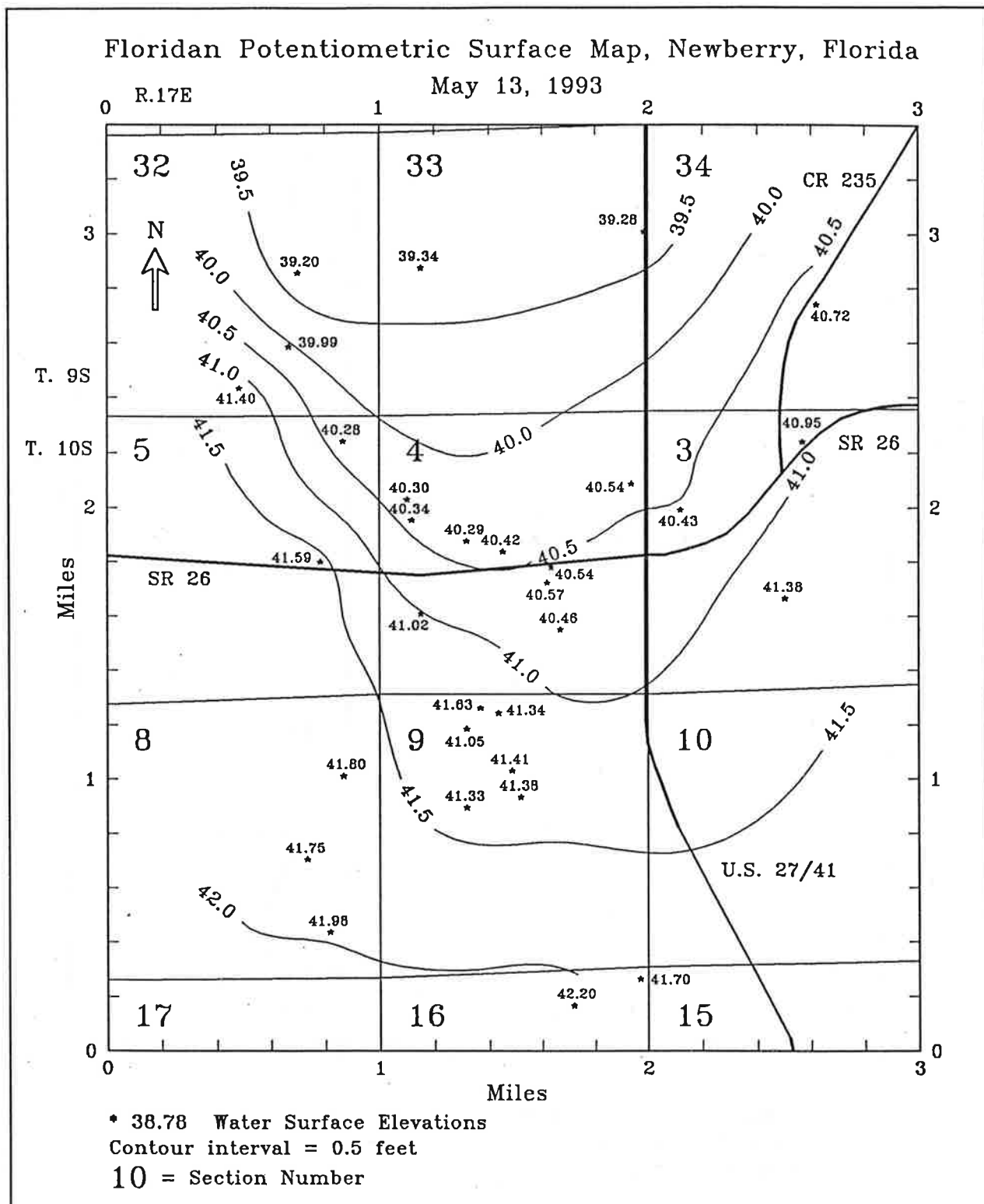


Figure 14 Floridan Aquifer System Potentiometric Surface in the Vicinity of Newberry, Florida, May 13, 1993



Figure 15 Location of the Aquifer Test Site, City of Newberry, Alachua County, Florida

Table 7a Floridan Aquifer System Hydraulic Properties in the Vicinity of Newberry, Florida (from Specific Capacity Tests)

Well Number	Date	b * (feet)	Q (gpm)	s (feet)	Calculated Specific Capacity ** (gpm/ft.)	Pumping Duration (hours)	Estimated T # (gpd/ft.)	Estimated T (sq.ft./day)	Estimated K ## (ft./day)
3	11/30/90	102	1,400	7.5	190	8	380,000	51,000	500
1	10/13/92	158	575	1.45	400	0.5	800,000	107,000	680
3	10/13/92	100	450	2.01	220	1	440,000	59,000	590
Test Well	05/18/93	77	1000	2.77	360	1	720,000	96,000	1,250
Test Well	05/19/93	77	1000	2.85	350	8	700,000	94,000	1,220

Table 7b Floridan Aquifer System Hydraulic Properties in the Vicinity of Newberry, Florida (from Constant Rate Aquifer Test)

Well Number	Analyst	b * (feet)	Q (gpm)	Calculated T (gpd/ft.)	T (sq.ft./day)	Estimated K ## (ft./day)
Theis						
Obs. 2 (or B)	ACEPD	77	1,000	190,000	25,000	320
Obs. 1 (or A)	GeoSolutions, Inc.	77	1,000	95,000	13,000	170
Obs. 2 (or B)	GeoSolutions, Inc.	77	1,000	126,000	17,000	220
Neuman						
Obs. 1 (or A)	GeoSolutions, Inc.	77 77	1,000	69,000 to 89,000	9,000 to 12,000	120 to 160
Obs. 2 (or B)	GeoSolutions, Inc.	77 77	1,000	112,000 to 177,000	17,000 to 24,000	220 to 310

* Difference between total depth of well and potentiometric surface

** Specific Capacity = Q/s where: Q = Pumping rate of well (gpm) and s = Drawdown in feet

$T(\text{gpd/ft}) = 2000 * \text{Specific Capacity (gpm/ft)}$ where: T = Transmissivity

$K = T/b$ where: K = Hydraulic conductivity and b = Aquifer thickness

3.6.2 Constant Rate Aquifer Test

A constant flow rate aquifer test was conducted May 19, 1993. On May 18, 1993 the test well was pumped at four steps; 500, 600, 800, and 1,000 gpm to select a pumping rate for the test. A pumping rate of 1,000 gpm was selected for the constant rate test. Water level data were collected during the stepped pumping and specific capacity was calculated (Table 7a). At a discharge rate of 1,000 gpm, 2.77 feet of drawdown was measured in the test well. The specific capacity for the test well was determined to be 360 gpm/ft.

The testing and data collection were performed by Layne Atlantic. The constant rate test was conducted at 1,000 gpm for approximately 14 hours. The water was discharged to a depression approximately 300 feet to the west of the test well. Water level data were measured in the pumping well and the two observation wells by using a pressure transducer (only 8.4 hours of electronic measurements were obtained). The water level changes were recorded by a data logger. Manual water level measurements were made to verify data logger readings. Table 8 presents selected time and drawdown data for the test well and both observation wells. After approximately eight hours (28,583 seconds) of pumping, 2.85 feet of drawdown was measured in the test well. See Table 7a for calculated specific capacity. The drawdown measured in monitoring wells one and two were 2.27 and 1.14 feet, respectively.

3.6.3 Analyses of Aquifer Test Data

Conduit and diffuse flow are present in karst aquifers. These aquifers are heterogeneous and anisotropic. Methodologies for aquifer test analysis assume homogeneous and isotropic conditions. The hydraulic properties determined from this testing should be viewed in light of these constraints.

Preliminary aquifer test data analyses were performed by the ACEPD using the Theis Method. A review of the drawdown data indicated that the data for observation well #2 would provide the best data for plotting and manual curve matching. Based on the drawdown data for observation well #2, a transmissivity (T) of 190,000 gallon per day per foot (gpd/ft) and a storativity or specific yield (S) of 0.001 were determined. Due to the short duration of the test, only early time data were available for analysis. In unconfined or water table aquifers the propagation of head loss is slow (Kruseman & Ridder, 1976). A test of longer duration, several days to a week, would have provided additional data for analysis.

To verify our analyses of these data, GeoSolutions Inc. reviewed and resolved the aquifer test data. Their results are presented in Table 7b. A letter report outlining their data analysis is presented in Appendix H. The transmissivity values for both observation wells were determined by GeoSolutions using two different methods, Theis and Neuman. Transmissivity values ranged from 69,000 to 177,000 gpd/ft. The storativity values determined from the observation wells ranged from 0.0006 to 0.0013.

The wide range of the transmissivity values may have been the result of a number of factors: the heterogeneous and anisotropic nature of the aquifer; the short duration of the test pumping; the

Table 8 Constant Rate Aquifer Test Drawdown Data for May 1993, Newberry, Florida

Time (sec.)	Time (minutes)	Time (hours)	Test Well (ft)*	#1 (ft)	#2 (ft)	Time (sec.)	Time (minutes)	Time (hours)	Test Well (ft)*	#1 (ft)	#2 (ft)
2	0.0333	0.0006	0.0340	0.0080	0.0090	496	8.2667	0.1378	3.0752	2.4666	1.1070
4	0.0667	0.0011	1.3178	0.3205	0.0170	526	8.7667	0.1461	3.0245	2.4497	1.1070
6	0.1000	0.0017	3.0499	1.4865	0.0680	556	9.2667	0.1544	3.0837	2.4666	1.1070
8	0.1333	0.0022	2.1880	2.2469	0.1270	586	9.7667	0.1628	3.0161	2.4920	1.1070
10	0.1667	0.0028	1.4529	1.6808	0.1860	616	10.2667	0.1711	3.1006	2.4920	1.1150
12	0.2000	0.0033	2.1542	1.2161	0.2450	646	10.7667	0.1794	3.0414	2.5004	1.1150
14	0.2333	0.0039	2.6781	1.5963	0.2960	676	11.2667	0.1878	3.0330	2.5173	1.1150
16	0.2667	0.0044	2.2218	2.0526	0.3380	706	11.7667	0.1961	3.1259	2.4835	1.1240
18	0.3000	0.0050	1.9937	1.8752	0.3890	736	12.2667	0.2044	3.0583	2.4835	1.1240
20	0.3333	0.0056	2.4838	1.6048	0.4230	766	12.7667	0.2128	3.0330	2.5258	1.1240
22	0.3667	0.0061	2.7710	1.7991	0.4650	796	13.2667	0.2211	3.1006	2.5427	1.1320
24	0.4000	0.0067	2.5514	2.1624	0.4990	826	13.7667	0.2294	3.0921	2.5596	1.1320
26	0.4333	0.0072	2.4246	2.1455	0.5410	856	14.2667	0.2378	3.1006	2.5258	1.1410
28	0.4667	0.0078	2.6528	1.9005	0.5750	886	14.7667	0.2461	3.0583	2.5596	1.1410
30	0.5000	0.0083	2.7457	1.9596	0.6000	946	15.7667	0.2628	3.1513	2.5427	1.1410
32	0.5333	0.0089	2.6865	2.2216	0.6340	1006	16.7667	0.2794	3.0837	2.5764	1.1490
34	0.5667	0.0094	2.6190	2.1962	0.6590	1066	17.7667	0.2961	3.1175	2.5849	1.1580
36	0.6000	0.0100	2.7288	2.0019	0.6850	1126	18.7667	0.3128	3.1175	2.5764	1.1580
38	0.6333	0.0106	2.7795	2.0610	0.7100	1186	19.7667	0.3294	3.1344	2.5258	1.1580
40	0.6667	0.0111	2.7119	2.2469	0.7270	1246	20.7667	0.3461	3.1344	2.5511	1.1660
42	0.7000	0.0117	2.7626	2.2047	0.7440	1306	21.7667	0.3628	3.1175	2.5596	1.1660
44	0.7333	0.0122	2.7626	2.0695	0.7610	1366	22.7667	0.3794	3.1090	2.5596	1.1660
46	0.7667	0.0128	2.8133	2.1455	0.7770	1426	23.7667	0.3961	3.0752	2.5849	1.1580
56	0.9333	0.0156	2.8217	2.2638	0.8540	1486	24.7667	0.4128	3.1090	2.5680	1.1490
66	1.1000	0.0183	2.8386	2.2131	0.9040	1546	25.7667	0.4294	3.0921	2.5173	1.1490
76	1.2667	0.0211	2.8893	2.2892	0.9300	1606	26.7667	0.4461	3.1006	2.5258	1.1660
86	1.4333	0.0239	2.8555	2.3314	0.9630	1666	27.7667	0.4628	3.0921	2.5764	1.1660
96	1.6000	0.0267	2.8809	2.3314	0.9800	1726	28.7667	0.4794	3.1259	2.5764	1.1750
106	1.7667	0.0294	2.9907	2.2976	0.9970	1786	29.7667	0.4961	3.2273	2.5173	1.1750
116	1.9333	0.0322	2.8893	2.3568	1.0140	2086	34.7667	0.5794	3.1597	2.5849	1.1750
126	2.1000	0.0350	2.9907	2.3821	1.0230	2386	39.7667	0.6628	3.1935	2.5596	1.1830
136	2.2667	0.0378	2.9569	2.3568	1.0310	2686	44.7667	0.7461	3.1090	2.5680	1.1660
146	2.4333	0.0406	2.9485	2.3737	1.0390	2986	49.7667	0.8294	3.1428	2.5596	1.1750
156	2.6000	0.0433	2.9654	2.4159	1.0390	3286	54.7667	0.9128	3.1935	2.5511	1.1750
166	2.7667	0.0461	2.9992	2.3652	1.0390	3586	59.7667	0.9961	3.1006	2.5680	1.1750
176	2.9333	0.0489	2.9907	2.3821	1.0560	4186	69.7667	1.1628	3.0668	2.5680	1.1750
186	3.1000	0.0517	2.9992	2.4244	1.0560	4786	79.7667	1.3294	3.0752	2.5596	1.1830
196	3.2667	0.0544	3.0414	2.4159	1.0650	5386	89.7667	1.4961	3.0668	2.5089	1.1750
206	3.4333	0.0572	3.0076	2.4244	1.0730	5986	99.7667	1.6628	3.1090	2.5933	1.1750
216	3.6000	0.0600	2.9823	2.3990	1.0730	6586	109.7667	1.8294	2.9992	2.6018	1.2170
226	3.7667	0.0628	3.0245	2.3990	1.0730	8783	146.3833	2.4397	2.9231	2.5258	1.2000
236	3.9333	0.0656	3.0414	2.4328	1.0730	10583	176.3833	2.9397	2.7879	2.4666	1.1660
246	4.1000	0.0683	3.0076	2.4328	1.0730	12383	206.3833	3.4397	2.8978	2.3652	1.1240
256	4.2667	0.0711	3.0414	2.4328	1.0820	14183	236.3833	3.9397	2.9654	2.3399	1.1320
266	4.4333	0.0739	2.9823	2.4328	1.0820	15983	266.3833	4.4397	2.8217	2.3399	1.1410
276	4.6000	0.0767	3.0076	2.4328	1.0820	17783	296.3833	4.9397	2.8893	2.3145	1.1750
286	4.7667	0.0794	2.9400	2.4413	1.0820	19583	326.3833	5.4397	2.7795	2.3061	1.1410
316	5.2667	0.0878	3.0245	2.4582	1.0820	21383	356.3833	5.9397	2.8724	2.2976	1.1150
346	5.7667	0.0961	3.0668	2.4244	1.0990	23183	386.3833	6.4397	2.8555	2.2892	1.1150
376	6.2667	0.1044	2.9907	2.4328	1.0900	24983	416.3833	6.9397	2.8217	2.3230	1.1240
406	6.7667	0.1128	2.9907	2.4751	1.0990	26783	446.3833	7.4397	2.8640	2.2807	1.1240
436	7.2667	0.1211	3.0668	2.4582	1.0990	28583	476.3833	7.9397	2.8471	2.2723	1.1410
466	7.7667	0.1294	3.1006	2.4413	1.0990	30383	506.3833	8.4397	2.7288	2.2554	1.1410

* Drawdown measurements in feet below static.

disposal of discharge water to a depression southwest of the test well; and the partial penetration of the aquifer by the observation and test wells.

A comparison of transmissivity calculated from the constant rate aquifer test and the transmissivity estimated from specific capacity testing is present in Tables 7a and 7b. The transmissivity estimated from City of Newberry Well #3 specific capacities ranged from 380,000 to 440,000 gpd/ft. The transmissivity estimated from the specific capacity calculated from pumping City of Newberry Well #1 was estimated to be 800,000 gpd/ft. These estimates of transmissivity are much higher than the values calculated from the constant rate aquifer test (Observation wells #1 and #2). The high estimated transmissivity for the City of Newberry Well #1 may be a function of the depth. This well is reported to be 200 feet in depth. Clark *et al.* (1964) reported the thickness of the Ocala Formation in the Newberry area to be 80 to 130 feet. Below the Ocala Formation is the Avon Park Formation, which is usually associated with much higher transmissivity than the Ocala Formation. The high transmissivity calculated from the specific capacity determined for the test well may be a result of the presence of fractures or cavernous zones intersecting the open borehole. Sproul (1994) pointed out that the transmissivity values of 380,000 to 440,000 gpd/ft were more representative of the hydraulic characteristics of the Floridan aquifer system in the area than the values obtained from the constant rate aquifer test.

The storativity values, 0.0006 to 0.0013, are more typical for a semi-confined or confined aquifer. Storage coefficients for unconfined aquifers are higher than confined aquifers and typically range from 0.01 to 0.3. Storativity for confined aquifers typically ranges from 10^{-5} to 10^{-3} (Driscoll, 1986; Freeze and Cherry, 1979). Sproul (1994) reported that these storativity values were common in western Alachua County. He speculated that the presence of Re-worked deposits (formerly known as the Alachua Formation) consisting mainly of clayey sands and the highly mineralized adjacent portion of the Ocala Formation may have caused the Floridan aquifer system in this area to respond more like a semi-confined unit in terms of storativity.

For comparison, aquifer coefficients for tests conducted in Alachua County and throughout north central Florida are presented in Tables 9a and 9b, respectively. The aquifer coefficients vary widely due to the formation penetrated, well construction, test discharge rate and length of the aquifer test. Transmissivities reported in Alachua County ranged from 3,500 to 2,120,000 gpd/ft (Table 9a). Transmissivities in the western portion of north central Florida (excluding Alachua County) ranged from 97,000 to 1,700,00 gpd/ft (Table 9b)

3.7 FRACTURE TRACE OR LINEAMENT ANALYSIS

Fracture trace or lineament analysis is a method for mapping subsurface solution features in karst terrains (Fetter, 1988). The surface expression of karst terrain is typified by the absence of surface drainage features and the predominance of internal drainage. Internally drained surface depressions, or sinkholes, are usually circular in shape and have been formed by the movement of surface or near surface materials into underlying cavities in soluble rock, such as limestone or dolomite. The number of sinkholes is dependent on the presence of cavities in the underlying rock, the proximity of the cavities to land surface, the solubility of the rock, the hydrologic conditions and the structural features (e.g. fractures, faults, joints, and bedding planes).

Table 9a. Aquifer Coefficients for Wells in Alachua County, Florida

Site Name	Location	Casing Diameter (inches)	Casing Depth (feet)	Total Depth (feet)	Formation Penetrated	Aquifer Test Flow (gpm)	Transmissivity (T) (gpd/ft)	Storage (S)	Leakance (L) (gpd/ft ³)	Aquifer Type
Amoco # 754 (1)	I-75 and US 441, Alachua	4	25	50	Ocala	11	8,700	0.04	--	Unconfined
BP (2)	405 NE 1st Avenue, High Springs	8	56	56	Ocala	8	3,500	0.4	--	Unconfined
Chevron #42067 (3)	I-75 and US 441, Alachua	8	43	55	Ocala	40	59,000	0.035	--	Unconfined
Coastal Mart #402 (4)	UD 441, Alachua	5	22.5	50.5	Ocala	6	49,000	--	--	Unconfined
DOT (5)*	SR 24, Fairbanks	4	191	208	Ocala	--	205,000	--	--	Confined
Kanapaha WWTP (6)	Tower Road, Gainesville	--	450	1020	Avon Park	Unknown	2,120,000	0.00023	0.00075	Confined
Murphree Well Field (7)	NE 53rd Avenue, Gainesville	24	173	530	Ocala/Avon Park	4500	170,000	0.00022	--	Confined
		24	185	475	Ocala/Avon Park	4400	170,000	0.0002	--	Confined
		24	217	540	Ocala/Avon Park	4800	330,000	0.00066	--	Confined
		24	190	545	Ocala/Avon Park	4000	260,000	0.00091	--	Confined
		24	190	500	Ocala/Avon Park	4900	230,000	0.00023	--	Confined
		24	189	521	Ocala/Avon Park	4400	200,000	0.0006	--	Confined
		24	180	365	Ocala/Avon Park	2030	110,000	0.00029	0.0004	Confined
Shell/Texasco (8)**	34th Street & Archer Road, Gainesville	4	20	47	Hawthorn	--	30,000	0.2	--	Unconfined

* Based on hydraulic conductivity of 2.3X10⁻² cm/sec from slug-recovery test; assuming a 350-foot formation thickness

** Based on slug test

- (1) Handex of Florida, Remedial Action Plan for Amoco #754, September 1991, P.5
 (2) Delta Environmental Consultants, Remedial Action Plan for Richardson Oil, September 1991, p.9
 (3) Handex of Florida, Remedial Action Plan for Chevron #42067, January 1993, p.5
 (4) Environmental Consulting and Technology, Remedial Action Plan for Coastal Mart #402, January 1992
 (5) Dames & Moore, Groundwater Contamination Investigation for FDOT, October 1983, p.33
 (6) Gainesville Regional Utilities, Kanapaha Deep Well Disposal Assessment, November 1986
 (7) Gainesville Regional Utilities, Murphree Well Field Pumping Projections, June 1986
 (8) Groundwater Technology, Remedial Action Plan for Shell/Texasco, May 1991, p.3-7

Table 9b Aquifer Coefficients for Wells in the Western Portion of North Central Florida

Site Name	Location (County)	Casing Diameter (inches)	Casing Depth (feet)	Total Depth (feet)	Formation Penetrated	Aquifer Test Flow (gpm)	Transmissivity (T) (gpd/ft)	Storage (S)	Leakance (L) (gpd/ft ³)	Aquifer Type
Circle Square	Marion	10	300	780	Ocala	1460	470,000	0.0062	0.017	Confined
Cross Bar Ranch	Pasco	12	72	625	Suwannee/Ocala	847	360,000	0.0004	0.01	Confined
Crystal River	Citrus	10	62	172	Ocala	684	1,500,000	—	234	Confined
FPC - Crystal River	Citrus	10	50	200	Avon Park	500	1,700,000	0.05	—	Confined
Green Swamp	Lake	8	66	200	Ocala	1,040	97,000	0.00025	0.015	Confined
Marion Oaks	Marion	10	107	300	Avon Park	460-750	500,000	0.0005	0.00075	Confined
Sugarmill Woods	Citrus	10	158	250	Ocala	695	290,000	0.008	1.8	Confined
Tidewater	Levy	10	300	780	Ocala	2,000	150,000	0.00054	0.0012	Confined

Reference: Southwest Florida Water Management District, Aquifer Characteristics Within
the Southwest Florida Water Management District, February 1987, p.7

Physiographic features may be identified and mapped as photographic tonal alignments from aerial photographs. The alignments have been called trends, linear features, lineaments, or photo-linears by different authors. Lattman and Ray (1965) define a photogeologic feature as "a natural linear feature consisting of topographic, vegetal, or soil tonal alignments, visible primarily on aerial photographs and expressed continuously for less than 1 mile".

Fracture traces, in this case the alignment of sinkholes or closed depressions, may provide evidence of subsurface cavern development. Where subsurface caverns occur, there exists the potential for collapse and sinkhole development. Subsurface caverns also provide conduits for rapid movement of ground water. Lineaments may also be used to locate potential high-yield sites for water supply well construction.

To identify lineaments associated with karst features within a 5-mile radius of the City of Newberry's municipal wells, GeoSys conducted an assessment from aerial photographs (Appendix I). United States Department of Agriculture 1938 and 1948 (scale of 1:20,000) aerial photographs, were used to map depressions and to identify open-pit phosphate mines. During the early 1900s, hard-rock phosphate mining was conducted throughout the study area. Presently, this area is the site of numerous limestone mines.

Excavations from limestone and hard-rock phosphate mining should not be confused with natural solution features. Approximately three miles northeast of Newberry is the community of Haile. This area has been extensively mined for limestone. Other, smaller quarries exist throughout the area.

GeoSys determined the distribution of possible karst related depressions by the presence of three or more closed contours (Figure 16a) and two or more closed contours (Figure 16b) using United States Geological Survey (USGS) 7.5 minute quadrangle maps (scale of 1:24,000). The depressions were selectively plotted based on the number of closed contours. The elongation of these depressions along the axis of a lineament was another factor used in the mapping. A complete description of the analysis is presented in Appendix I. Copies of the four USGS 7.5 minute quadrangle maps are presented as Plated X through XIII.

Volume two contains copies of the USGS 7.5 minute quadrangle maps (scale of 1:24,000) of Archer, Newberry, Newberry SW, and Waters Lake with the lineaments identified. A number of small, deep sinkholes are present in Section 33, T9S, R17E (Newberry quadrangle map). These deep sinks are filled with water and offer a surface expression of the water table in the Floridan aquifer system.

Only one lineament was mapped in close proximity to the City of Newberry supply wells and the aquifer test site. This lineament trends to the northwest (Figures 16a and 16b and Plate XI).

3.8 HYDROGEOLOGIC MODELING

Hydrogeologic modeling to determine wellhead protection zones was conducted based on the aquifer test performed on May 19, 1993. The EPA Modular Semi-Analytical Model for the

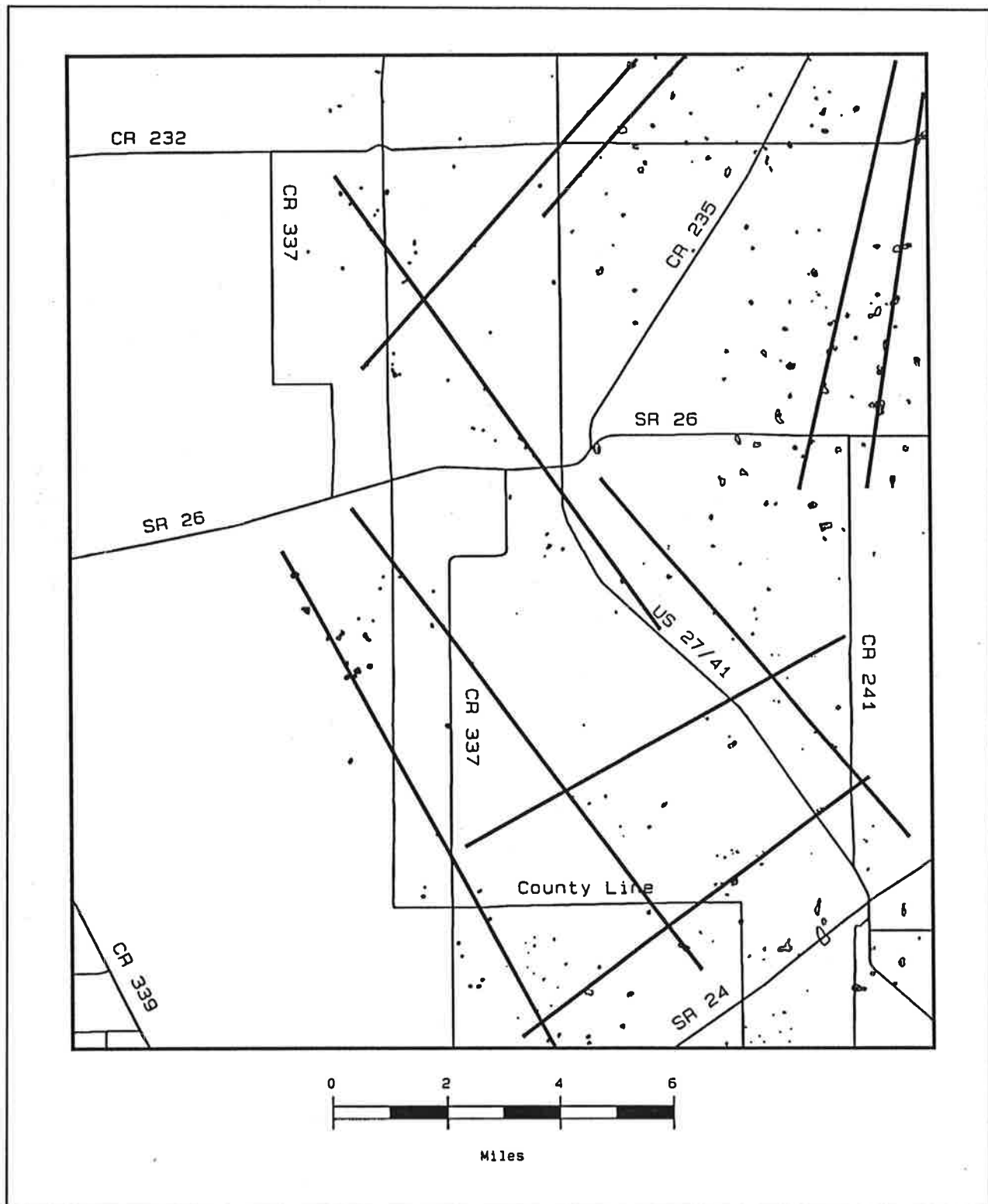


Figure 16a Depressions of Three or More Topographic Contours and Lineaments Associated with Karst Features in the Vicinity of Newberry, Florida

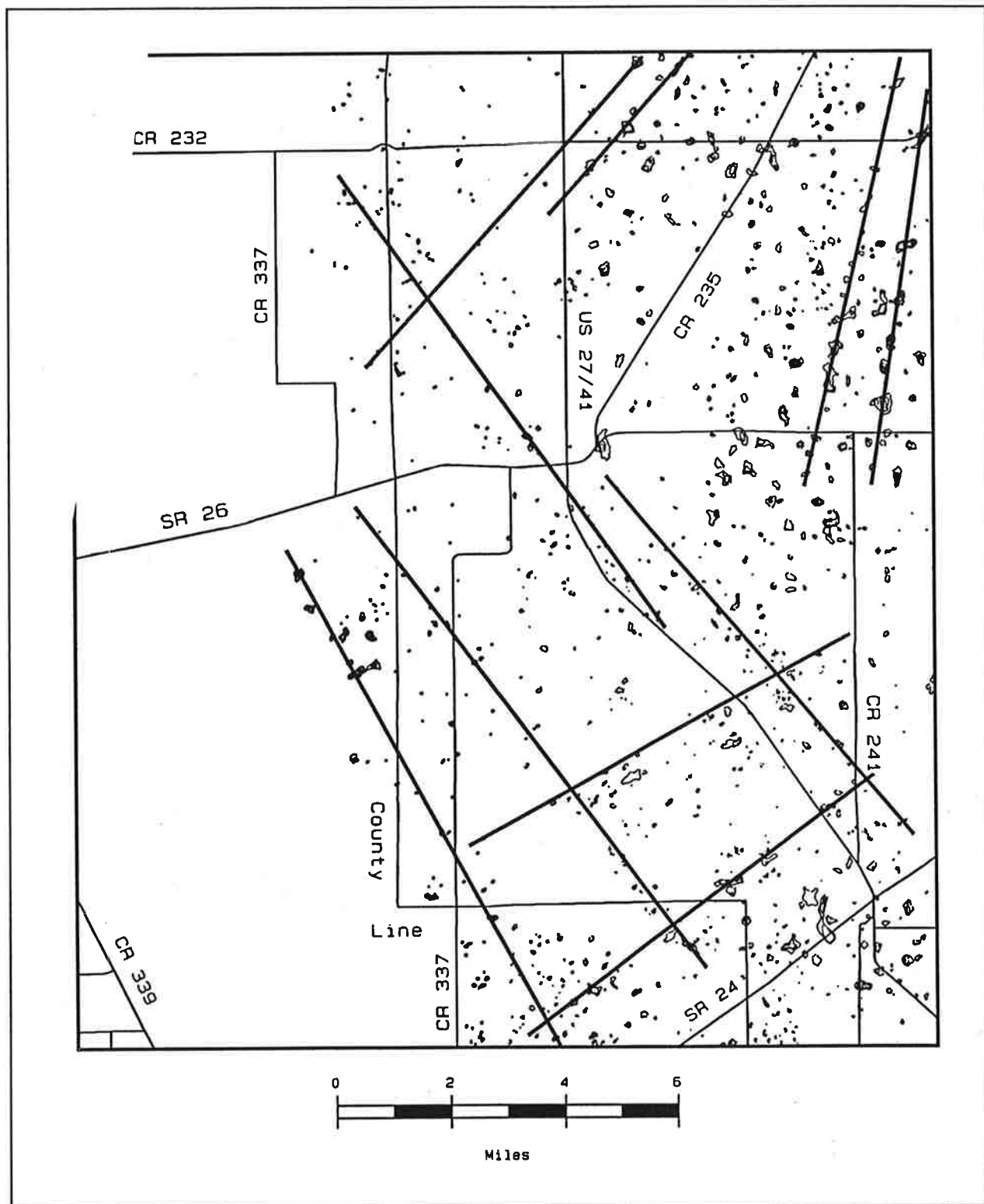


Figure 16b Depressions of Two or More Topographic Contours and Lineaments Associated with Karst Features in the Vicinity of Newberry, Florida

Delineation of Wellhead Protection Areas was used to model capture zones for the City of Newberry public water supply wells.

The Multiple Well Capture Zone Module (MWCAP) is designed to provide delineation of steady-state, time-related and hybrid capture zones for one or more pumping wells in homogeneous aquifers (Blandford and Huyahorn, 1991). The MWCAP assumes the wells operate independently of one another and well interferences are ignored. This module is for fully penetrating pumping wells in aquifers that are essentially homogeneous. To account for heterogeneity, anisotropy, and partial penetrating wells a more complex model, such as ModFlow, would need to be used. In these models, aquifer hydraulic parameters can be varied horizontally or vertically to more accurately represent the field conditions.

The MWCAP module of the "EPA Modular Semi-Analytical Model for the Delineation of Wellhead Protection Areas" was chosen so that a conservative protection zone could be established for each well. The assumptions used in modeling are presented below. Modeling was conducted by GeoSys, Inc. (November 15, 1993 and December 5, 1994). The wells are pumped in sequence with only one well operating at a given time. With the high transmissivities in the area, well interferences are negligible. There are two limitations to the model: 1) No recharge provision in model; recharge would reduce capture zone size, and 2) MWCAP model does not include provision for well interference effects.

The value for transmissivity used for the modeling, 14,000 ft²/day, or approximately 105,000 gpd/ft is an average value of the transmissivities computed from the aquifer test (Tables 7a and 7b). Although the high specific capacities determined from the testing conducted on the City of Newberry's wells #1 and #3 (see section 3.6 and Table 7a) may indicate that a higher transmissivity value could be used in the modeling, a conservative transmissivity was chosen. The assumption was made that the aquifer thickness equals the open hole interval of the well. By definition, the aquifer thickness for an unconfined aquifer is the height of the water table above the top of the underlying aquitard that bounds the aquifer (Freeze and Cherry, 1979).

A porosity of 10 percent was used for the initial modeling (GeoSys, Inc., November 15, 1993). Freeze and Cherry (1979) reported a range of porosities from 5 to 50 percent for karst limestone and 0 to 20 percent for limestone and dolomite. Fetter (1988) reported a porosity range of 3 to 30 percent for limestone and dolomite. Sproul (1994) reported using 15 percent for porosity for the upper portion of the Floridan aquifer system. The 10 percent used in the modeling is a conservative number.

CAPTURE ZONE MODEL AND PLOTS: (GeoSys, Inc., November 15, 1993)

Model Used: MWCAP

Area of Coverage: Same as potentiometric surface maps: 3 miles (15,840 feet) east-west by 3.4 miles (17,592 feet) north-south

Values Used: Porosity: 10%
 Transmissivity: 14,000 ft²/day or 105,000 gpd/ft
 Pumping Rate: 500 gpm or 96,250 ft³/day
 Aquifer Thickness: Same as the open hole interval
 Well #1 - 100 feet
 Well #2 - 77 feet
 Well #3 - 58 feet

Uniform Regional Gradient: 1 foot/mile or 0.0001893
 Travel Time Periods: 2 Year, 5 Year, 10 Year, 25 Year

- Run 1: Averaged Case - Pumping rate divided among three wells, each pumping 32,083 ft³/day for 2 year, 5 year, 10 year, and 25 year capture zones.
- Run 2: Worst Case - Assumes a full pumping rate (96,250 ft³/day) at each well for 2 year, 5 year, 10 year, and 25 year capture zones.

Figures 17, 18, 19, and 20 present 2-year, 5-year, 10-year, and 25-year capture zones based on an average pumping rate of 500 gpm distributed evenly among the three wells. Figures 21, 22, 23, and 24 present 2-year, 5-year, 10-year, and 25-year capture zones based on a maximum pumping rate of 500 gpm at each of the three wells. Table 10 presents the upgradient and downgradient distances and the areas of each protection zone modeled.

Additional model runs were plotted for porosity values of 10, 15, and 20 percent at transmissivities of 105,000 and 400,000 gpd/ft (GeoSys, Inc., December 5, 1994) A pumping rate of 500 gpm or 96,250 ft³/day was assumed. The pumping was modeled in two scenarios: for the first scenario the pumping was averaged among the wells (average pumping); in the second scenario the entire discharge from each well simultaneously (fully pumped) was used. The assumed aquifer thickness for each well was the difference between the total depth of the well and the potentiometric surface.

CAPTURE ZONE MODEL AND PLOTS: (GeoSys, Inc., December 5, 1994)

Model Used: MWCAP

Area of Coverage: Same as potentiometric surface maps: 3 miles (15,840 feet) east-west by 3.4 miles (17,592 feet) north-south

Values Used: Porosity: 10%, 15%, 20%
 Transmissivity: 14,000 ft²/day or 105,000 gal/day/ft and 53,333 ft²/day or 400,000 gal/day/ft
 Pumping Rate: 500 gpm or 96,200 cu.ft/day
 Aquifer Thickness: Difference between the Depth of Well and the Potentiometric Surface
 Well #1 - 160 feet

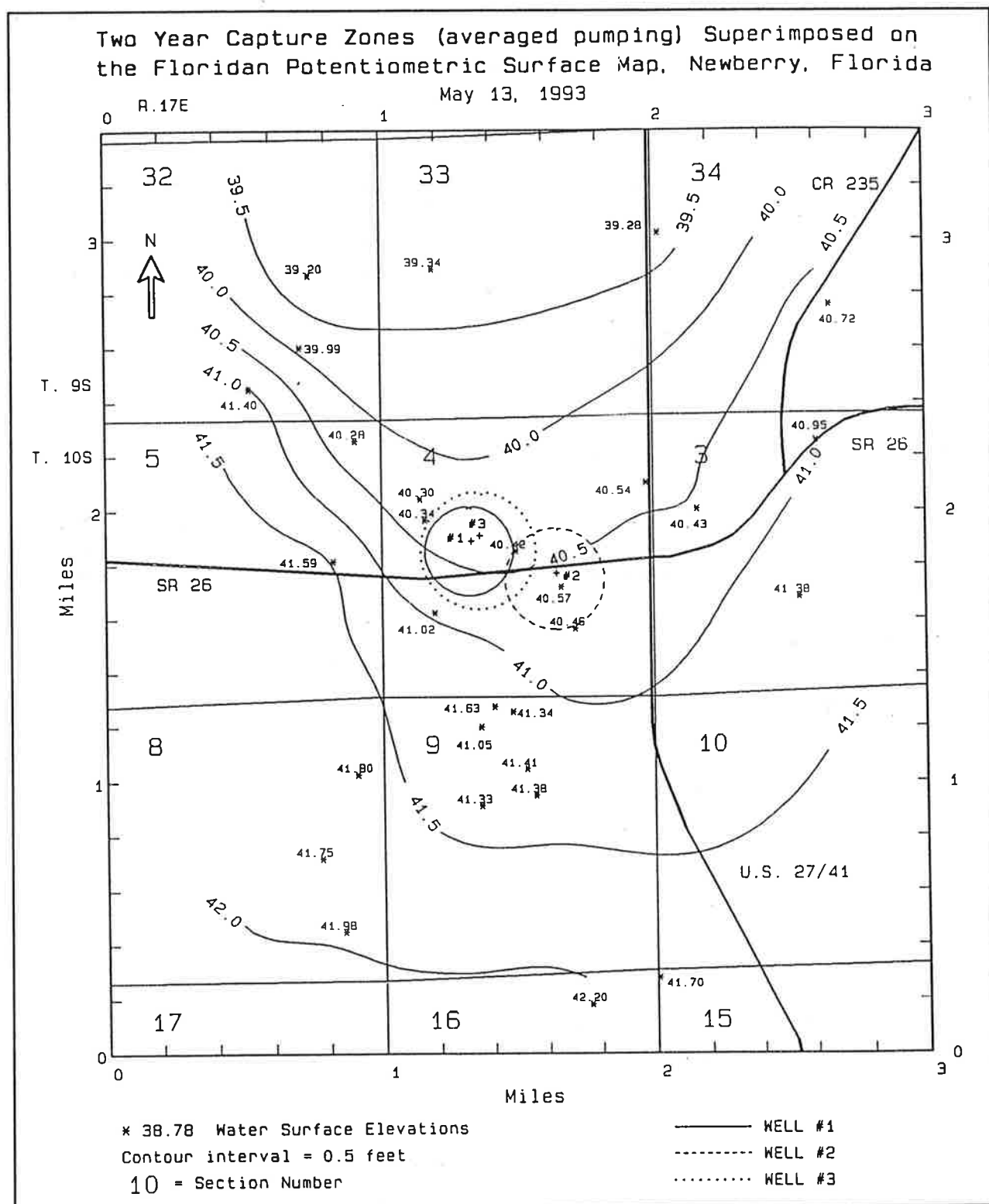


Figure 17 Two-Year Capture Zones for Averaged Pumping (500 gpm Total Discharge) Superimposed on the Floridan Aquifer System Potentiometric Surface Map, Newberry, Florida (GeoSys, Inc., November 15, 1993)

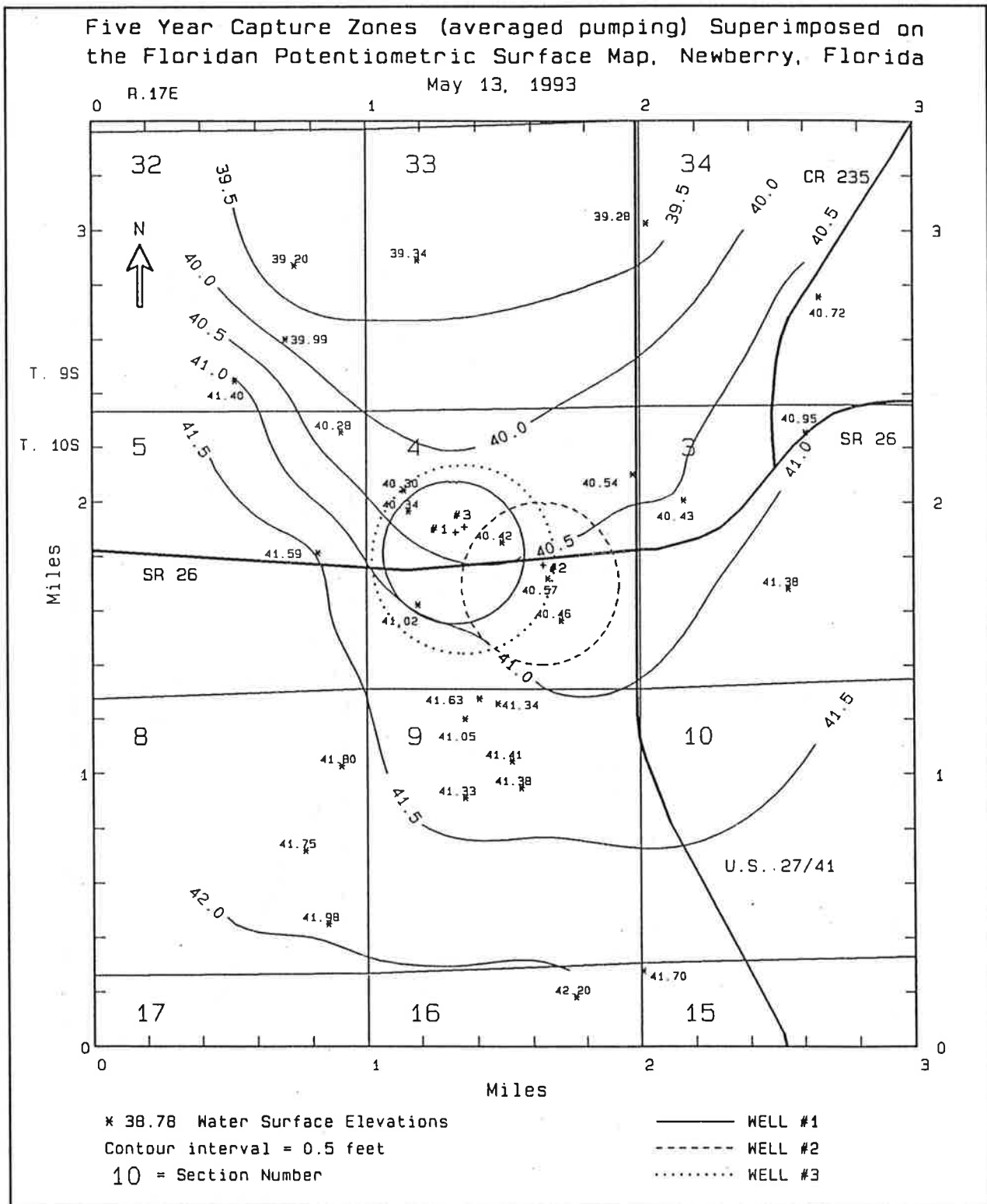


Figure 18 Five-Year Capture Zones for Averaged Pumping (500 gpm Total Discharge) Superimposed on the Floridan Aquifer System Potentiometric Surface Map, Newberry, Florida (GeoSys, Inc., November 15, 1993)

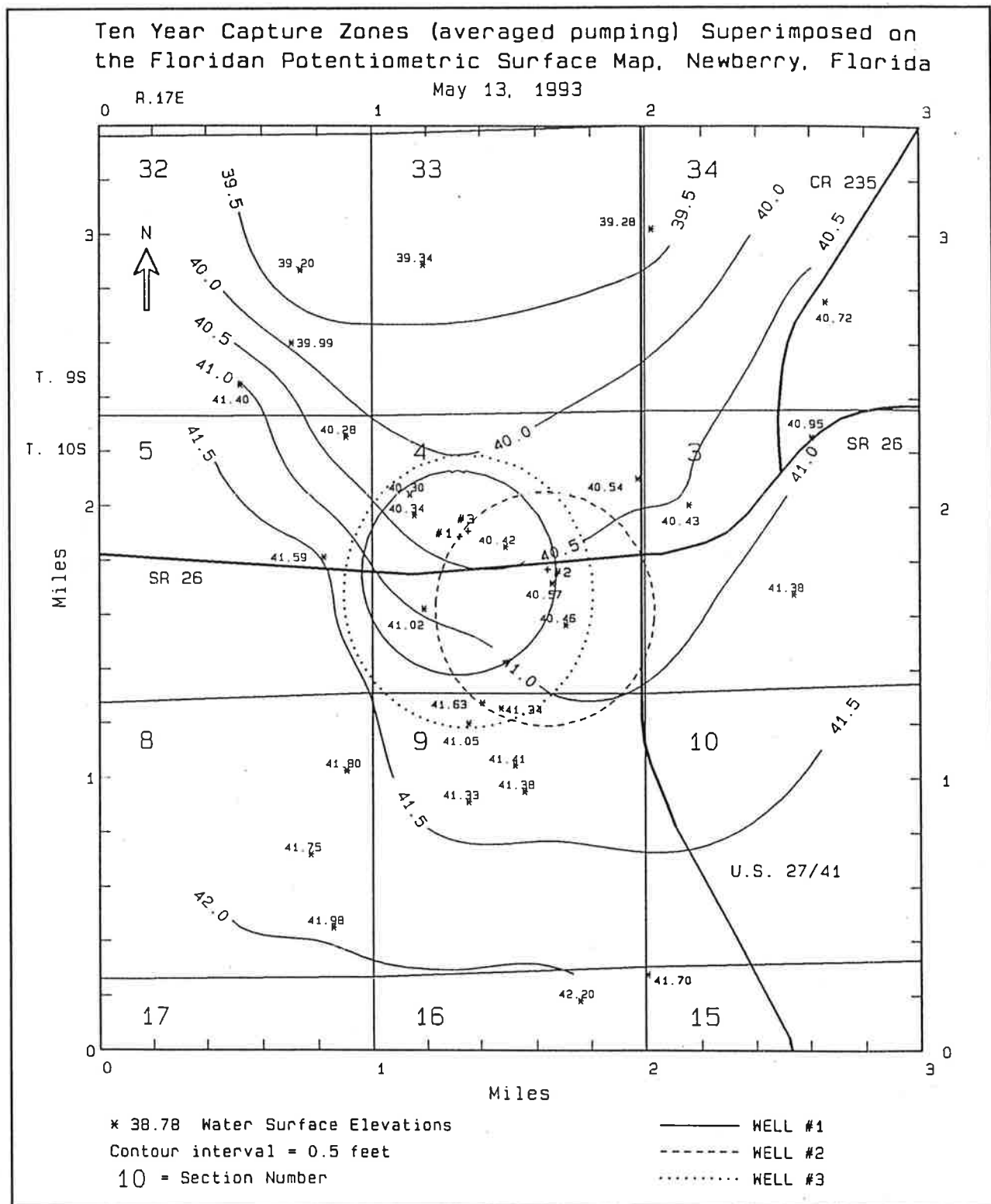


Figure 19 Ten-Year Capture Zones for Averaged Pumping (500 gpm Total Discharge) Superimposed on the Floridan Aquifer System Potentiometric Surface Map, Newberry, Florida (GeoSys, Inc., November 15, 1993)

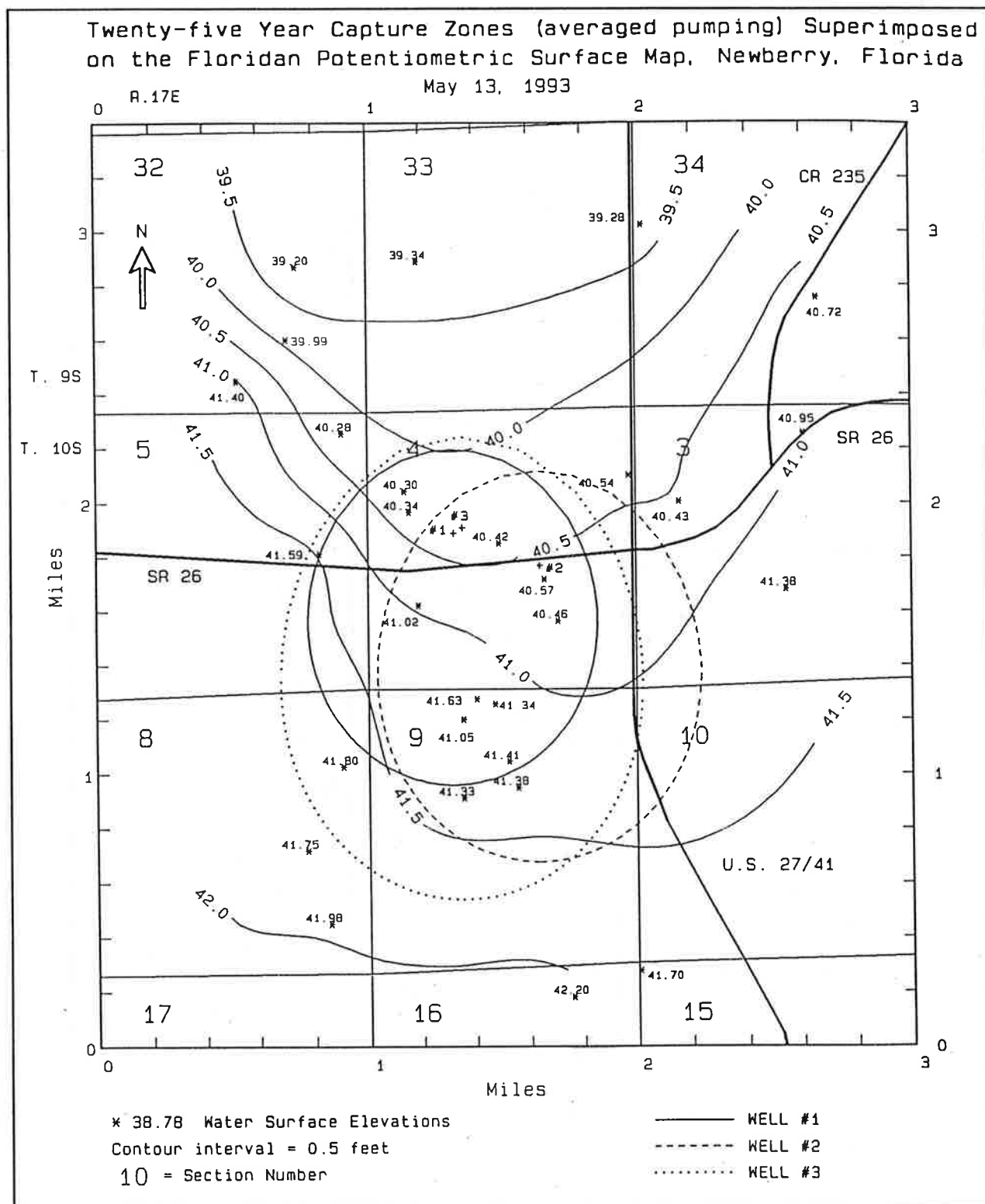


Figure 20 Twenty-five-Year Capture Zones for Averaged Pumping (500 gpm Total Discharge) Superimposed on the Floridan Aquifer System Potentiometric Surface Map, Newberry, Florida (GeoSys, Inc., November 15, 1993)

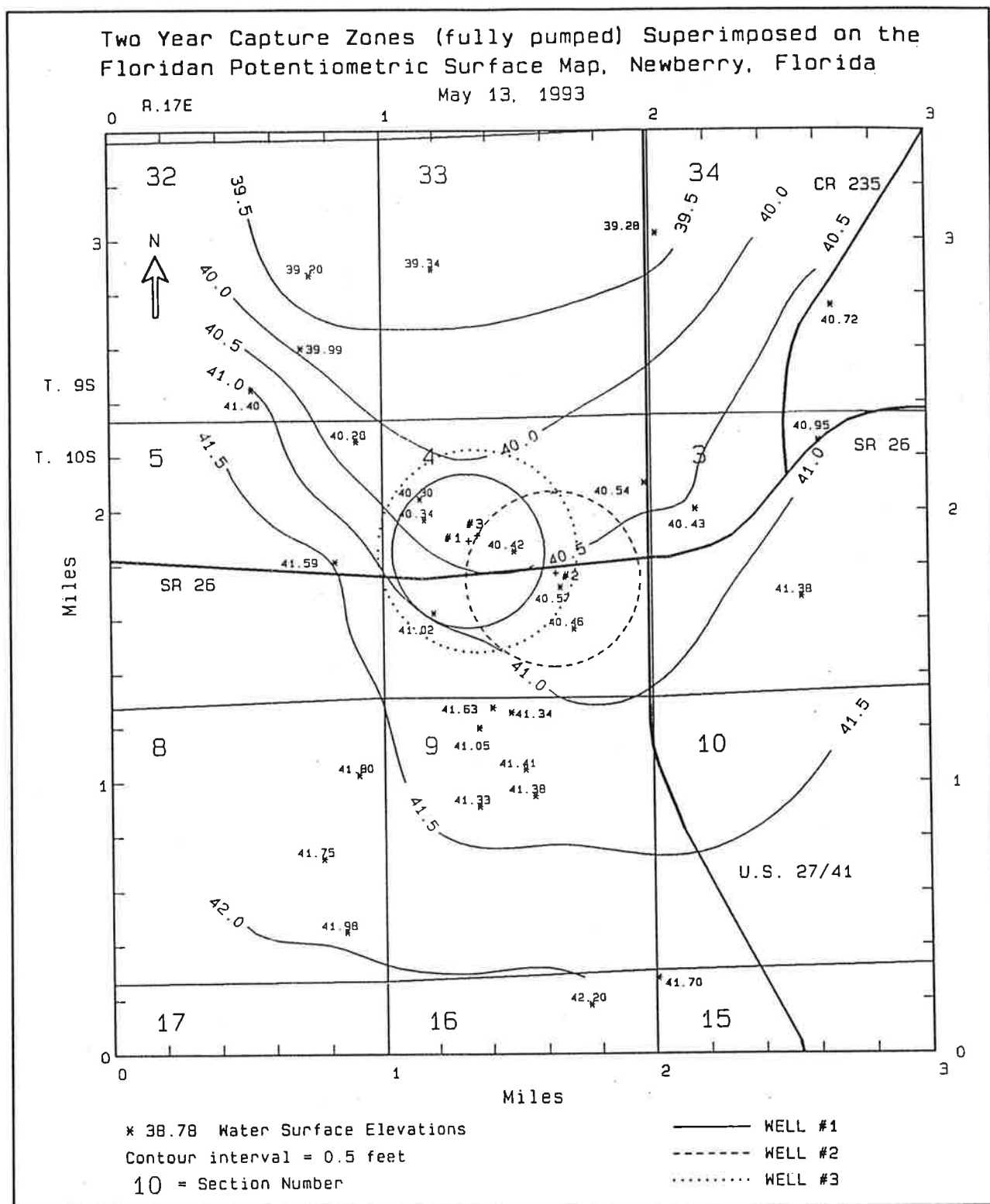


Figure 21 Two-Year Capture Zones for Full Pumping (500 gpm Discharge for Each Well) Superimposed on the Floridan Aquifer System Potentiometric Surface Map, Newberry, Florida (GeoSys, Inc., November 15, 1993)

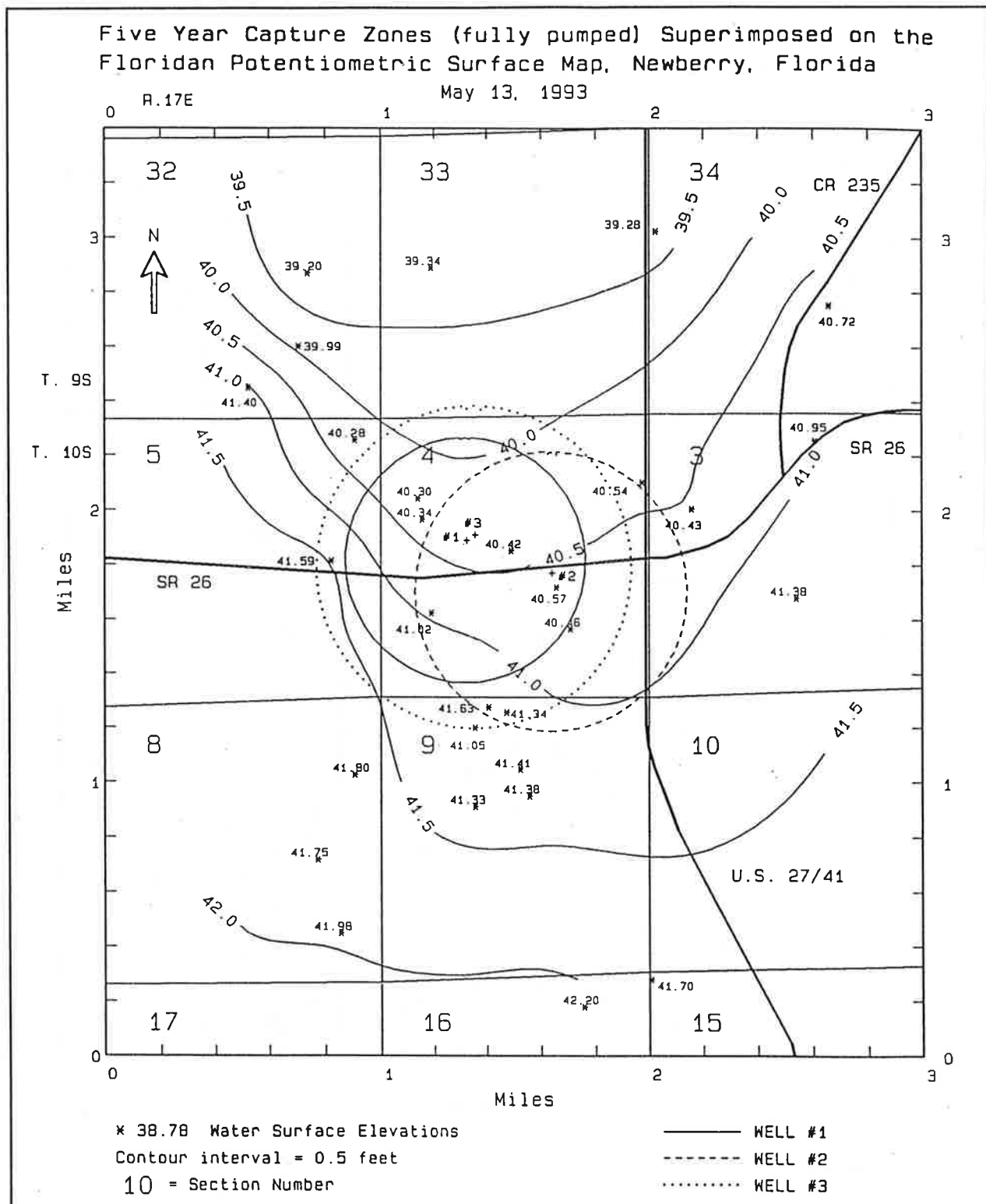


Figure 22 Five-Year Capture Zones for Full Pumping (500 gpm Discharge for Each Well) Superimposed on the Floridan Aquifer System Potentiometric Surface Map, Newberry, Florida (GeoSys, Inc., November 15, 1993)

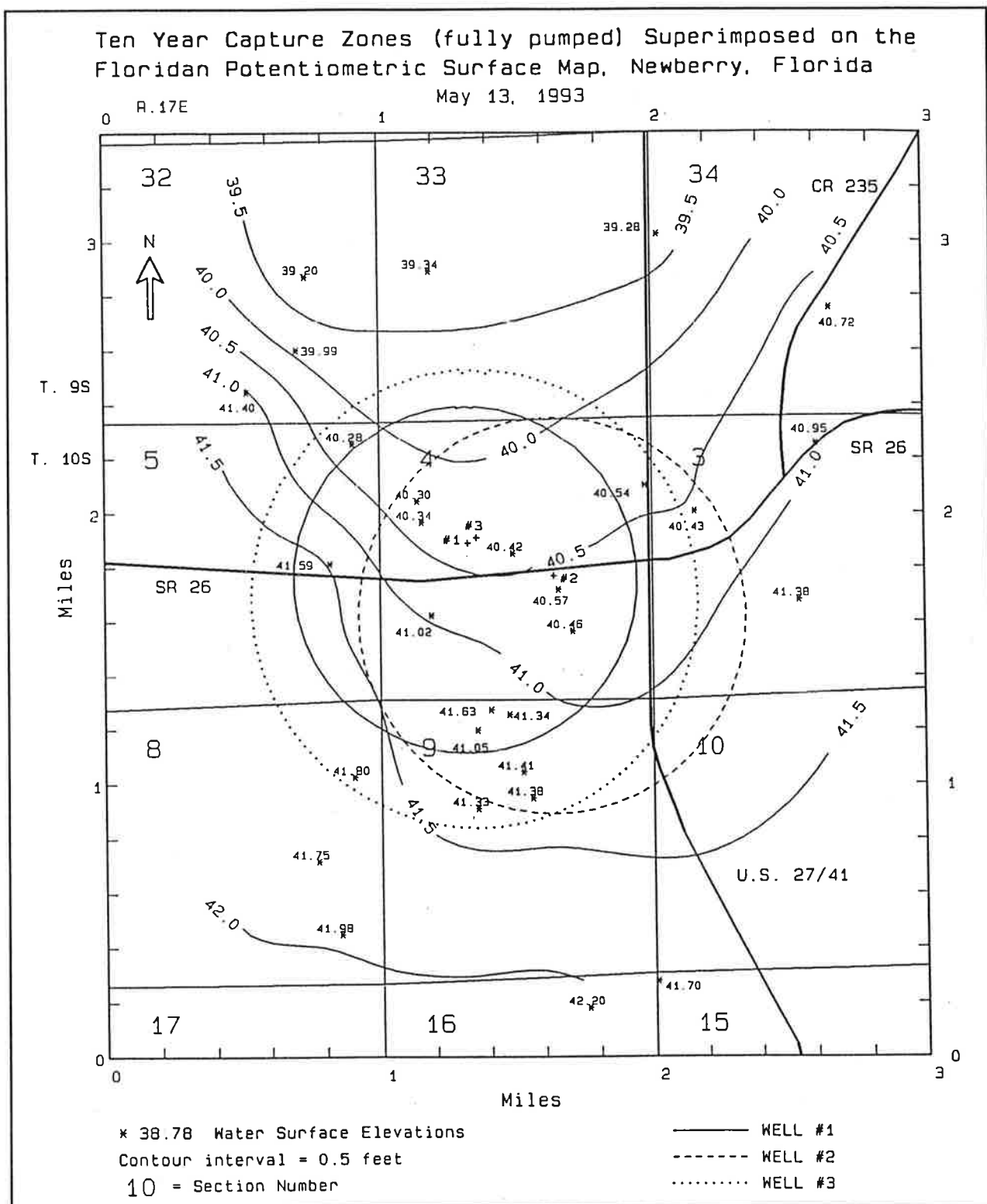


Figure 23 Ten-Year Capture Zones for Full Pumping (500 gpm Discharge for Each Well) Superimposed on the Floridan Aquifer System Potentiometric Surface Map, Newberry, Florida (GeoSys, Inc., November 15, 1993)

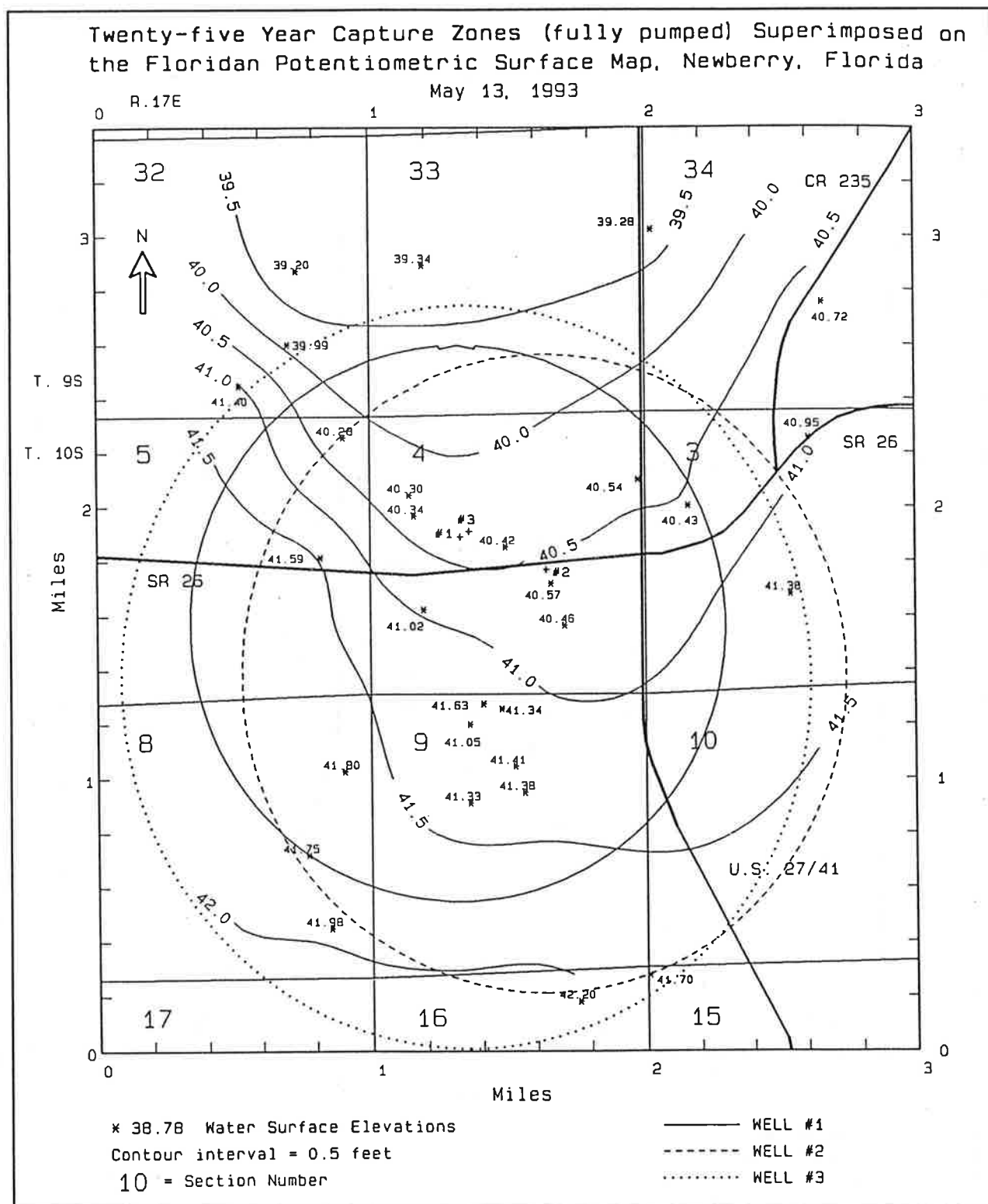


Figure 24 Twenty-five-Year Capture Zones for Full Pumping (500 gpm Discharge for Each Well) Superimposed on the Floridan Aquifer System Potentiometric Surface Map, Newberry, Florida (GeoSys, Inc., November 15, 1993)

Table 10 Model Wellhead Protection Zone Travel Time Distances and Areas, City of Newberry, Alachua County, Florida

Well Number	Modeled Scenario		2 Years	5 Years	10 Years	25 Years
1	Averaged Pumping	Upgradient (feet)	1,100	1,800	2,600	4,800
		Downgradient (feet)	700	1,000	1,300	1,600
		Area (acres)	60	140	270	740
		Area (sq. miles)	0.09	0.22	0.42	1.16
1	Fully Pumped	Upgradient (feet)	1,700	2,700	4,100	7,000
		Downgradient (feet)	1,300	2,000	2,600	400
		Area (acres)	160	400	810	990
		Area (sq. miles)	0.25	0.63	1.27	1.55
2	Averaged Pumping	Upgradient (feet)	1,100	1,900	3,000	5,700
		Downgradient (feet)	900	1,200	2,300	1,800
		Area (acres)	70	170	510	1,020
		Area (sq. miles)	0.11	0.27	0.8	1.59
2	Fully Pumped	Upgradient (feet)	1,800	3,000	4,600	8,100
		Downgradient (feet)	1,600	2,300	3,000	4,200
		Area (acres)	210	510	1,040	2,730
		Area (sq. miles)	0.33	0.8	1.63	4.27
3	Averaged Pumping	Upgradient (feet)	1,500	2,400	3,800	7,200
		Downgradient (feet)	800	1,200	1,100	1,800
		Area (acres)	100	230	430	1,460
		Area (sq. miles)	0.16	0.36	0.67	2.28
3	Fully Pumped	Upgradient (feet)	1,800	3,600	5,500	9,900
		Downgradient (feet)	1,200	1,900	3,300	4,400
		Area (acres)	160	550	1,400	3,690
		Area (sq. miles)	0.25	0.86	2.19	5.77

* Distances and areas based on model output diagrams, Figures 17 through 24.

Well #2 - 127 feet
Well #3 - 102 feet

Uniform Regional Gradient Used: 1 foot/mile - 0.0001893
Time Period: 10 years

Run 1: Averaged Case - Pumping rate divided among three wells, each well pumping 32,083 cu.ft./day for 10 year capture zone. Model run for porosities of 0.10, 0.15 and 0.20 and transmissivities of 105,000 gpd/ft and 400,000 gpd/ft.

Run 2: Worst Case - Assumes a full pumping rate (96,250 cu.ft./day) at each well for the 10 year capture zone. Run for porosities of 0.10, 0.15 and 0.20 and transmissivities of 105,000 gpd/ft and 400,000 gpd/ft.

Only the ten-year capture zone was modeled. Table 11 presents approximate upgradient and downgradient distances and the areas of each protection zone modeled. Figures 25, 26, and 27 present the ten-year capture zones based on an average pumping rate of 500 gpm distributed evenly among the three wells, a transmissivity of 105,000 gpd/ft and porosities of 10, 15, and 20 percent, respectively. Figures 28, 29, and 30 present the ten-year capture zones based on an average pumping rate of 500 gpm distributed evenly among the three wells, a transmissivity of 400,000 gpd/ft and porosities of 10, 15, and 20 percent, respectively. Figures 31, 32, and 33 present 10-year capture zones based on a maximum pumping rate of 500 gpm at each of the three wells, a transmissivity of 105,000 gpd/ft and porosities of 10, 15, and 20 percent, respectively. Figures 34, 35, and 36 present 10-year capture zones based on a maximum pumping rate of 500 gpm at each of the three wells, a transmissivity of 400,000 gpd/ft and porosities of 10, 15, and 20 percent, respectively.

The ten year capture zones for both the average pumped and the fully pumped scenarios using an assumed transmissivity of 105,000 gpd/ft are circular. Changing the transmissivity to 400,000 gpd/ft the capture zones become more elliptical with a greater portion of the zone being in the upgradient direction.

3.9 SITES FOR FUTURE WELLHEAD DEVELOPMENT

Sites for future wellhead development are limited to the northwest area of the city due to existing infrastructure and presence of potential pollution sources. Figure 37 presents the area best suited for future wellhead expansion or replacement given these constraints.

Table 11 Model Wellhead Protection Zone Travel Time Distances for the 10-Year Travel Time Varying Porosity and Transmissivity,
City of Newberry, Alachua County, Florida

Well Number	Modeled Scenario	Transmissivity (gpd/ft)		10% Porosity	15% Porosity	20% Porosity
1	Averaged Pumping	105,000 gpd/ft	Upgradient (feet)	1,980	1,650	1,320
			Downgradient (feet)	990	990	500
	Fully Pumped	105,000 gpd/ft	Upgradient (feet)	3,960	2,480	1,490
			Downgradient (feet)	2,150	2,310	830
1	Averaged Pumping	400,000 gpd/ft	Upgradient (feet)	4,620	2,480	2,640
			Downgradient (feet)	500	330	330
	Fully Pumped	400,000 gpd/ft	Upgradient (feet)	4,290	3,300	3,630
			Downgradient (feet)	1,320	1,160	990
2	Averaged Pumping	105,000 gpd/ft	Upgradient (feet)	2,150	1,490	1,320
			Downgradient (feet)	1,320	1,160	1,160
	Fully Pumped	105,000 gpd/ft	Upgradient (feet)	3,300	2,640	2,310
			Downgradient (feet)	2,640	2,310	1,650
2	Averaged Pumping	400,000 gpd/ft	Upgradient (feet)	3,630	2,600	2,150
			Downgradient (feet)	660	660	660
	Fully Pumped	400,000 gpd/ft	Upgradient (feet)	5,120	3,630	2,970
			Downgradient (feet)	1,650	1,320	1,320
3	Averaged Pumping	105,000 gpd/ft	Upgradient (feet)	2,640	1,980	1,320
			Downgradient (feet)	1,320	1,160	660
	Fully Pumped	105,000 gpd/ft	Upgradient (feet)	3,960	3,300	2,640
			Downgradient (feet)	2,640	2,150	1,980
3	Averaged Pumping	400,000 gpd/ft	Upgradient (feet)	3,300	3,470	2,810
			Downgradient (feet)	500	500	300
	Fully Pumped	400,000 gpd/ft	Upgradient (feet)	5,940	4,290	3,630
			Downgradient (feet)	1,320	1,320	990

* Distances based on model output diagrams Figures 26 through 36.

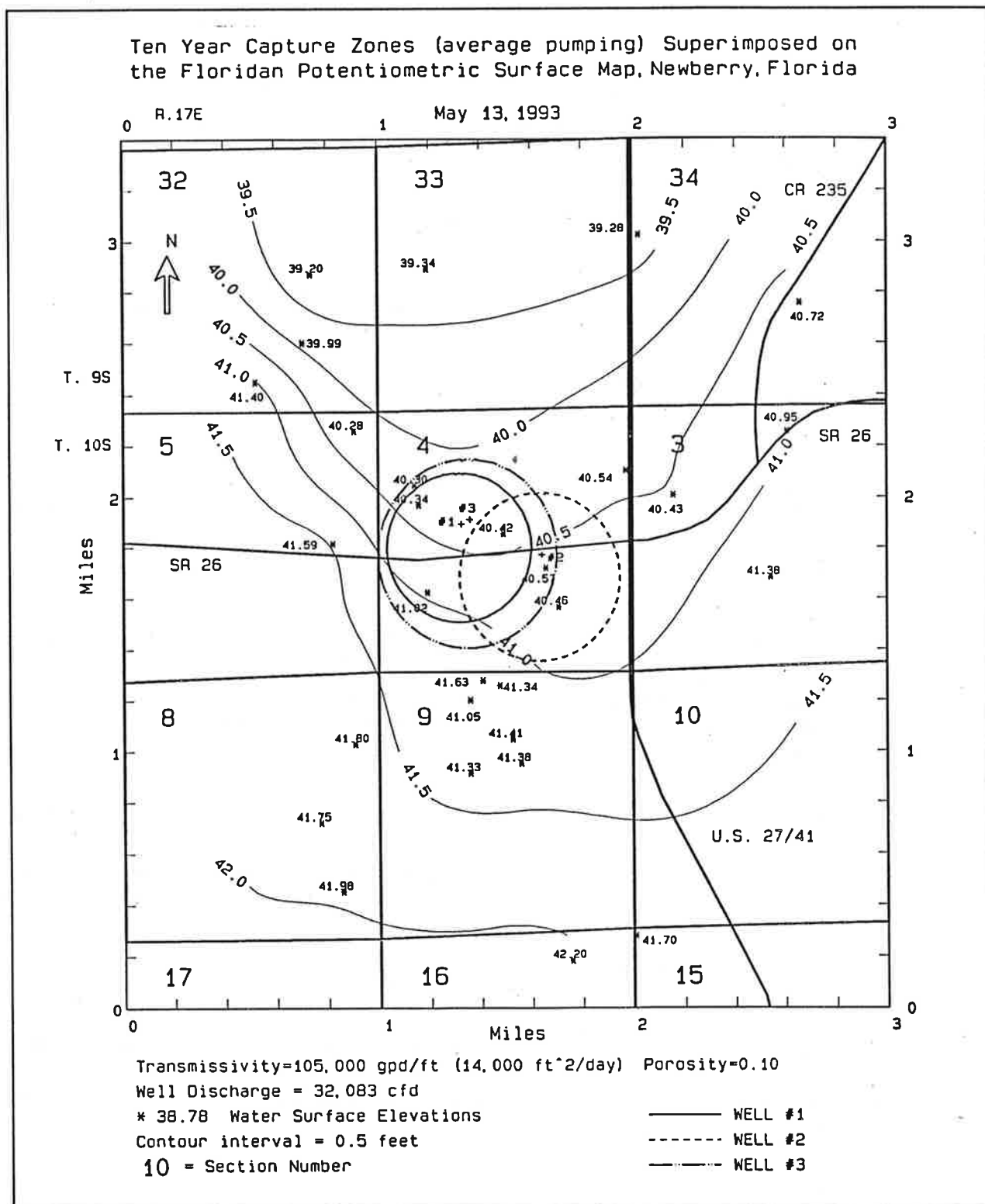


Figure 25 Ten-Year Capture Zones ($n=.10$ and $T=105,000$ gpd/ft) for Averaged Pumping (500 gpm Total Discharge) Superimposed on the Floridan Aquifer System Potentiometric Surface Map, Newberry, Florida (GeoSys, Inc., December 5, 1994)

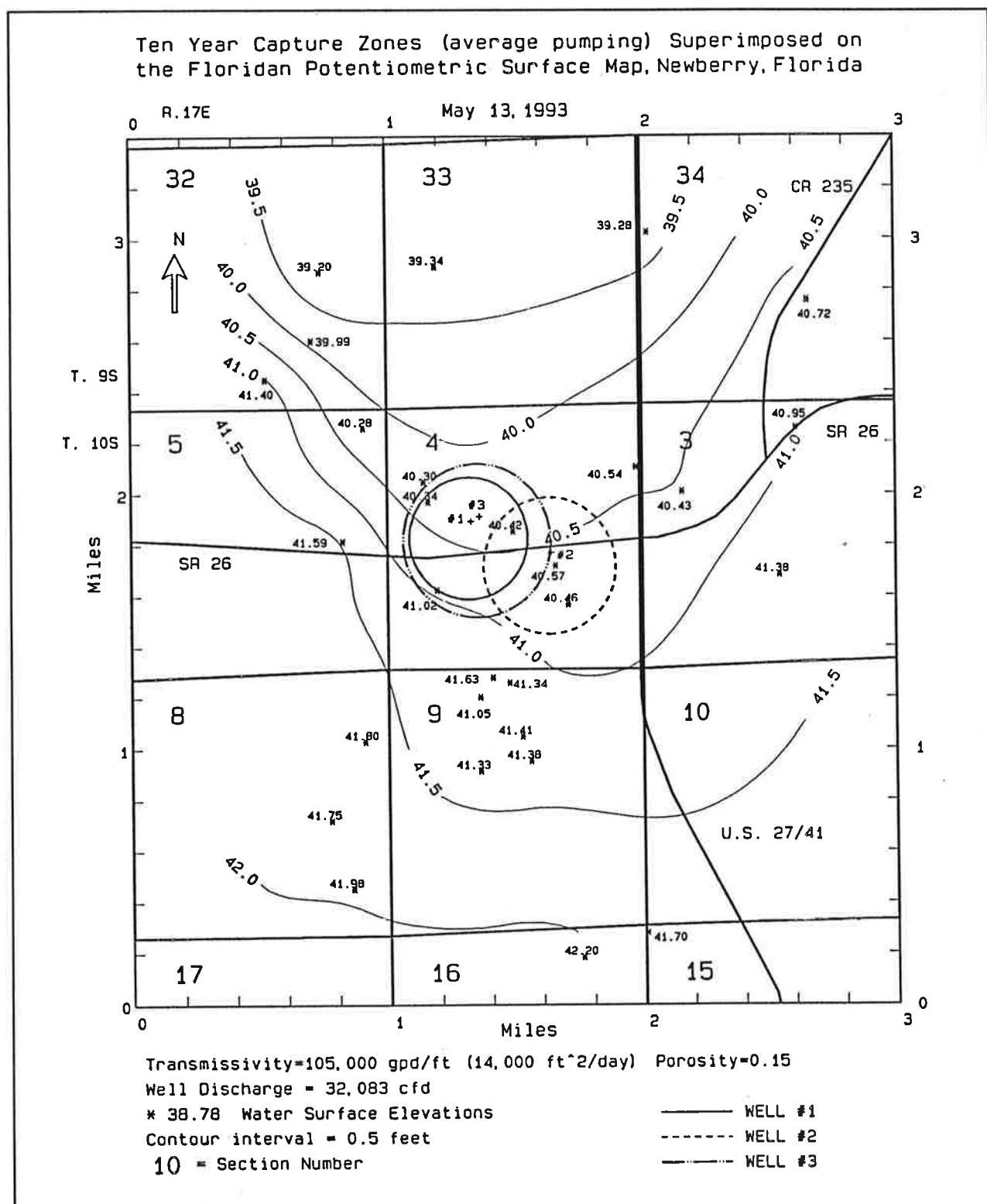


Figure 26. Ten-Year Capture Zones ($n=.15$ and $T=105,000$ gpd/ft) for Averaged Pumping (500 gpm Total Discharge) Superimposed on the Floridan Aquifer System Potentiometric Surface Map, Newberry, Florida (GeoSys, Inc., December 5, 1994)

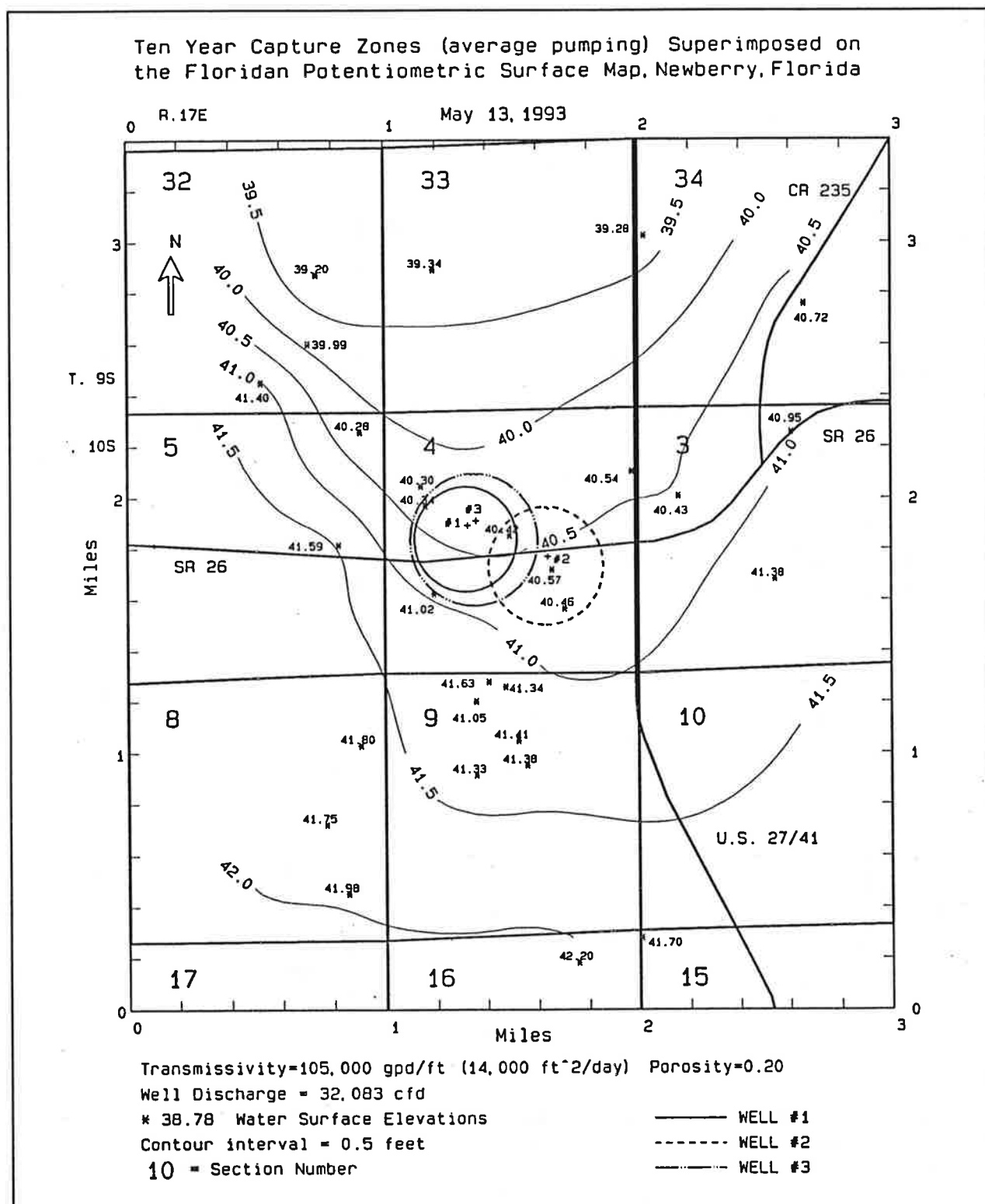


Figure 27 Ten-Year Capture Zones ($n=.20$ and $T=105,000$ gpd/ft) for Averaged Pumping (500 gpm Total Discharge) Superimposed on the Floridan Aquifer System Potentiometric Surface Map, Newberry, Florida (GeoSys, Inc., December 5, 1994)

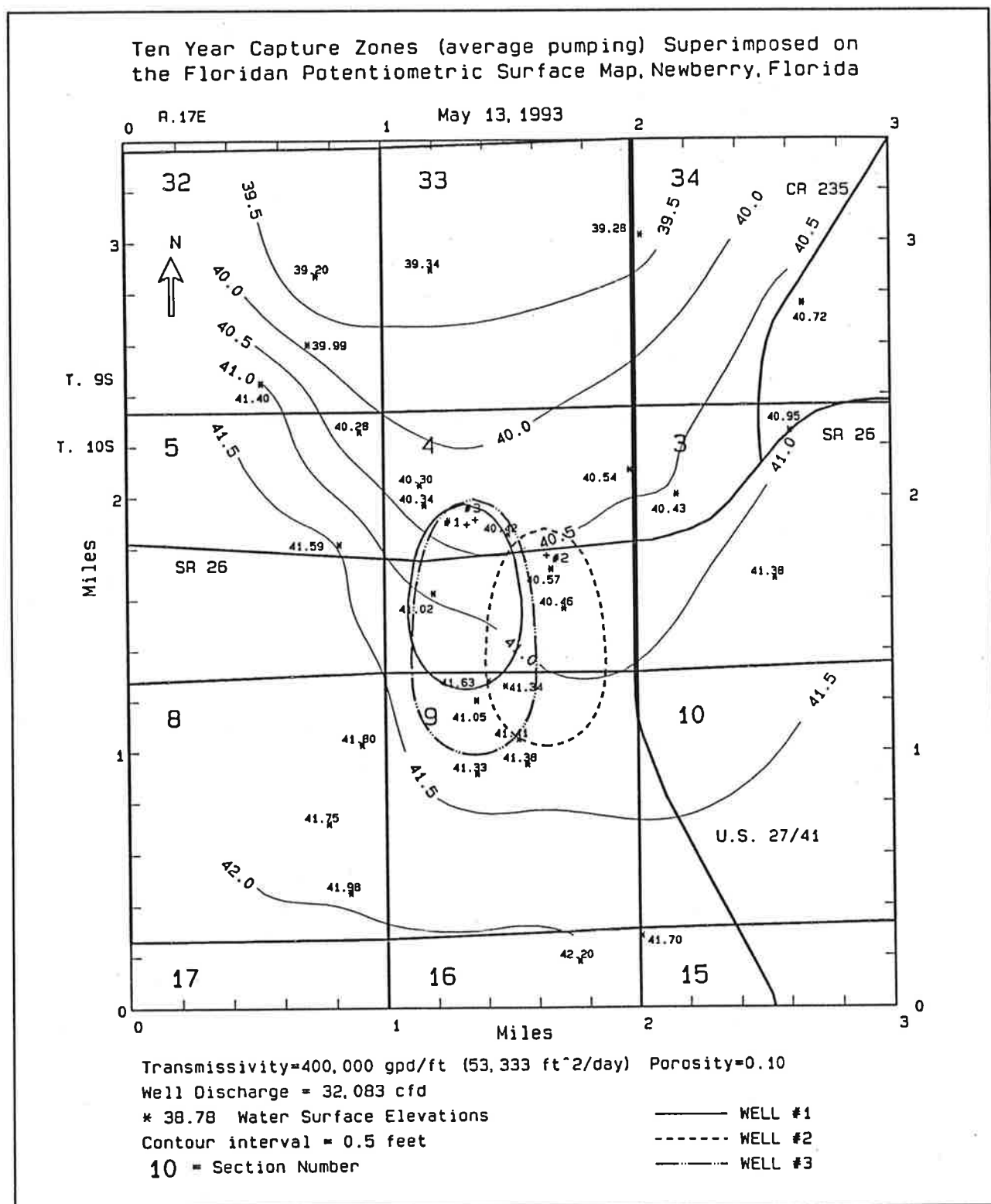


Figure 28 Ten-Year Capture Zones ($n=.10$ and $T=400,000$ gpd/ft) for Averaged Pumping (500 gpm Total Discharge) Superimposed on the Floridan Aquifer System Potentiometric Surface Map, Newberry, Florida (GeoSys, Inc., December 5, 1994)

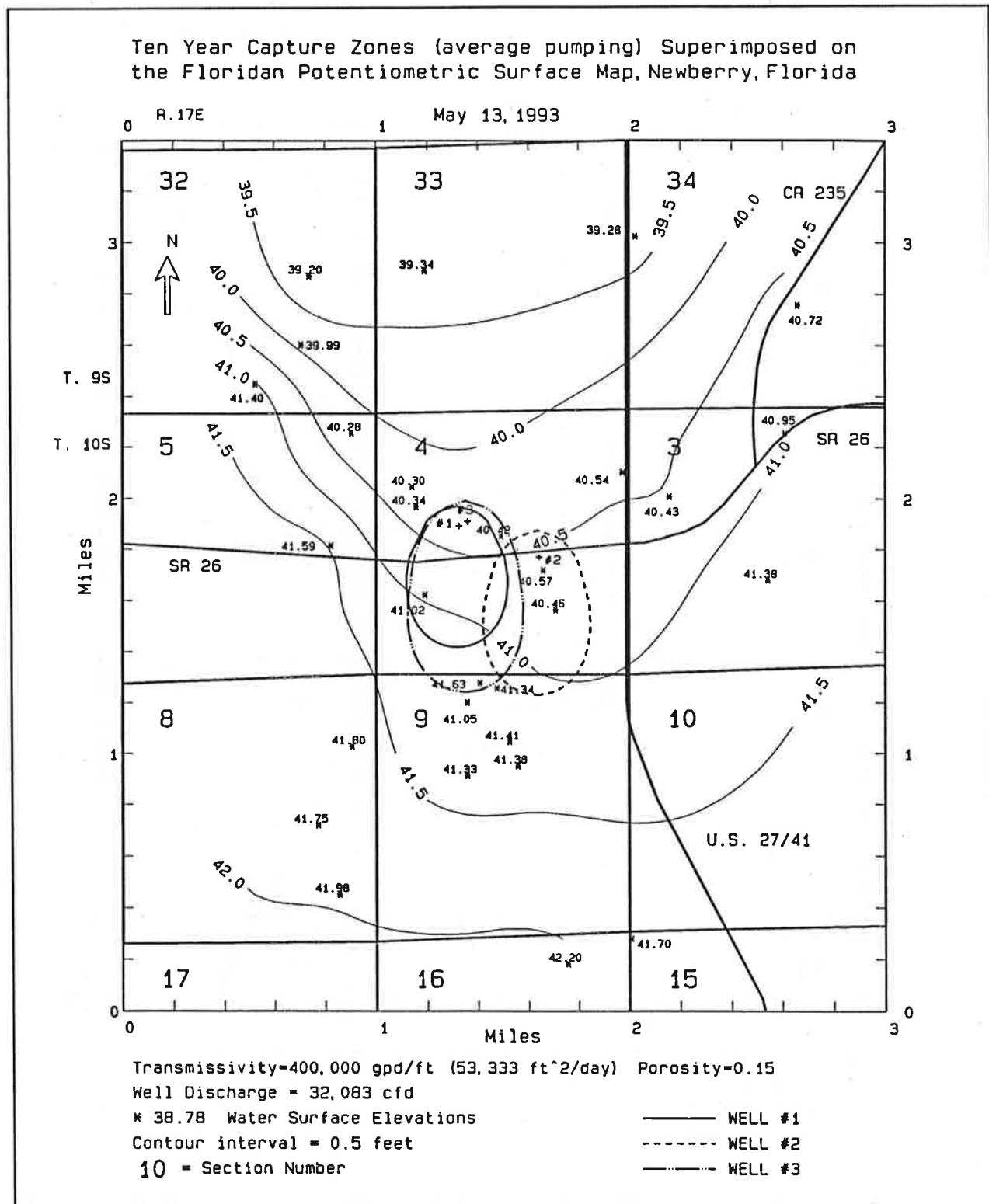


Figure 29 Ten-Year Capture Zones ($n=.15$ and $T=400,000$ gpd/ft) for Averaged Pumping (500 gpm Total Discharge) Superimposed on the Floridan Aquifer System Potentiometric Surface Map, Newberry, Florida (GeoSys, Inc., December 5, 1994)

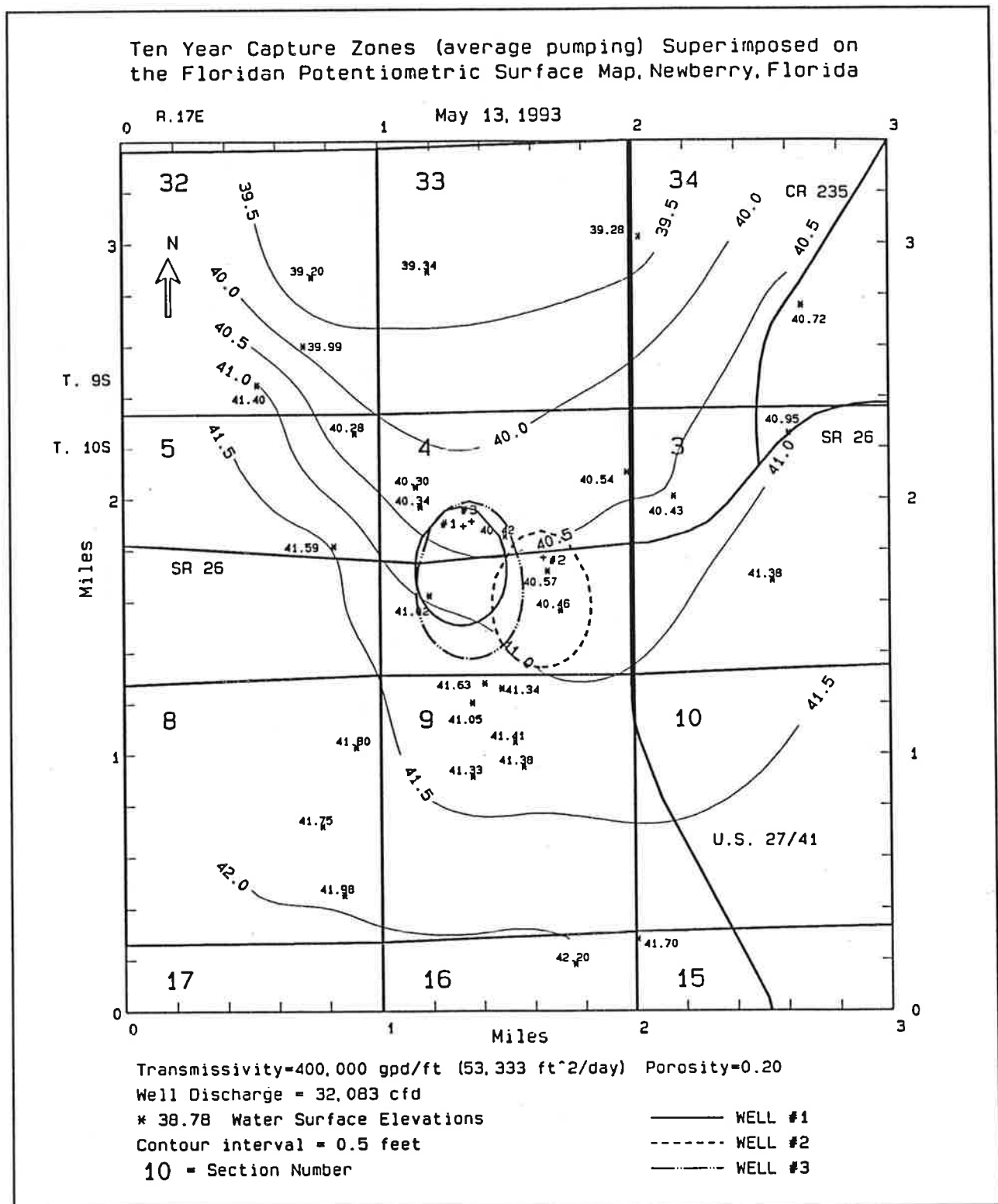


Figure 30 Ten-Year Capture Zones ($n=.20$ and $T=400,000$ gpd/ft) for Averaged Pumping (500 gpm Total Discharge) Superimposed on the Floridan Aquifer System Potentiometric Surface Map, Newberry, Florida (GeoSys, Inc., December 5, 1994)

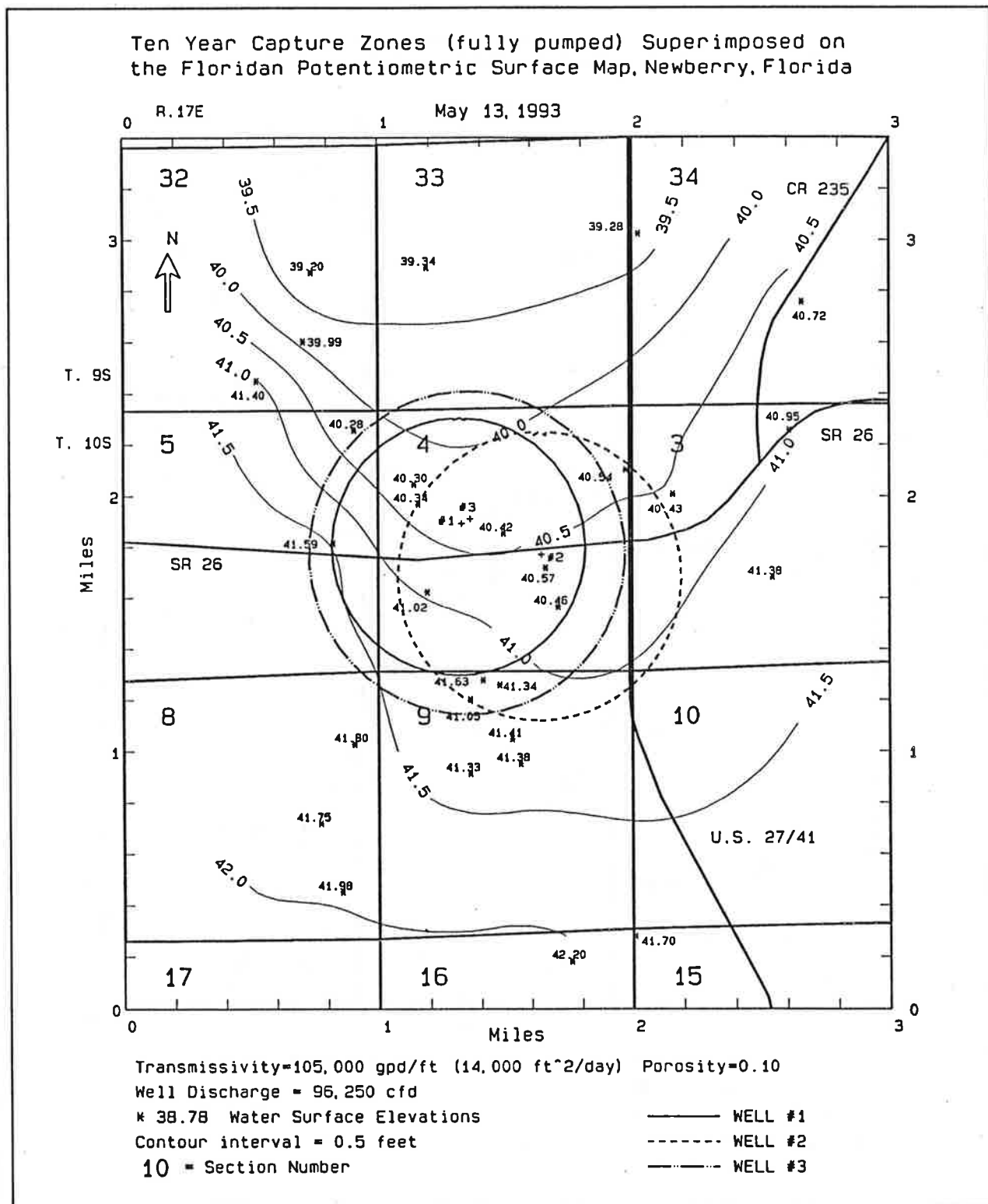


Figure 31 Ten-Year Capture Zones ($n=.10$ and $T=105,000$ gpd/ft) for Full Pumping (500 gpm Discharge for Each Well) Superimposed on the Floridan Aquifer System Potentiometric Surface Map, Newberry, Florida (GeoSys, Inc., December 5, 1994)

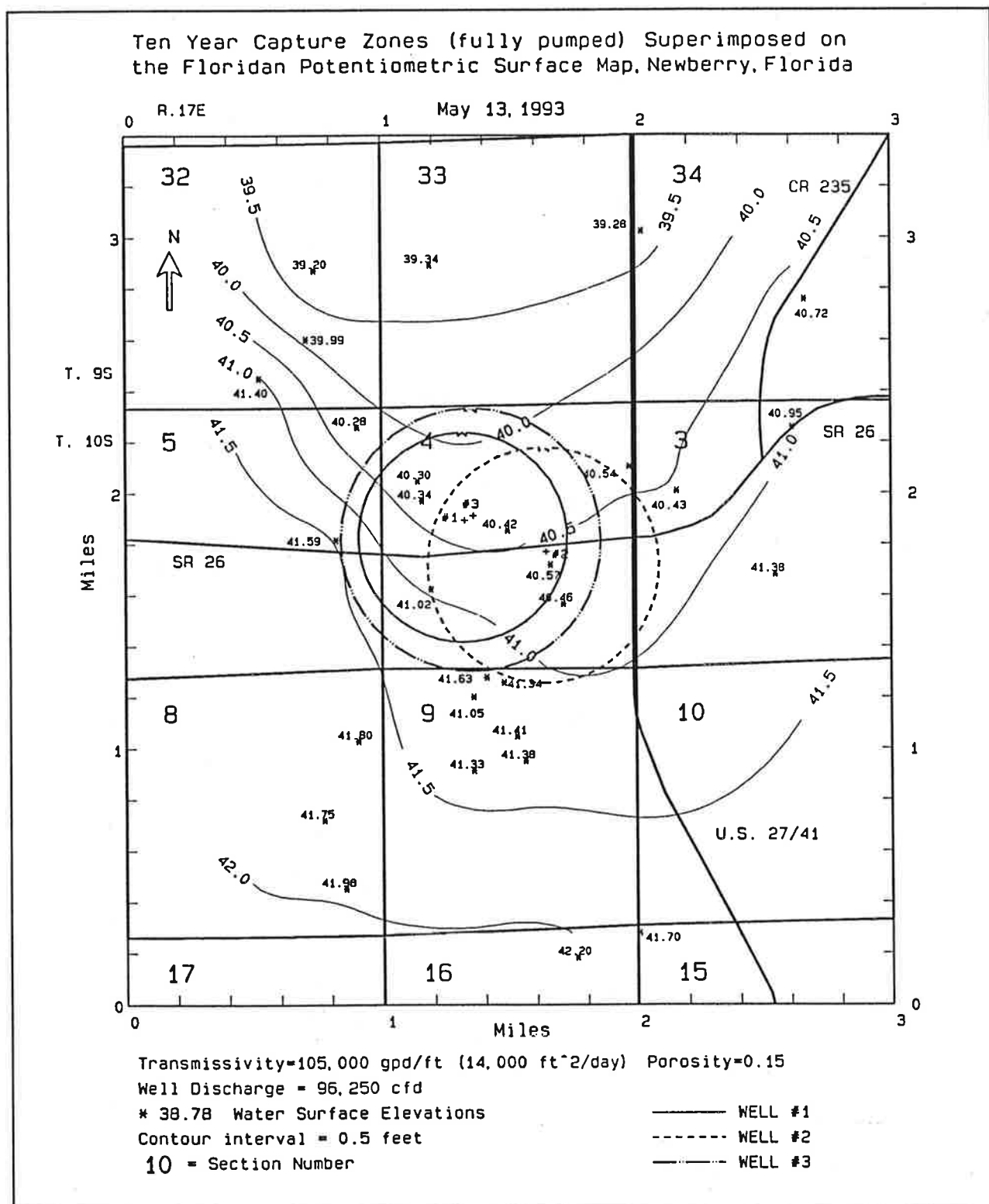


Figure 32 Ten-Year Capture Zones ($n=.15$ and $T=105,000$ gpd/ft) for Full Pumping (500 gpm Discharge for Each Well) Superimposed on the Floridan Aquifer System Potentiometric Surface Map, Newberry, Florida (GeoSys, Inc., December 5, 1994)

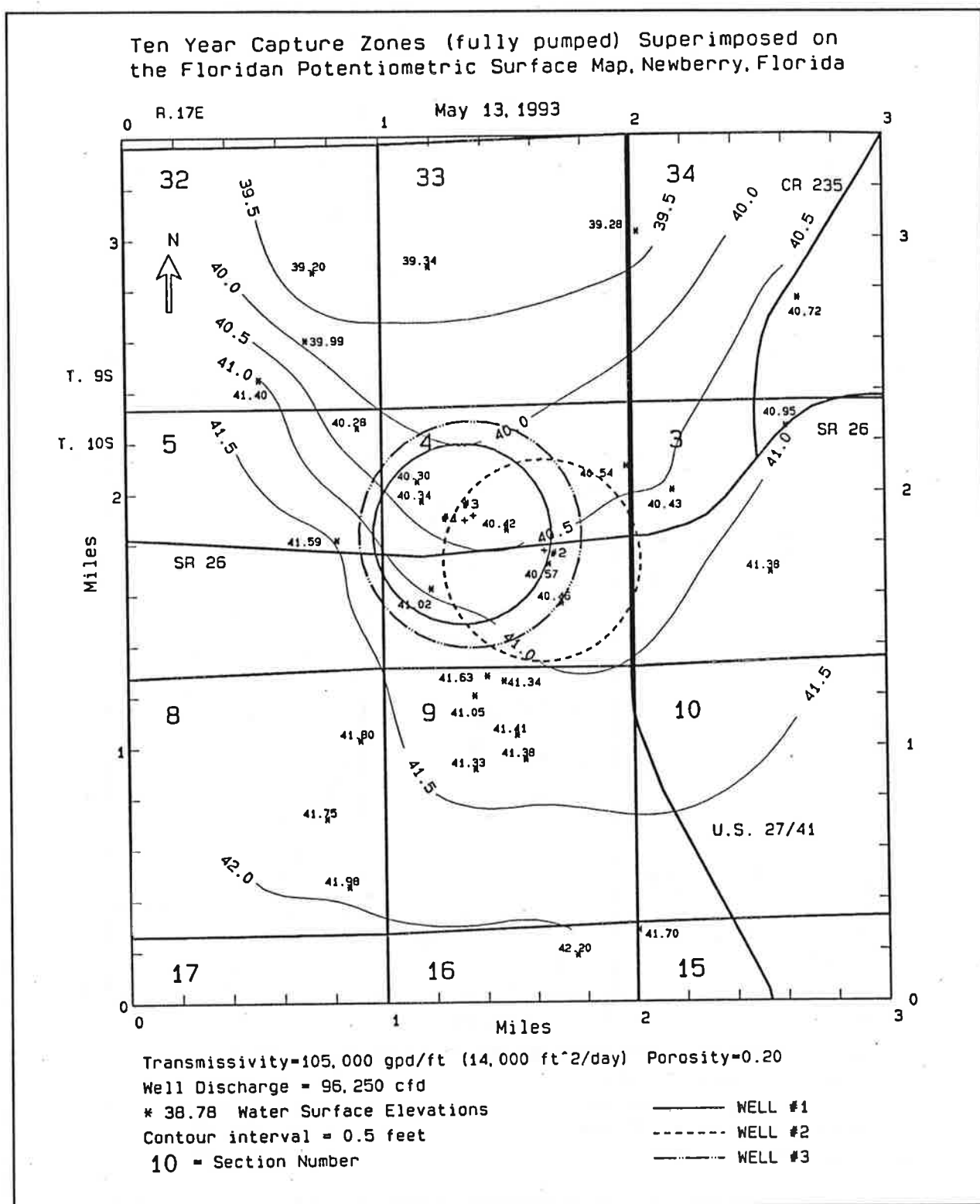


Figure 33 Ten-Year Capture Zones ($n=.20$ and $T=105,000$ gpd/ft) for Full Pumping (500 gpm Discharge for Each Well) Superimposed on the Floridan Aquifer System Potentiometric Surface Map, Newberry, Florida (GeoSys, Inc., December 5, 1994)

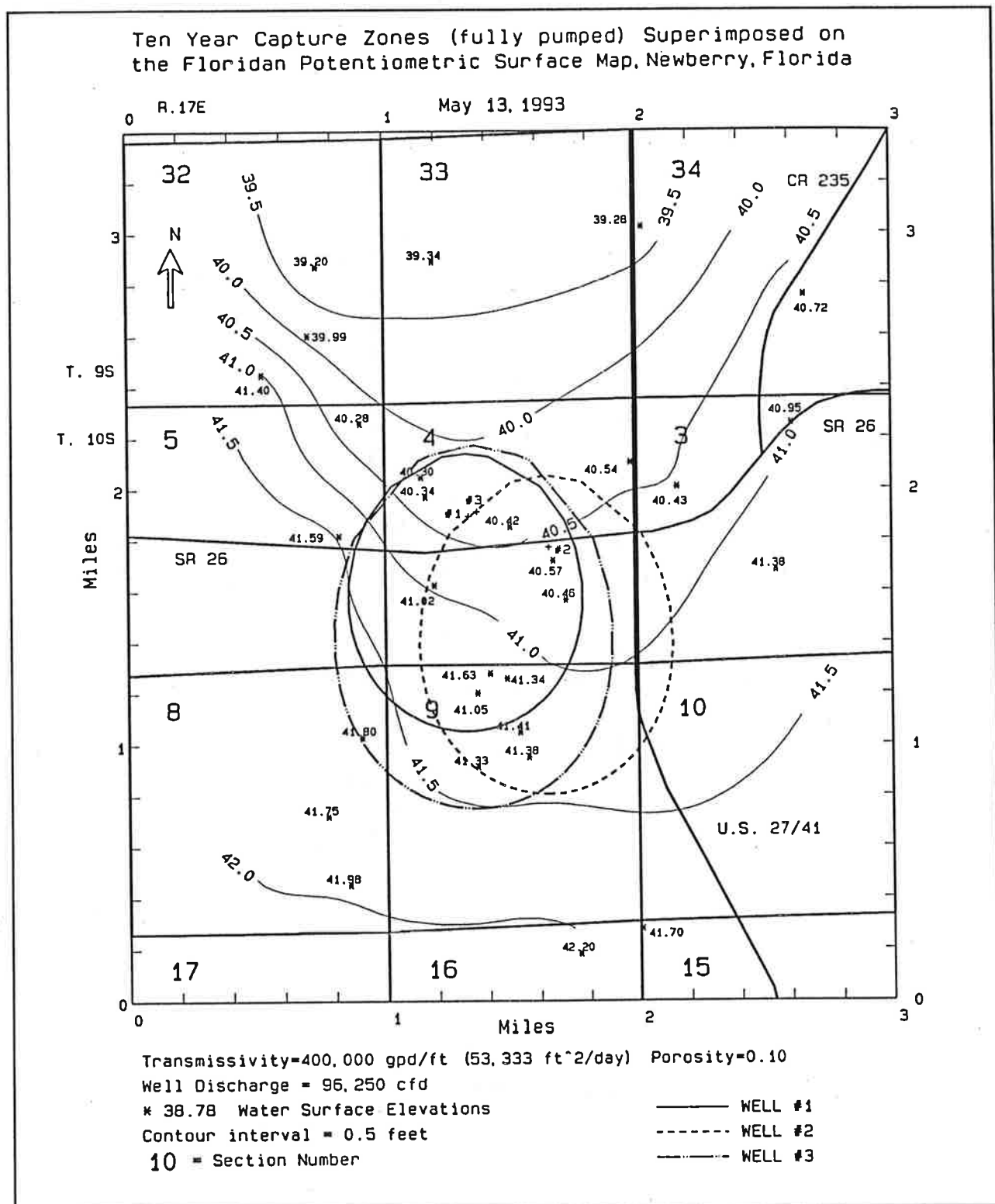


Figure 34 Ten-Year Capture Zones ($n=.10$ and $T=400,000$ gpd/ft) for Full Pumping (500 gpm Discharge for Each Well) Superimposed on the Floridan Aquifer System Potentiometric Surface Map, Newberry, Florida (GeoSys, Inc., December 5, 1994)

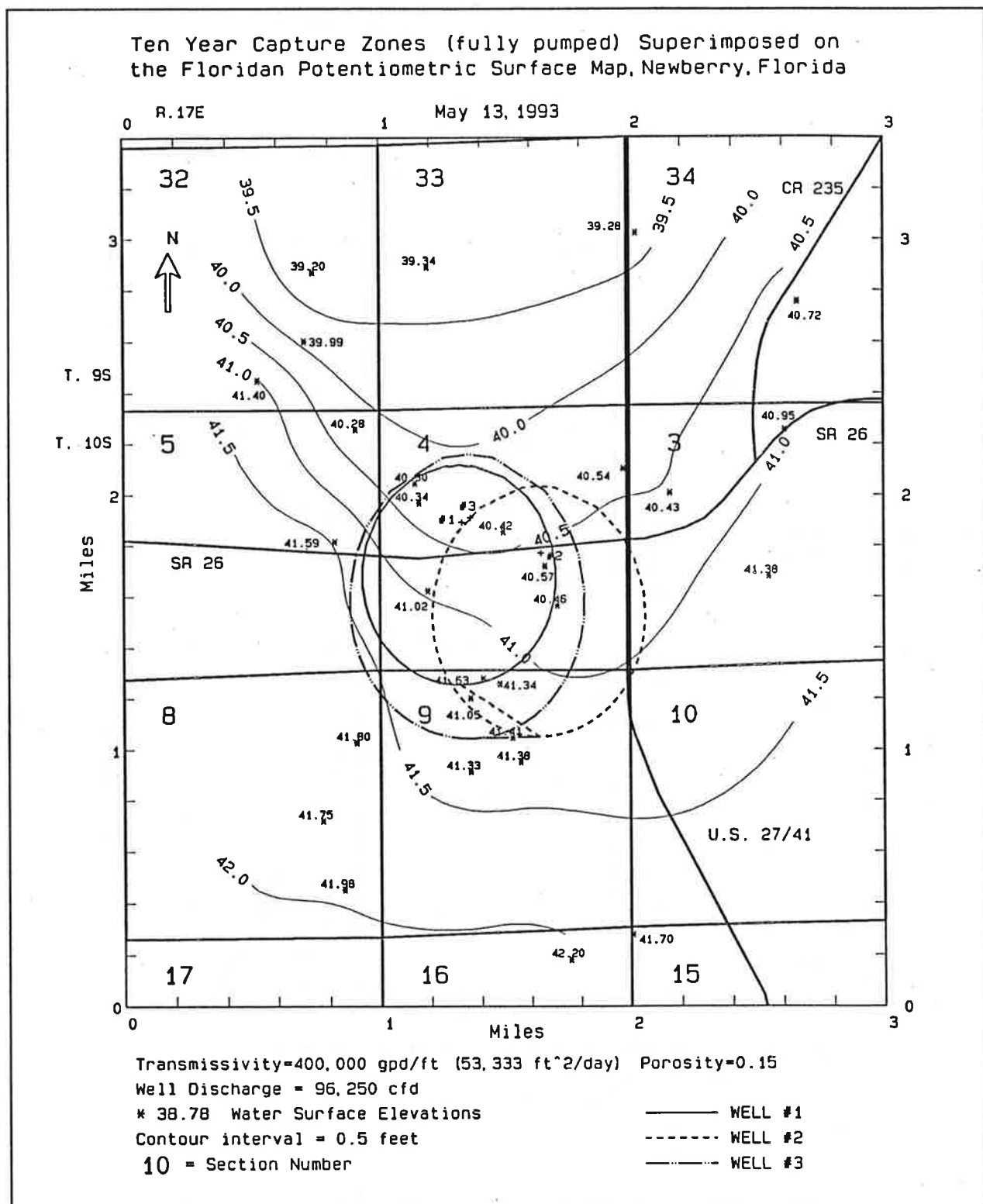


Figure 35 Ten-Year Capture Zones ($n=.15$ and $T=400,000$ gpd/ft) for Full Pumping (500 gpm Discharge for Each Well) Superimposed on the Floridan Aquifer System Potentiometric Surface Map, Newberry, Florida (GeoSys, Inc., December 5, 1994)

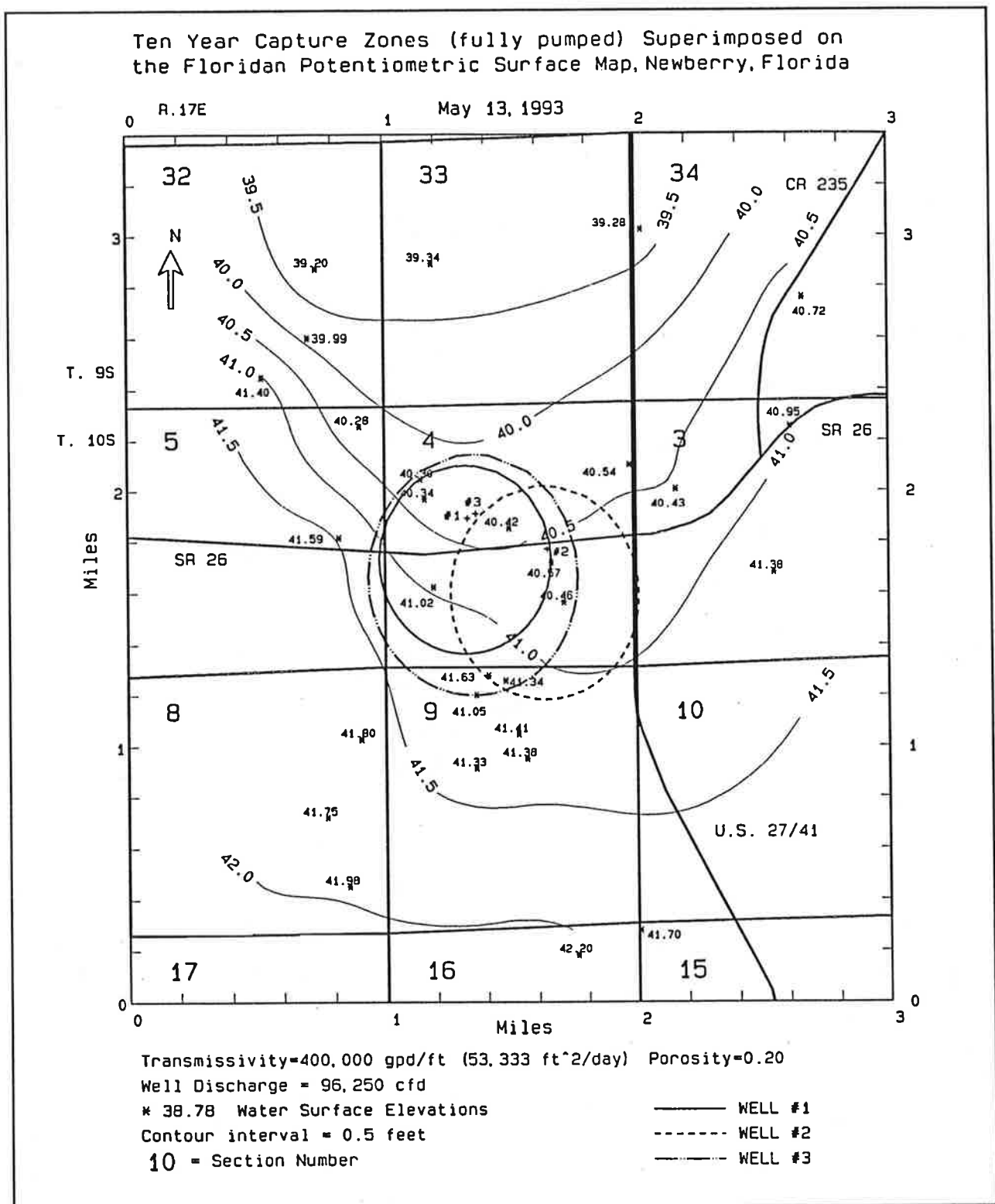


Figure 36 Ten-Year Capture Zones ($n=.20$ and $T=400,000$ gpd/ft) for Full Pumping (500 gpm Discharge for Each Well) Superimposed on the Floridan Aquifer System Potentiometric Surface Map, Newberry, Florida (GeoSys, Inc., December 5, 1994)



Figure 37 Potential Locations for Future Public Water System Sites, Newberry, Florida

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5.0 DESIGN AND IMPLEMENTATION OF THE WELLHEAD PROTECTION PLAN

This section presents a model wellhead protection ordinance. The ordinance was developed from material in existing ordinances and our experiences with the Murphree Wellfield Management Code (Alachua County Ordinance 88-15) and the Alachua County Hazardous Materials Management Code, Ordinance 91-6 (Appendix J).

We will be providing this ordinance in draft form to the City of Newberry for their comments. Adoption of any regulations by the City of Newberry is their responsibility. As the model ordinance is written the City is responsible for implementation of the ordinance. Staff from our office will be available to assist the City with questions relating to hazardous materials use and storage.

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APPENDIX A DEFINITIONS

APPENDIX B MAP OF WELLHEAD PROTECTION AREA (not included)

APPENDIX C LAND USE LISTING (not included)

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Section 1. Title. This ordinance shall be known and cited as the "City of (municipality) Wellhead Protection Ordinance".

Section 2. Legislative Findings. The City Commission of (municipality), Florida, finds and declares that:

2.1 The primary source of potable water supply is the Floridan aquifer. The protection of this water resource is of utmost importance in order to protect public health and safety and the environment.

2.2 The need exists to protect the present and future potable water supply source of the City of (municipality) from degradation in quality and from the introduction of hazardous substances into the water supply source.

2.3 Inappropriate and unplanned development and land use contribute to groundwater quality degradation.

2.4 Future land uses shall be in accordance with the land use element of the Alachua County Comprehensive Plan (ACCP).

2.5 Water supply development and use shall be consistent with the water supply element of the ACCP.

2.6 It is deemed to be necessary and in the best interest of public health, safety and welfare of the citizens of the city of (municipality) to adopt regulations pertaining to land uses and development within defined areas around public water supply wells, and to establish city wide ground water protection criteria for the city's existing and future potable water resources.

Section 3. Purpose and Intent.

3.1 To protect the groundwater supply source so that it may continue to be the city's present and future water source.

3.2 To designate wellhead protection zones which have specific allowable land uses to preserve the groundwater quality by preventing the introduction of known hazardous substances.

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3.3 To augment the City Comprehensive Plan by establishing land development regulations which can safeguard the groundwater resource by prohibiting activities associated with inappropriate land uses that have been found to be detrimental to the water supply.

3.4 It is the intent of the Board of City Commissioners of (municipality) City, Florida that this ordinance implement and be consistent with the Alachua County Growth Management Plan. Implementation will provide for the long term protection of the city's ground water resource. This ordinance intended to be consistent with principles of property rights, as balanced with the health, safety and welfare of the general public.

Section 4. Definitions. For the purpose of this code, certain terms or words shall be interpreted to have the meanings as defined in Appendix A. The word "shall" is mandatory; the words "may" or "should" are permissive.

Section 5. Applicability. All provisions of this code shall be effective within the incorporated and unincorporated areas of the City of (municipality), and shall set restrictions, constraints and prohibitions to protect present and future public water supply wells from degradation caused by contamination from hazardous substances.

Section 6. Administration. The (city position title of designated official) is hereby designated as the city official responsible for the administration and enforcement of this code. The (city position title) shall have the following powers and duties:

6.1 Administer and enforce the provisions of this code.

6.2 Investigate complaints, study and observe contamination conditions and make recommendations in order to abate nuisances caused by contamination.

6.3 Make appropriate surveys, tests, and inspections of property and facilities operating under the provisions of the code to determine whether the provisions of the code are being complied with interact with the Alachua County Environmental Protection Department and the Florida Department of Environmental Protection, and make recommendations for methods by which contamination may be reduced or eliminated. Inspections shall be conducted as follows:

6.3.1 Any duly authorized representative of the (city position title) may, at any reasonable time, enter and inspect, for the purpose of ascertaining the state of

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compliance with this code, any property, premises, or place except a building which is used exclusively for a private residence, on or at which a regulated facility is located or is being constructed.

6.3.2 Any duly authorized representative may, at reasonable times, have access to and copy any records required under this code, inspect any monitoring equipment or method, sample for any hazardous material which the owner or operator of such source may be discharging or which may otherwise be located on or underlying the owner's or operator's property, and obtain any other information necessary to determine compliance with permit conditions or other requirements of the code.

6.3.3 No person shall refuse reasonable entry or access to any authorized representative of the (city position title) who requests entry for purposes of inspection and who presents appropriate credentials, nor shall any person obstruct or interfere with any such inspection. The owner or operator of the premises shall receive a report, if requested, setting forth all facts found which relate to compliance status.

6.4 Maintain, review, and supervise all operating records required to be filed with the (city position title) by persons operating facilities subject to the provisions of this code.

6.5 Render all possible assistance and technical advice to persons owning and/or operating regulated facilities, except that the (city position title) and/or city employees shall not design the facility systems for any person.

6.6 Perform such other administrative duties as may be assigned by the City Commission.

6.7 Issue or deny permits.

Section 7. Wellhead Protection Area(s)

7.1 General. The wellhead protection area(s) shown on the map in Appendix B and described in Section 7 is/are incorporated herein and made a part of this code. This map shall be on file and maintained by the (city position title). Any amendments, additions, or deletions to the Wellhead Protection Area(s) map shall be approved by amendment by the City Commission.

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7.2 Basis for Wellhead Protection Area Delineation. The wellhead protection area(s) map is based upon groundwater travel time and the average withdrawal.

7.3 Annual Review. The Wellhead Protection Area map shall be reviewed at least on an annual basis. However, failure to conduct said review shall not affect the validity of the existing approved map. The basis for updating said map may include, but is not limited to, the following:

7.3.2 Changes in the technical knowledge concerning the applicable aquifer.

7.3.3 Changes in pumping rate of well.

7.3.4 Designation of new wells.

7.3.5 Wellfield reconfiguration

7.4 Wellhead Protection Areas. The wellhead protection areas indicated on the maps are as follows:

7.4.1 Zone One (1): The land area situated between the well(s) and a 500-foot radius contour.

7.4.2 Zone Two (2): The land area situated between the 500-foot radius contour and the ten year travel time contour.

The boundaries of the wellhead protection areas reflect the best hydrogeologic information available as of the date of the map. Where these bounds are in dispute, the burden of proof shall be upon the owner(s) of the land in question to show where the boundaries should be properly located.

7.5 Legal Description. The legal description of the Wellhead Protection Area(s) is shown below: not included

7.6 Determination of Property Locations. In determining the location of properties within the zones depicted on the Wellhead Protection Area maps, the following rules shall apply:

7.6.1 Properties located wholly within one (1) zone as reflected on the applicable Wellhead Protection Area map shall be governed by the restrictions applicable to that zone.

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- 7.6.2 Properties having parts lying within more than one (1) zone as reflected on the applicable Wellhead Protection map shall be governed by the restrictions applicable to the zone in which the part of the property is located.
- 7.6.3 Where a travel time contour which delineates the boundary between two wellhead protection zones passes through a building, the entire building shall be considered to be in that zone if said zone contains more than fifty (50) percent of the floor space of the building.

Section 8. Allowable Land Uses.

8.1 General. No city officer, agent, employee or board shall approve, grant or issue any building permit, certificate of use and occupancy, platting action or zoning action for any land use within the Wellhead Protection Area without obtaining the prior written approval of the (city position title). Furthermore, no person shall construct, utilize, operate, occupy or cause, allow, let, permit or suffer to be constructed, utilized, operated or occupied any land use within the Wellhead Protection Area without obtaining the prior written approval of the (city position title).

8.2 Approval Procedure. The (city position title) shall issue a written approval only if:

8.2.1 The property is within the Wellhead Protection Area and the existing land use(s) for the property or the land use(s) requested for the property is one or more of the land uses set forth in Appendix C.

8.2.2 The property is not within the Wellhead Protection Area and the existing land use(s) for the property or the land use(s) requested for the property is in compliance with Section 10, or

8.2.3 The land use is not listed in Appendix C, the land use(s) is not set forth as a permitted use, special exception, or unusual use. The land use(s) is comparable to a land use(s) set forth in Appendix C, and the land use(s) will not have an adverse environmental impact on groundwater quality in the Wellhead Protection Area.

In determining whether a land use is comparable to one or more land use(s) set forth in Appendix C, the (city position title) shall consider the following factors:

8.2.3.1 The materials used, handled and stored, and the products and wastes produced

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8.2.3.2 The activities, processes and methods which are employed and utilized

8.2.3.3 The machinery and other facilities utilized and maintenance requirements of said machinery and facilities

8.2.3.4 Uses commonly associated with the primary use.

In determining whether a land use does not or will not have an adverse environmental impact on the groundwater quality in the Wellhead Protection Area, the (city position title) shall consider the following factors:

8.2.3.5 The land use will not injure public health, welfare and safety, create a nuisance, nor increase the level of water pollution within the Wellhead Protection Area;

8.2.3.6 The use, generation, handling, disposal, discharge or storage of hazardous materials will not occur within the Wellhead Protection Area;

8.2.3.7 The only liquid waste (excluding storm water) which will be generated, disposed of, discharged, or stored within the Wellhead Protection Area shall be domestic sewage discharged to a public sanitary sewer;

8.2.3.8 Storm water runoff shall be retained on the property and disposed of through means which are in accordance with acceptable storm water management practices.

Section 9. Regulated Materials.

9.1 General. No city officer, agent, employee or board shall approve, grant or issue any building permit, certificate of use and occupancy (except for changes in ownership), municipal occupational license (except for changes in ownership), platting action or zoning action for any nonresidential land use other than for bona fide agricultural land use, public sewer facilities use, or public water supply facilities use within the Wellhead Protection Area without obtaining the prior written approval of the (city position title).

The (city position title) shall issue a written approval only if the (city position title) determines that all potential sources of pollution will be installed upon the property as far

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away as is reasonably possible from all potable water supply wells; regulated materials will not be used, generated, handled, disposed of, discharged or stored on that portion of the property within the Wellhead Protection Area. For a description of those materials which are regulated in this code, refer to Appendix A or Section I of the Alachua County Hazardous Materials Management Code, Ordinance 91-6.

9.2 Requirements. The use, handling or storage of factory prepackaged products intended primarily for domestic use or consumption determined by the (city position title) to be regulated material shall not be prohibited. The owner of the property will submit to the (city position title) a covenant with the land executed by the property owner in favor of the City which provides that hazardous materials shall not be used, generated, handled, disposed of, discharged or stored on that portion of the property located within the Wellhead Protection Area.

The covenant shall provide that small quantity generators of hazardous wastes as defined in this code, within the Wellhead Protection Area, shall not be prohibited when all of the following water pollution prevention and abatement measures and practices are provided:

9.2.1 Monitoring and detection of water pollution caused by hazardous materials.

9.2.2 Secondary containment of water pollution caused by hazardous materials.

9.2.3 Inventory control and record keeping of hazardous materials.

9.2.4 Storm water management of water pollution caused by hazardous materials.

9.2.5 Protection and security of facilities utilized for the generation, storage, usage, handling, disposal or discharge of hazardous materials.

In addition, the covenant shall provide that use, handling or storage of factory prepackaged products intended primarily for domestic use or consumption determined by the (city position title) to be hazardous materials shall not be prohibited, provided, however, that:

9.2.6 The use, handling or storage of said factory prepackaged products occurs only within a building, and

9.2.7 The nonresidential land use is an office building use (or equivalent municipal land use) or a business district use (or equivalent municipal land use) engaged exclusively in retail sales of factory prepackaged products intended primarily for domestic use or consumption, and

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9.2.8 The nonresidential land use is served or is to be served by public water and public sanitary sewers, and

9.2.9 Said building is located more than two year's groundwater flow travel time from any City well.

Section 10. Prohibitions.

10.1 General. No new uses of land shall be allowed within the Zone One (1) and Zone Two (2) Wellhead Protection Areas which include the following activities:

10.1.1 Hazardous materials facilities

10.1.2 Hazardous waste facilities

10.1.3 Solid waste facilities

10.1.4 Septic tanks

10.1.5 Waste water treatment facilities

10.1.6 Storm water management facilities

10.1.7 Injection wells

10.1.8 Storage tank systems except where exempt under State rule

10.1.9 Pesticide application except where exempt under Section 13.

10.1.10 Excavation

10.1.11 Water wells

10.1.12 Discharges to sinkholes or other karst related features

10.1.12.1 Only those present and future water supply wells which are or will be part of the City's wellhead are allowed.

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10.1.12.2 Any unused well within the Wellhead Protection Area shall be abandoned properly according to well abandonment guidelines by the SRWMD.

10.2 Regulated Materials. The use, handling, production, and storage of regulated materials associated with nonresidential activities is prohibited in the Wellhead Protection Area, except as provided under Section 13. All existing nonresidential activities within the Wellhead Protection Area which store, handle, use or produce any regulated materials shall cease to do so within one year from the date of notification under this Code, except as provided in this section. The owners or operators of such activities within the Wellhead Protection Area shall be notified by the City within sixty (60) days of the effective date of this code as to the requirement to cease the use, handling, storage, and production of regulated materials.

10.3 Exemption or Special Condition. All nonresidential activities within the Wellhead Protection Area which store, handle, use or produce any regulated material are prohibited from doing so unless they qualify as an Exemption, or receive an Operating Permit from the City which complies with the following conditions:

10.3.1 Containment of Regulated Materials. All containment systems shall be installed in accordance with the Alachua County Hazardous Materials Management Code (Ordinance 91-6, Sections 7 and 15).

10.3.2 Emergency plan. An emergency plan shall be prepared and filed with the Operating Permit application indicating the procedures which will be followed in the event of spillage of a regulated material.

10.3.3 Inspection. A person designated by the permittee who stores, handles, uses or produces the regulated materials shall check on every day of operation, for breakage or leakage of any container storing the regulated materials. Monitoring records shall be kept and made available to the City for examination.

10.3.4 Maintenance of containment and emergency equipment. Procedures shall be established for the quarterly in-house inspection and maintenance of containment and emergency equipment. A checklist and schedule of maintenance shall be established and a log shall be kept of inspections and maintenance. Such logs and records shall be available for inspection by the City.

10.3.5 Reporting of spills. Any spill of a regulated material shall be reported to the City within twenty-four (24) hours of discovery of the spill. Clean-up shall

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commence immediately upon discovery of the spill. A full written report including the steps taken to contain and clean up the spill shall be submitted to the City within fifteen (15) days of discovery of the spill.

10.3.6 Alterations and expansion. The City shall be notified in writing prior to the expansion, alteration or modification of any activity holding an Operating Permit.

10.4 A notice to cease, a permit or exemption issued under this ordinance shall not relieve the owner or operator of the obligations to comply with any other applicable federal, state, regional or local regulation, rule, ordinance or requirement. Nor shall said notice, permit or exemption relieve any owner or operator of any liability for violation of such regulations, rules, ordinances or requirements.

Section 11. Permits.

11.1 Wellhead Protection Permits.

11.1.1 This section provides the requirements and procedures by the City for the issuance of Operating and Closure Permits required by this Code.

11.1.12 An application which satisfies the requirements of the Wellhead Protection Area and Section 11.b. and Section 13 shall be approved and a permit issued.

11.1.13 An Operating Permit shall remain valid provided the permittee is in compliance with the terms and conditions of the permit.

11.1.14 The City shall have the right to make inspections of facilities at reasonable times to determine compliance with this code.

11.2 Permit Applications.

11.2.1 Operating Permit. All applications, as a minimum, shall provide the following information;

11.2.1.1 A list of all regulated materials which are to be stored, handled, used or produced and their quantities.

11.2.1.2 A description of the storage, handling, use or production of the regulated materials and their quantities. In addition to the failure to satisfy

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these requirements, the City may deny a permit based on repeated violations of this code.

11.2.1.3 A description of the containment method, emergency collection devices and emergency plan that will be employed.

11.2.1.4 The application for the Operating Permit shall be filed with the City within ninety (90) days of receipt of written notification from the City.

11.2.2 Closure Permit. Closure permit applications shall provide the following information:

11.2.2.1 A schedule of events to complete the closure of an activity that does or did store, handle, use, or produce regulated materials. As a minimum, the following actions shall be addressed:

11.2.2.1.1 Disposition of all regulated materials and contaminated containers.

11.2.2.1.2 Cleanup of the activity and environs to prevent leaching of unacceptable levels of residual regulated materials into the aquifer.

11.2.2.1.4 An appointment for an inspection by the City.

11.2.2.1.5 An agreement to indemnify and hold the City harmless from any and all claims, liabilities, causes of action, or damages arising out of the issuance of the permit.

11.2.2.2 The issue of well reconfiguration shall be evaluated by the City as an alternative to a closure permit during the permit application process.

11.2.3 Permit conditions. The permit conditions shall ensure compliance with all the prohibitions, restrictions and requirements as set forth in the code. Such conditions may include, but are not limited to, monitoring wells, periodic groundwater analysis reports, and compliance schedules.

11.2.4 Clean-Up and Reimbursement. Any person subject to regulation under this code shall be liable with respect to regulated materials emanating on or from the

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person's property, for all costs of removal or remedial action incurred by the City and damages for injury to, destruction of, or loss of natural resources, including the reasonable costs of assessing such injury, destruction or loss resulting from the release or threatened release of a regulated material.

Such removal or remedial action by the City may include, but is not limited to, the prevention of further contamination of groundwater, monitoring, containment, and clean-up or disposal of regulated materials resulting from the spilling, leaking, pumping, or dumping of any regulated material which creates or is expected to create an emergency hazardous situation.

11.3 Fee Schedule. Fees shall be established by the City Commission by resolution and shall accompany this code as an attachment.

11.4 Revocation or Revision of Permit.

11.4.1 The City may revoke any permit issued by it by first issuing a written notice of intent to revoke (certified mail return receipt requested, or hand delivery) if it finds that the permit holder:

11.4.1.1 Has failed or refused to comply with any of the provisions of this code, including but not limited to permit conditions; or

11.4.1.2 Has submitted false or inaccurate information in the application; or

11.4.1.3 Has failed to submit operational reports or other information required by this code; or

11.4.1.4 Has refused lawful inspection under subsection 11.a.(4); or

11.4.1.5 Is subject to revocation under Section 10.

11.4.2 Within thirty (30) days of any spill of a regulated material in the Wellhead Protection Area, the City may issue a notice of intent to revoke or revise, or elect not to issue such notice. In consideration of whether to revoke or revise the permit, the City may consider the intentional nature or degree of negligence associated with the spill, the extent to which containment or cleanup is possible, the nature, number and frequency of previous spills by the permittee, and the potential degree of harm to the groundwater.

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11.5 Change of Ownership. In the event there is a change of ownership, a new lease, or an assignment of a lease, a sublease, or any other change in regards to the person conducting the operation being regulated, the (city position title) shall be notified by the property owner upon payment of the appropriate application fee and completion of the

Section 12. Containment Standards. No person, firm, or corporation shall store any material regulated by this code until approval has been granted pursuant to this code. All requirements for proper containment of regulated materials shall be in accordance with the Alachua County Hazardous Materials Management Code (Ordinance 91-6, Sections 7 and 15).

Section 13. Exemptions.

13.1 General Exemption.

13.1.1 A General Exemption application and Operating Permit shall be required for any nonresidential activity. When claiming a General Exemption, notification shall be filed with the City. No new nonresidential facilities shall be permitted into the Wellhead Protection Area after the effective date of this code if the new nonresidential facility stores, handles, produces or uses any regulated material.

13.1.2 Such application shall contain a concise statement by the applicant detailing the circumstances upon which the applicant believes would entitle him or her to an exemption pursuant to subsection 13.a.(1).

13.1.3 Within thirty (30) working days of receipt of an application for General Exemption, the City shall inform the applicant whether such application contains sufficient information for proper determinations to be made. The applicant shall inform the City within ten (10) working days of the date of the written statement of his or her intent to either furnish the information or have the application processed as it stands.

13.2 Fire, police, emergency medical services and City emergency management center facilities. Existing fire, police, emergency medical services and City emergency management center facilities are exempt from the Wellhead Protection Area prohibitions as set forth in Section 10.

13.3 Utilities. Except for maintenance and refueling of vehicles, utilities as defined herein shall be exempt from the Wellhead Protection Area prohibitions as set forth in Section 10. However, an Operating Permit shall be obtained pursuant to Section 11.

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13.4 Vehicle (Continuous Transit). The transportation of any regulated material throughout the Wellhead Protection Area shall be exempt from the provisions of this code provided the transporting motor vehicle is in continuous transit.

13.5 Vehicular and Lawn Maintenance Fuel and Lubricant Use. The use in a vehicle or lawn maintenance equipment of any regulated material solely as fuel in that vehicle or equipment fuel tank, or as lubricant in that vehicle or equipment shall be exempt from the provisions of the code.

13.6 Pesticide Application. The application of those regulated materials used as pesticides, herbicides, fungicides, and rodenticides in recreation, agriculture, pest control and aquatic weed control activities shall be exempt from the provisions of the code provided that:

13.6.1 The application is in strict conformity with the use requirement as set forth in the substances EPA registries and as indicated on the containers in which the materials are sold; and

13.6.2 The application is in strict conformity with the use requirement as set forth in Chapter 482 and 487, Florida Statutes, and Chapter 5E-2 and 5E-9, Florida Administrative Code.

13.6.3 The application of any of the pesticides, herbicides, fungicides, and rodenticides shall be noted in the records of the certified operator. Records shall be kept of the date and amount of these materials applied at each location and said records shall be available for inspection at reasonable times by the City.

13.6.4 All nonresidential applicators of pesticides, herbicides, fungicides, and rodenticides who apply those materials in the Wellhead Protection Area shall obtain an Operating Permit and shall comply with operations using these materials under one permit and shall comply with all the requirements of Section 10.

13.7 Retail/Wholesale Sales Activities. Retail/wholesale sales establishments in the Wellhead Protection Area that store and handle regulated materials for resale in their original unopened containers shall be exempt from the prohibition in the Wellhead Protection Area provided that those establishments obtain an Operating Permit.

13.8 Office Uses. Office uses, except for the use of regulated materials for the maintenance and cleaning of office buildings, shall be exempt from the provisions of this code.

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13.9 Construction Activities. The activities of constructing, repairing or maintaining any facility or improvement on lands within the Wellhead Protection Area must use applicable Best Management Practices.

Section 14. Water Conservation Plan.

14.1 General. The (city position title) shall evaluate the data from a groundwater elevation monitoring program and groundwater quality monitoring program for the well which shall be conducted by the (city position title) or a contractor designated by the city. If the (city position title), after evaluating the monitoring data, determines that a reduction in well pumpage is necessary to prevent contamination of the well, the (city position title) shall impose water conservation restrictions in the unincorporated and incorporated areas of the City.

14.2 Water Conservation Restrictions. These water conservation restrictions shall consist of one of, or any combination of, the following:

14.2.1 Ordering public utilities owning or operating public water systems to reduce water system pressure.

14.2.2 Mandatory water conservation restrictions similar to the applicable water use restrictions set forth in the rules of the SRWMD Chapter C, FAC, as may be amended from time to time.

The duration of these water conservation restrictions shall be determined by the (city position title) after periodic evaluation of well pumpage data and pertinent monitoring program data. The water conservation restrictions in effect may be subsequently changed or rescinded by the (city position title) after such periodic evaluation.

14.3 Criteria and Declaration of Shortage. The (city position title) shall use the following to determine if a water shortage condition exists:

14.3.1 the criteria contained in FAC Rules 40C-21.221 and 40C-21.331, (01-01-84); and

14.3.2 any warnings or declarations issued by the SRWMD; and

14.3.3 any drought advisories or projections issued by other State or Federal agencies; and

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14.3.4 other such information or requests that are made available to the (city position title).

Recommendation by the (city position title) that the City Commission declare a water shortage shall comply with the appropriate requirements of the City Codes. The recommendation may be to declare a warning/advisory or an emergency /mandatory notice. If the (city position title) declares an emergency/mandatory shortage, the implementing procedures of the appropriate city codes, shall be followed by the City Commission.

Section 15. Protection of Future Wellhead. The prohibitions and restrictions set forth in this code and in regulations promulgated pursuant hereto shall apply to any sites officially designated by the City Commission for a future well. Such prohibitions and restrictions shall become effective upon approval by the City Commission of the wellhead protection zones map for the designated future well. Prior to final action by the City Commission in designating a future well or approving the wellhead protection zones map for those wells, all property owners and discernible operating activities within the area affected shall receive written notice at least thirty (30) days prior to the proposed public hearing at which the action shall be considered.

Section 16. Penalties, Enforcement, and Injunctive Relief.

16.1 Penalties. Violations of this code shall be punishable as provided by general law.

16.2 Enforcement. The (city position title) may enforce this code using authority and procedures authorized by chapter 162, Florida Statutes. Violations of this code may be referred to the (City) Codes Enforcement Board for enforcement in accordance with Chapter 162, Florida Statutes. Violations of this code may also be referred to the Department of Environmental Protection and/or the State Attorney's Office.

16.3 Injunctive Relief. It is hereby found and declared that a violation of the provisions of this code constitutes an irreparable injury to the citizens of the City of (municipality). The City may institute a civil action in a court of competent jurisdiction to seek injunctive relief to enforce compliance with this code or order; to enjoin any violation of this code; and to seek injunctive relief to prevent injury to the soils, air, and water, including animal, plant, and aquatic life in the City and to protect human health, safety, and welfare caused or threatened by any violation.

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Section 17. Designation of Hearing Official. The City Manager shall designate a hearing official to conduct administrative hearings as required by the provisions of this code. The hearing official shall conduct the hearings in accordance with the provisions of the Hearing Procedure as presented in Appendix D. The hearing official shall be an attorney or engineer with environmental law or other appropriate technical experience.

Section 18. Severability. It is the declared intent of the City Commission that, if any section, subsection, sentence, clause, phrase, or provision of this is held invalid or unconstitutional by a court of competent jurisdiction, such invalidity or unconstitutionality shall not be so construed as to render invalid or unconstitutional the remaining provisions of this code.

Section 19. Ordinance to be Liberally Construed. This code shall be liberally construed in order to effectively carry out the purposes hereof which are deemed to be in the best interest of public health, safety, and welfare of the citizens and residents of the City of (municipality), Florida.

Section 20. Inclusion in the Code. It is the intention of the City Commission and it is hereby provided that the provisions of the code shall become and be made a part of the Code of Laws and Ordinances of the City of (municipality), Florida, that the sections of this code may be renumbered or relettered to accomplish such intention, and that the word "ordinance" may be changed to "section", "article", or other appropriate designation.

Section 21. Effective Date. A certified copy of this code shall be filed with the Department of State by the Clerk of the City Commission within ten (10) days after enactment by the City Commission, and shall take effect sixty (60) days from receipt of official acknowledgement from that office that the same has been filed.

