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PROPOSAL FOR ASSESSMENT OF DIELDRIN CONTAMINATION AT CORRY FIELD WITH TRANSMITTAL NAS PENSACOLA FL

4/29/1991

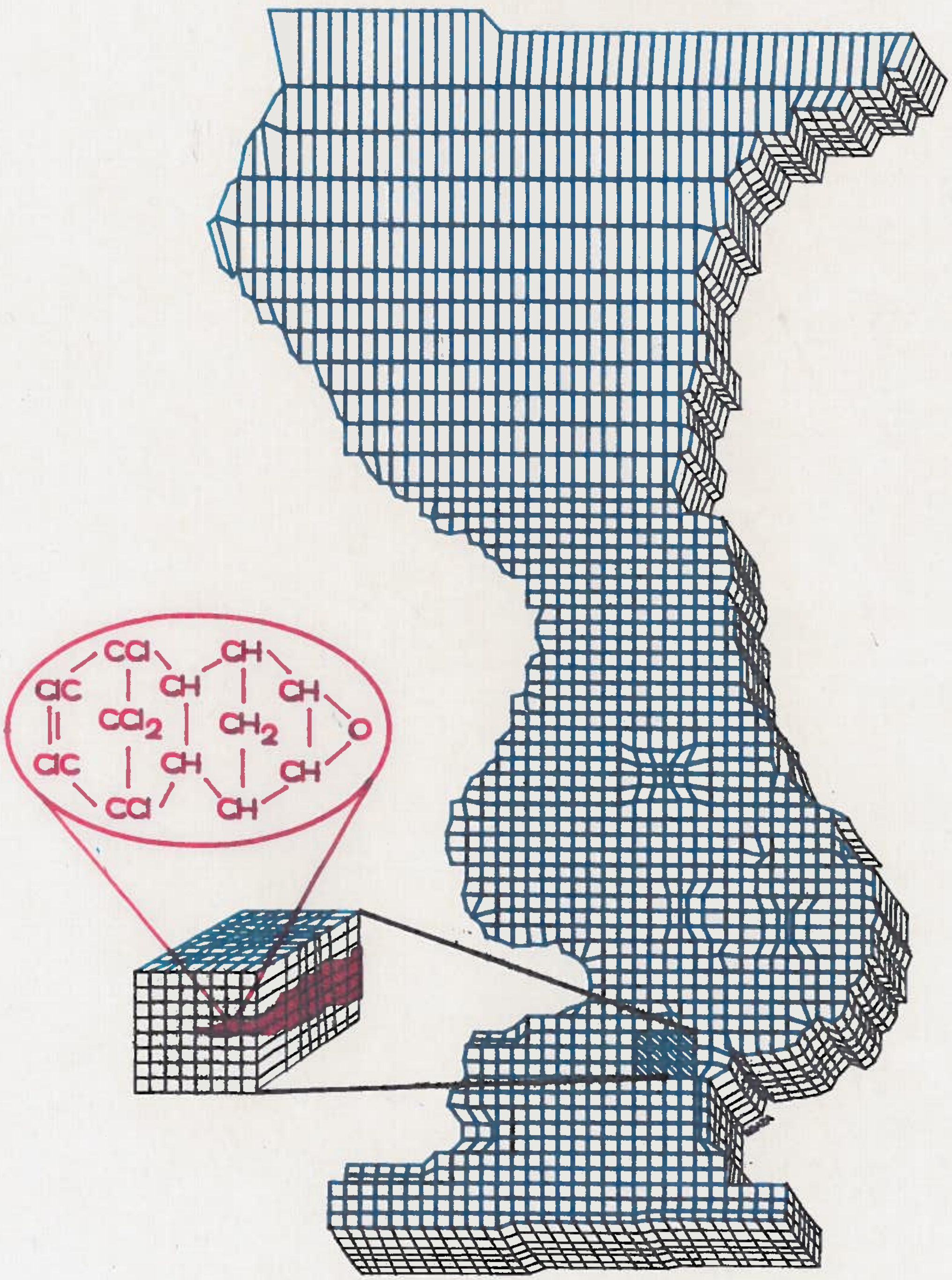
NORTHWEST FLORIDA WATER MANAGEMENT DISTRICT

PROPOSAL FOR :

ASSESSMENT OF DIELDRIN CONTAMINATION AT CORRY FIELD, PENSACOLA, FLORIDA

PREPARED FOR :

NAVAL FACILITIES ENGINEERING COMMAND, SOUTHERN DIVISION



SUBMITTED BY :

NORTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Northwest Florida Water Management District

Route 1, Box 3100, Havana, Florida 32333-9700
(On U.S. Highway 90, 10 miles west of Tallahassee)

Walter D. Dover
Executive Director

(904) 539-5999

April 29, 1991

Mr. Ted Campbell
Southern Division, Naval Facilities
Engineering Command
Environmental Division, Code 18214
2155 Eagle Drive
Charleston, South Carolina

Dear Mr. Campbell:

The Northwest Florida Water Management District is pleased to submit the enclosed proposal for the project entitled "Assessment of Dieldrin Contamination at Corry Field, Pensacola, Florida." Based on our meeting of 8 April, 1991, we have included in the proposal all work associated with the dieldrin assessment. This includes surface soils sampling and analysis, installation and sampling of monitor wells, collection of necessary data regarding the hydraulic properties of the Sand-and-Gravel Aquifer, and development of the three-dimensional finite-element model of ground water flow and contaminant transport at the site. In preparing the proposal, care was taken to insure that the Corry Field work is fully integrated with the regional ground water model, currently under development by the District, and other District data collection activities in southern Escambia County.

We have proposed to complete the project in three phases. The first phase is primarily devoted to compilation of existing information, site reconnaissance and problem conceptualization. The second phase will entail field data collection including, for example, installation of soil borings and monitor wells, water quality and soil analyses, and aquifer tests. This will provide the information necessary to characterize the nature, extent, and distribution of dieldrin contamination in the soils and ground water of the area. Finally, the District would propose to develop and apply the ground water flow and contaminant transport model of the site in the third phase of the project. As outlined in the proposal, the ground water model will be developed within the framework of the regional model utilizing a method referred to as the telescoping mesh refinement (TMR) technique. This technique, and the model code the District will utilize, were developed by GeoTrans, Inc. Consequently, we are planning to retain this firm to aid in the development of the model, and to provide independent quality control on all aspects of the model application.

We sincerely appreciate the opportunity to submit this proposal, and look forward to working with the Southern Division, Naval Facilities Command, and NAS Pensacola on this project. If you have any questions or require any additional or supplemental information, please feel free to call.

Sincerely,

Douglas E. Barr
Deputy Executive Director

DEB/em
Enclosure
cc: Lt. Ken Alexander w/ two copies of proposal

INTRODUCTION

Proposal For:

ASSESSMENT OF DIELDRIN CONTAMINATION AT CORRY FIELD, PENSACOLA, FLORIDA

Prepared For:

NAVAL FACILITIES ENGINEERING COMMAND, SOUTHERN DIVISION

Charleston, South Carolina

Submitted By:

NORTHWEST FLORIDA WATER MANAGEMENT DISTRICT
Route 1 Box 3100
Havana, Florida 32333-9700

April 1991

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1.00 INTRODUCTION

1.10 Project Overview and Approach

The Sand-and-Gravel Aquifer in southern Escambia County is utilized for a variety of uses including public water supply and industrial demands. Traditionally, the availability of water from the aquifer has been more than adequate to meet the water needs of the area. This is attributable to the excellent water-bearing characteristics of the aquifer and the high rate of local rainfall recharge. Unfortunately, these same characteristics allow for rapid infiltration and transport of surface contaminants into the surficial sands, and ultimately into the underlying main producing zone of the Sand-and-Gravel Aquifer, which serves as the primary source of ground water for the area. In recent years, two of the area's principal water supply utilities have experienced contamination problems in selected production wells. In both cases, the contamination has been attributed to the transport of surface contaminants through the surficial zone and low permeability zone, and subsequent migration to the public supply wells open to the main producing zone.

The U.S. Navy operates 10 production wells at Corry Field which supply water to Corry Field and NAS. Within the past several years, detectable levels of the insecticide dieldrin have been detected in at least five of the Corry Field wells. Dieldrin concentrations range from <0.01 to 1.3 micrograms per liter (µg/L), with an apparent concentration gradient extending to the south and west from production well MW08 located in the northeast corner of Corry Field (Oak Ridge National Lab., 1989). As a result of the dieldrin contamination of the Corry Field wells, the Navy has identified the need to perform a detailed hydrogeologic and water quality site assessment in an effort to characterize the extent of the contamination, determine the potential source(s), identify possible future well locations, and develop a remediation plan for the site. To assist in this endeavor, the U.S. Navy, Southern Division, requested the Northwest Florida Water Management District to prepare a proposal to perform the site assessment.

The District is currently preparing a regional assessment of the ground water flow and contaminant transport characteristics of the Sand-and-Gravel Aquifer for several utilities in southern Escambia County. In addition to data collection activities, this project entails the development of a three-dimensional, finite-element model of the aquifer for use in preparing management plans for the siting of wells, preparation of production well pumping plans, and simulating the migration of contaminants in the subsurface. In preparing the proposal for the Corry Field site assessment, therefore, it was considered essential that the proposed work be performed within the framework of the regional ground water model. In this manner, maximum use can be made of the data collected as part of the regional effort, and the impacts of withdrawals, variations in aquifer parameters, and contamination outside the Corry Field area can be incorporated into the site assessment. The result is an integrated study plan that will provide for a comprehensive site assessment of Corry Field.

The site assessment will be accomplished using a combination of District staff and qualified subcontractors for the water quality and soil analyses, and the drilling/field data collection programs. All contractors will be retained under the provisions of Florida Statutes, and selected using standard District procedures. These procedures are intended to provide for a competitive process for the selection of contractors in the most cost-effective manner possible, based on the qualifications and experience of the firms. In addition, the District plans to retain GeoTrans, Inc., an internationally recognized firm with specialized expertise in the areas of numerical modeling of ground water flow and contaminant transport. GeoTrans, Inc., will provide independent quality control on all aspects of the proposed ground water model for Corry Field.

The District would propose to complete the site assessment using a phased approach. In this manner the results from each phase of the project can be used to modify and refine the tasks and work plan for subsequent phases. The first phase will be devoted to compilation of existing information pertinent to the site assessment, identification of data deficiencies, and refinement of the data collection program. The compilation of existing information will include available data regarding water quality, aquifer water levels, hydraulic properties, soil analyses, and records of ground water withdrawals. Also of critical importance will be the compilation of all available records on pesticide use, handling areas, and disposal areas (if any) that were used at Corry Field. This information will provide a historical baseline of information on the use of dieldrin at the site, and may provide information useful in guiding the initial data collection. Finally, during phase one the District will select the contractors that will be used for the water quality and soil analysis, and performance of the drilling and field data collection activities.

The second phase of the site assessment will be devoted primarily to field data collection, and environmental sampling (water and soils) for determining the levels of dieldrin contamination at Corry Field, and other areas. As presently planned, the data collection will include examination of the contaminant levels in the surface soils, and the surficial, low permeability, and main producing zones of the Sand-and-Gravel Aquifer in an effort to determine the extent and nature of the contamination (point or nonpoint sources). This will be accomplished through a program of soil borings and installation of monitor wells in the major production zones underlying the site. In addition, the District currently anticipates the need to perform two multi-well aquifer tests to obtain information on the hydraulic properties of the surficial zone, low permeability zone, and main producing zone. This information is currently lacking, and is required for the development of the ground water flow and contaminant transport model.

Data analysis and application of the ground water flow and contaminant transport model will be accomplished in the third (final) phase of the project. The Corry Field model will be calibrated and applied as a sub-domain of the regional model being prepared for Escambia County. A telescoping mesh refinement (TMR) technique will be utilized for this purpose, and will allow the results from the regional model to be used as the initial and boundary conditions for the finer scale model of Corry Field. In this manner, external pumping, and the resulting variations in water levels, and regional variations in the aquifer properties can be fully incorporated into the Corry Field analysis. Following calibration and verification of the model, simulations will be made of the contaminant plume with emphasis on the future movement of the contamination, the rate of movement, and an evaluation of alternatives for remediation of the problem. In the third phase, the District will also prepare a final report providing the results of all field data collection activities, full documentation of the model calibration and application, the results and interpretation of all model simulations, and recommendations for future actions.

Timely completion of all projects in the most cost-effective manner possible is a high priority for the District. For this reason, the District has established procedures for tightly controlling project schedules and expenditures. In addition to these procedures, the District would propose that frequent workshops be held with Navy personnel to review the status of the project, and to discuss any modifications to the work schedule and technical components of the project that may be necessary based on completed work. The District would also propose that detailed progress reports be submitted on a quarterly basis and supplemented with interim reports prepared at the completion of each major study phase. This project management plan is intended to provide for completion of the project on schedule and within budget, while also maintaining the appropriate level of communication between the Navy and District staff.

1.20 Regional Hydrogeologic Setting

The dieldrin contamination at Corry Field is best understood if placed within a context of the regional hydrogeology and existing contamination found elsewhere in Escambia County. The hydrologic response of the Sand-and-Gravel Aquifer (and associated movement of dieldrin) at Corry Field is a result of natural and induced stresses imposed both on Corry Field and elsewhere, as well as boundary conditions, such an recharge/discharge boundaries, that may be far removed from Corry Field. In order to accurately understand and model the aquifer at Corry Field it is necessary to develop an understanding of the regional hydrogeology. A description of the regional hydrogeologic framework and the hydrogeology in the vicinity of Corry Field is provided in the following sections.

Northwest Florida has been subdivided into a number of distinct ground water regions based on similar ground water characteristics. These characteristics include hydrostratigraphy, water quality, water availability, recharge-discharge mechanisms, and susceptibility to contamination. The Sand-and-Gravel Aquifer is unique to the Western Panhandle hydrogeologic region and constitutes a major aquifer system in northwest Florida. Figure 1.20-1 illustrates the occurrence and extent of the Sand-and-Gravel Aquifer and the other major systems. Within the Western Panhandle hydrogeologic region, the Sand-and-Gravel Aquifer is underlain by a thick confining bed referred to as the Intermediate System. The Floridan Aquifer, which extends over much of Florida and the southeastern United States, underlies the Intermediate System and is an important source of ground water in much of northwest Florida. In Escambia County, however, water in the Floridan Aquifer is highly mineralized and not suitable as a potable supply. For this reason, the Sand-and-Gravel Aquifer is the sole source for potable ground water in Escambia County.

As illustrated by Figure 1.20-2, the Sand-and-Gravel Aquifer can be in excess of 400 feet thick in Escambia County. Lithologically, the aquifer is composed of admixtures of fine to coarse sand, clay and silt. Locally, where the clay, silt and fine sand dominate the sediments, low permeability zones exist which may partially confine the underlying sands. These semi-confining zones, however, are highly discontinuous, lithologically variable and function as leaky confining layers.

In Escambia County, the Sand-and-Gravel Aquifer can be subdivided into three zones. The designation of these zones is based on permeability contrasts and includes the surficial zone, a low permeability zone, and the main producing zone.

The uppermost layer, or surficial zone, is composed primarily of fine sand. Locally, some gravel and layers of sandy clay are also present in the zone. Underlying the surficial zone is the low permeability zone which is composed of various mixtures of clay, silt and sand. In the northern and central portions of the county, clay and silt-size sediment dominate this zone, while to the south the unit becomes considerably more sandy. The permeability of this layer is less than that of the overlying and underlying

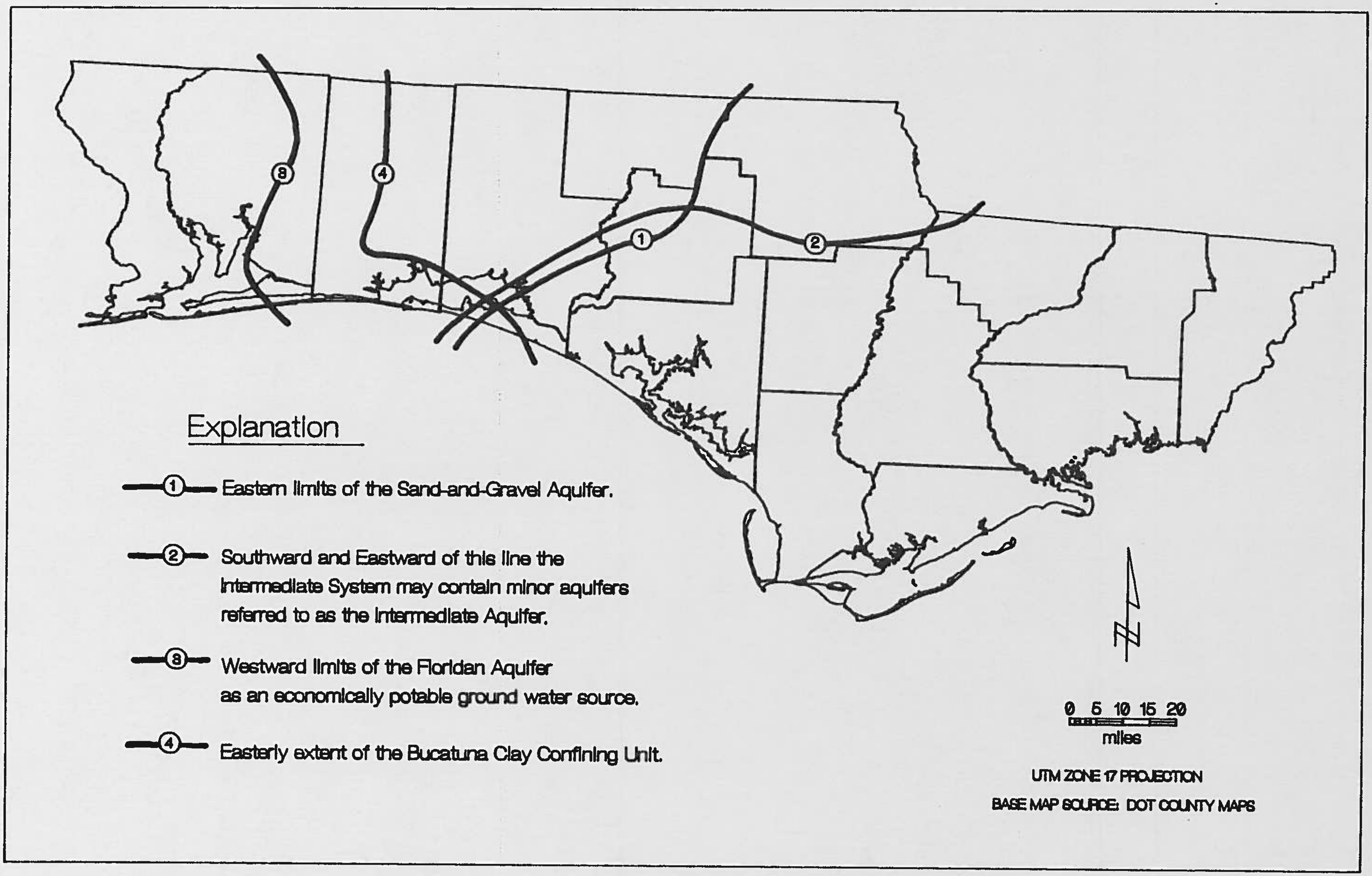


Figure 1.20-1. Occurrence and Extent of Ground Water Systems.

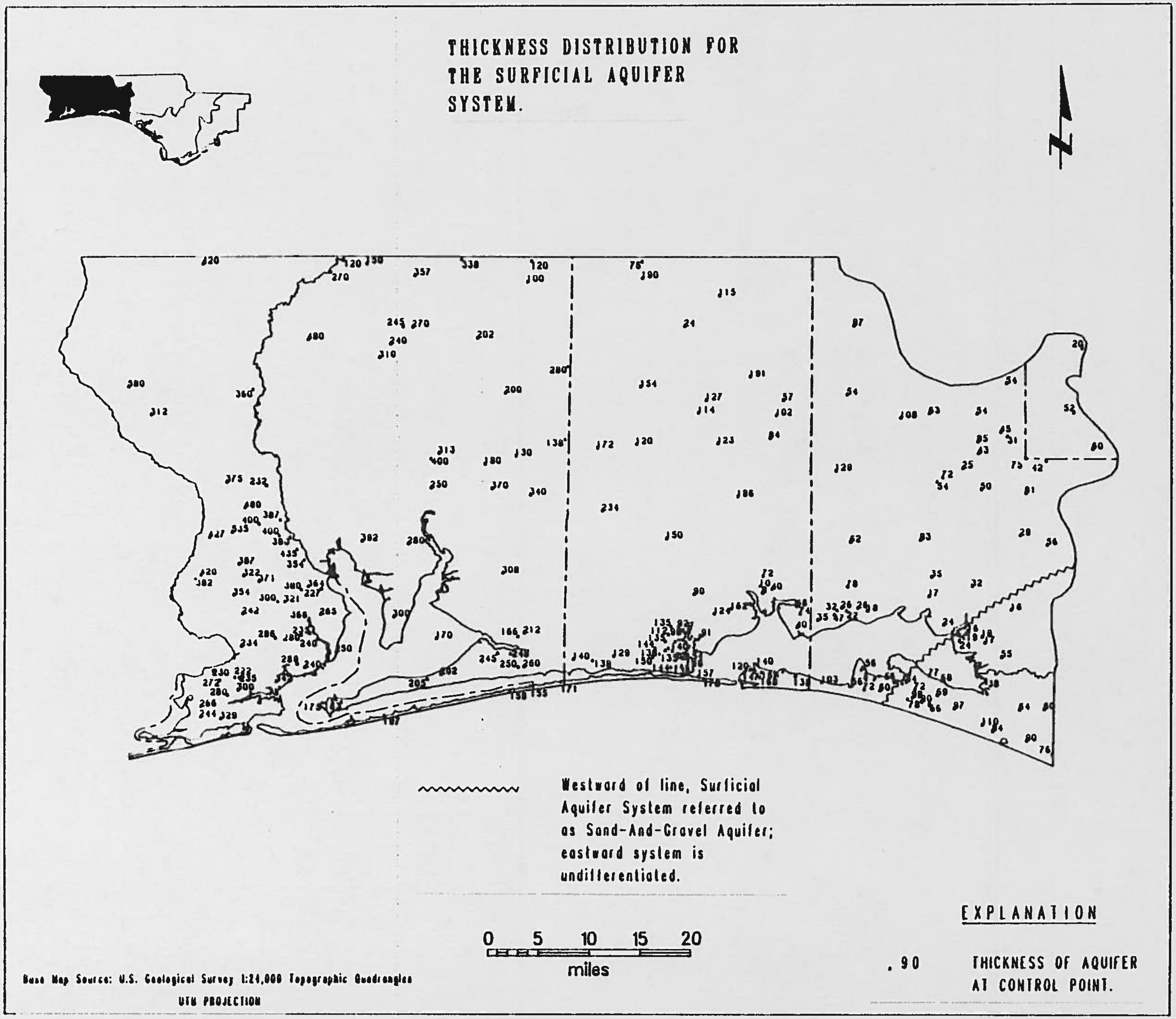


Figure 1.20-2. Thickness Distribution of the Surficial Aquifer System.

zones. Beneath this confining layer lies the main producing zone of the Sand-and-Gravel Aquifer, which consists of moderately to well sorted sand and gravel layers which are typically interbedded with fine sand and clayey beds. The majority of the ground water withdrawn from the Sand-and-Gravel Aquifer is derived from the main producing zone.

Due to the predominantly sandy nature of all three zones within the Sand-and-Gravel Aquifer and the highly variable spatial distribution of clay and silt-sized materials, contrasts in vertical permeability can be subtle and difficult to detect. Because of this, the zonation within the Sand-and-Gravel Aquifer is best delineated by borehole geophysical logs. Figure 1.20-3 shows the distribution of approximately 180 geophysical logs for Escambia County in the District files. Location traces for the hydrogeologic sections are also shown on this figure. Regional hydrogeologic sections indicating the altitude and general lithology of the Sand-and-Gravel Aquifer in Escambia County are shown in Figures 1.20-4 and 1.20-5. The hydrogeologic sections were constructed from geophysical log data and descriptions of the associated lithology.

In the Western Panhandle hydrogeologic region, the Intermediate System is a highly efficient confining unit that effectively separates the Sand-and-Gravel Aquifer from the underlying Floridan Aquifer System. The structural surface of the Intermediate System, which also coincides with the base of the Sand-and-Gravel Aquifer, is illustrated on Figure 1.20-6. The Intermediate System is composed of thick beds of clays and other low permeability sediments. Its thickness varies from 200 feet to over 1,000 feet (Figure 1.20-7). The thicker sections are found in Escambia County. No significant water bearing zones exist within this system in the western panhandle area.

The top of the Floridan Aquifer dips from 100 feet above sea level in the northeast part of the western panhandle region to 1,400 feet below sea level in southern Escambia County (Figure 1.20-8). Beginning in the vicinity of eastern Choctawhatchee Bay and extending west through Escambia County, the Floridan Aquifer is divided by a regionally extensive confining bed known as the Bucatunna Clay Confining Unit. This clay unit divides the aquifer into upper and lower limestone portions. The upper limestone is comprised of the

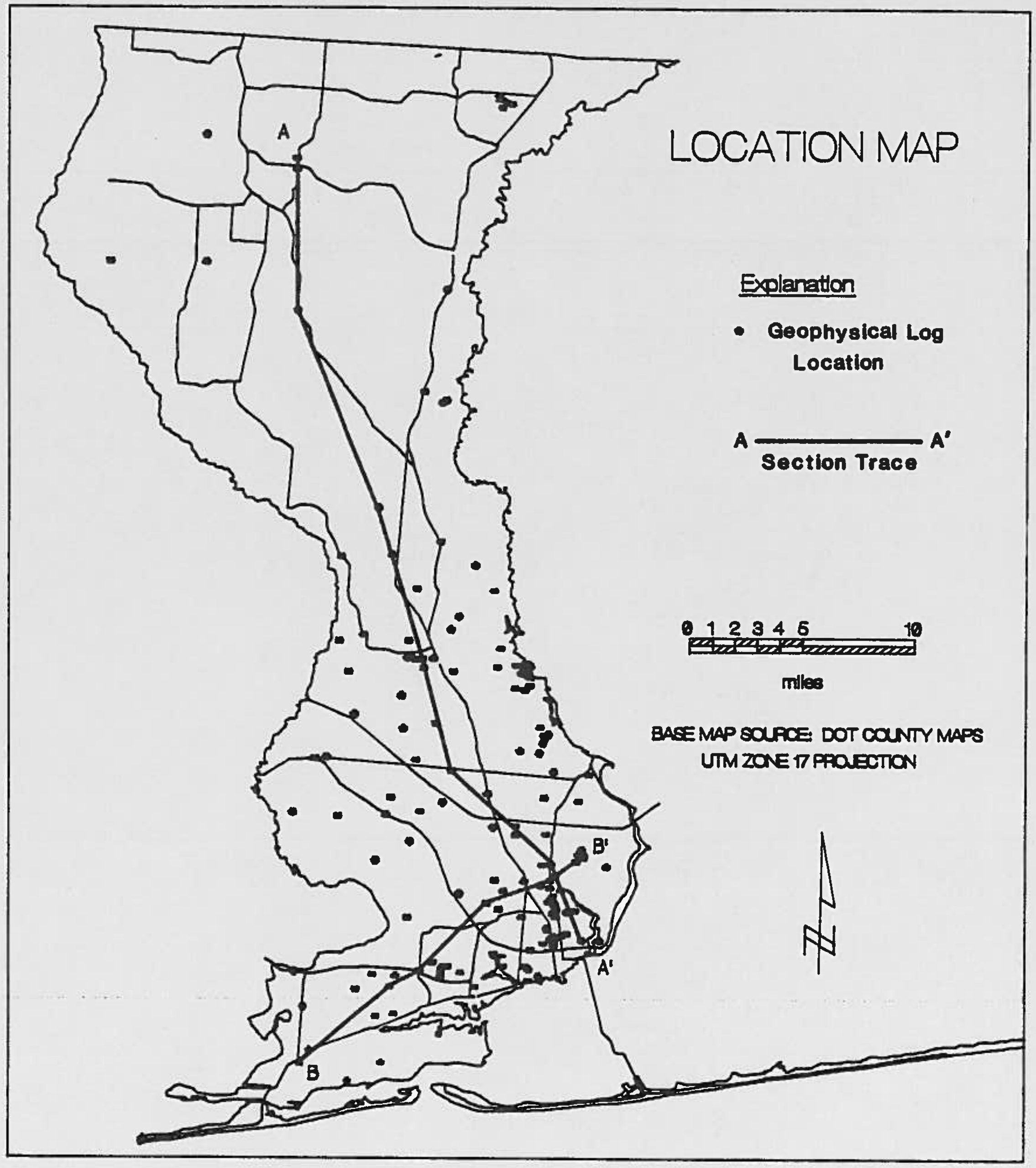
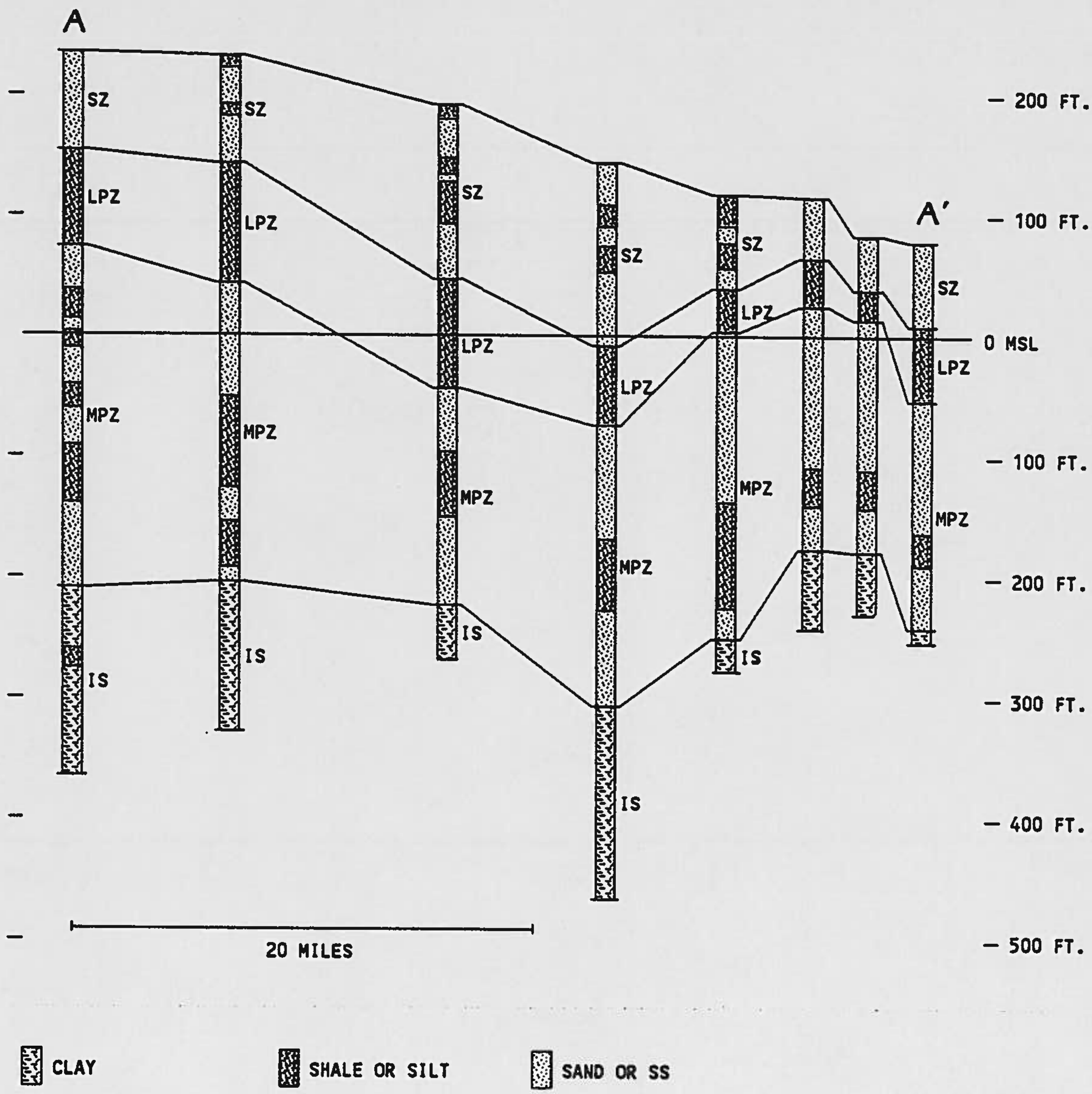


Figure 1.20-3. Location of Geophysical Logs and Hydrogeologic Sections A-A′ and B-B′.



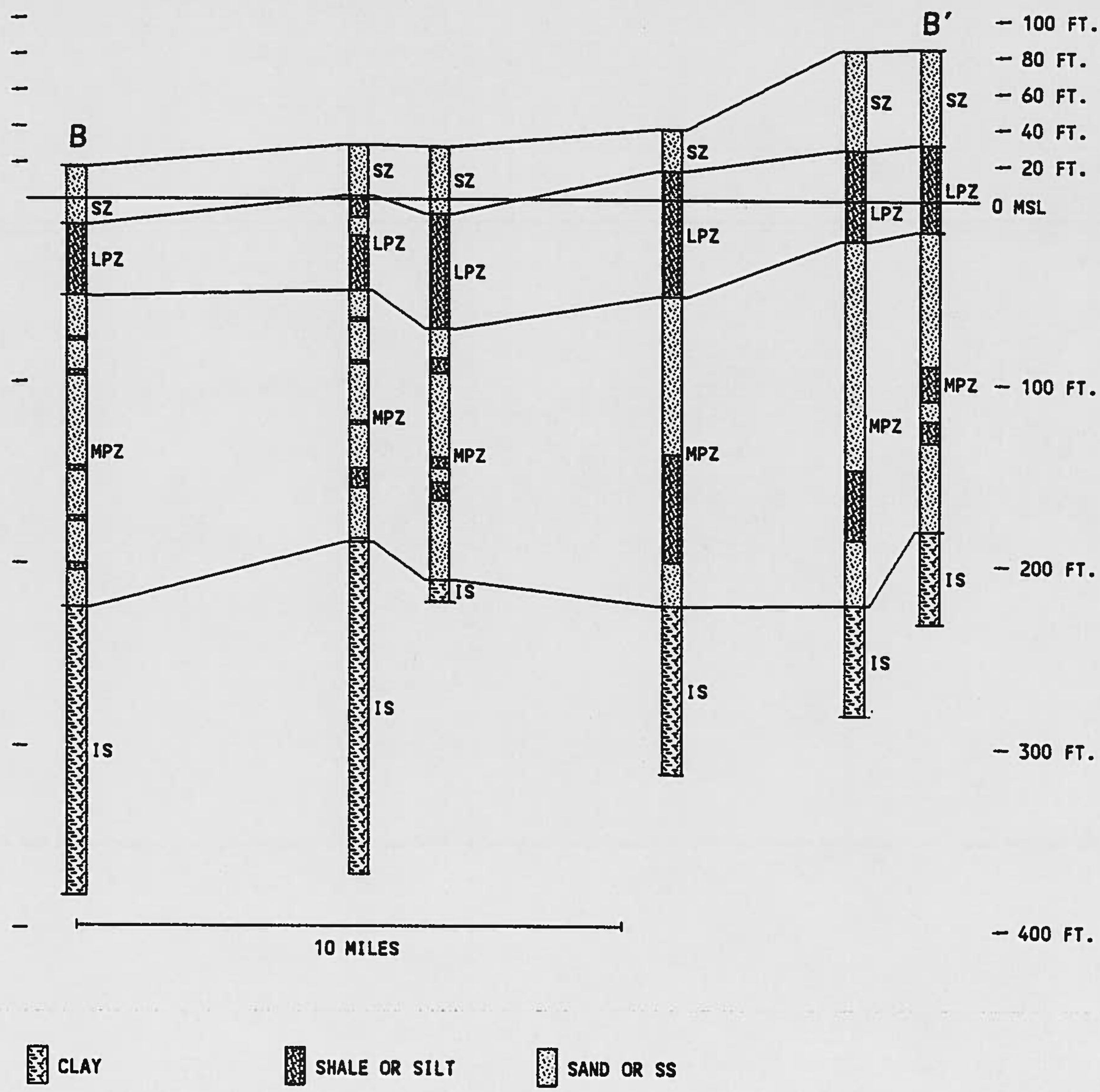
SZ - SURFICIAL ZONE

LPZ - LOW PERMEABILITY ZONE

MPZ - MAIN PRODUCING ZONE

IS - INTERMEDIATE SYSTEM

Figure 1.20-4. Hydrogeologic Section A-A′.



SZ - SURFICIAL ZONE
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Figure 1.20-5. Hydrogeologic Section B-B′.

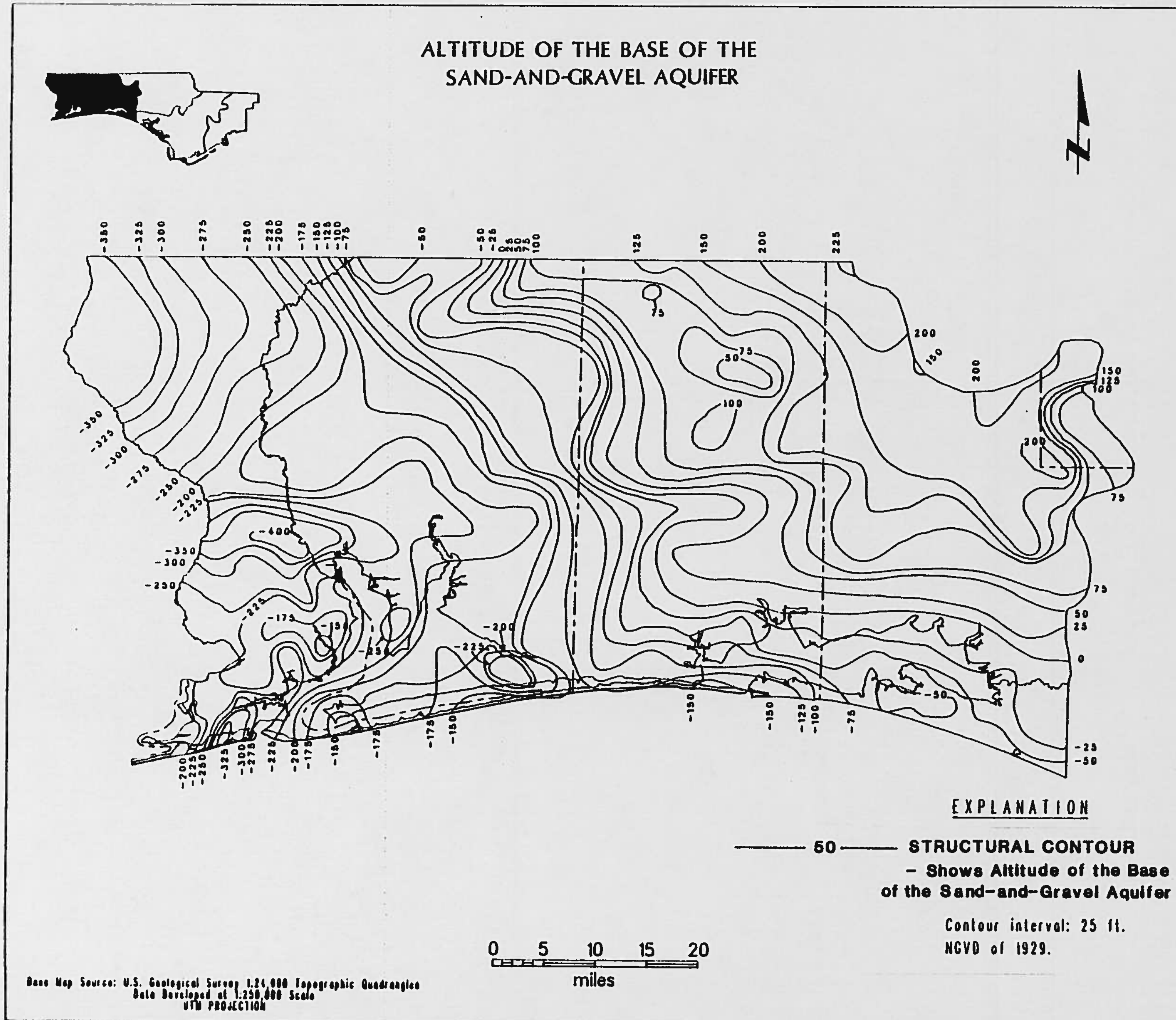


Figure 1.20-6. Altitude of the Base of the Sand-and-Gravel Aquifer.

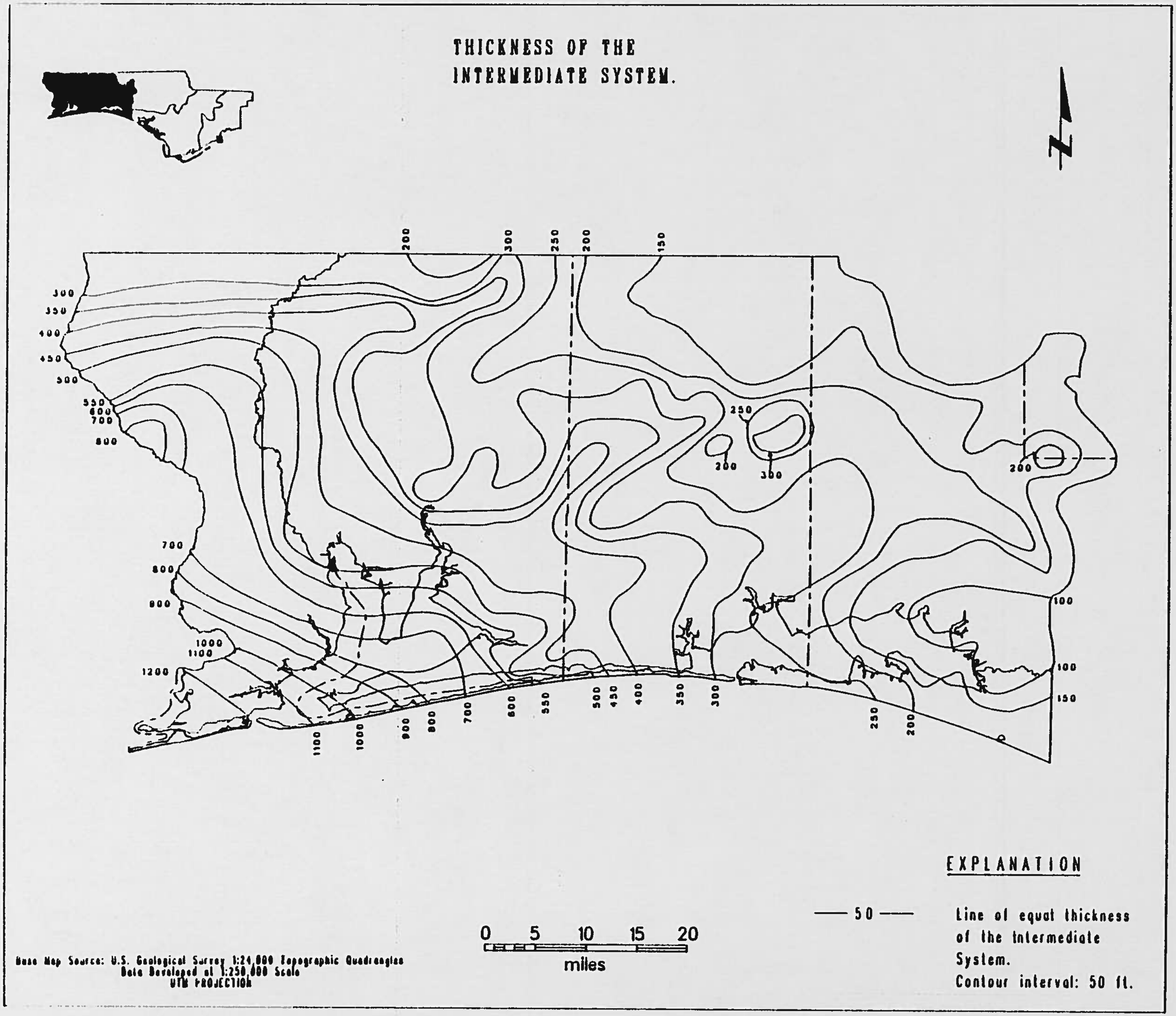


Figure 1.20-7. Thickness of the Intermediate System.

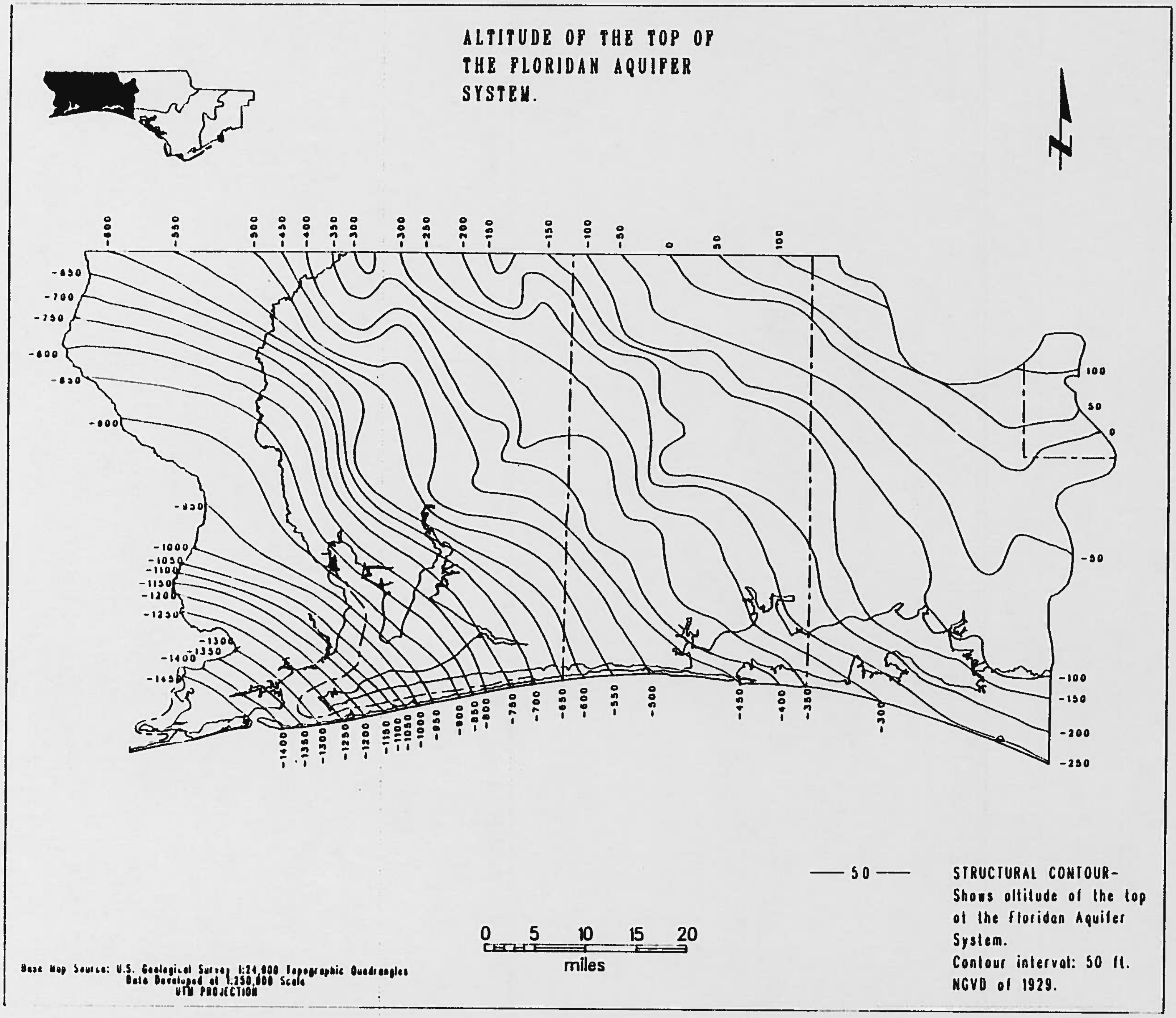


Figure 1.20-8. Altitude of the Top of the Floridan Aquifer System.

Oligocene and Lower Miocene carbonates, and the lower limestone is composed entirely of the Ocala Limestone. In southwestern Santa Rosa and Escambia counties, the upper limestone of the aquifer is mineralized, and is not used as a drinking water source. Likewise, the lower limestone unit is highly mineralized, and the water quality is so poor that the unit is used to dispose of industrial waste in the Pensacola area.

1.21 Overview of Production from the Sand-and-Gravel Aquifer

The Sand-and-Gravel Aquifer is the sole source of ground water for potable, industrial, and irrigation uses in Escambia County. The largest uses of ground water are public potable supply and industrial. Other uses include self-supplied domestic, agricultural irrigation, and (particularly in the southern portion of the County) landscape irrigation.

There are 13 major utilities and industries which utilize the aquifer, including nine public supply systems, and four industrial users. The principal public supply systems include: Escambia County Utilities Authority, U.S. Navy, Peoples Water Service Company, Molino Utilities, Town of Century, Farm Hill Utilities, Gonzalez Utilities, Cottage Hills Utilities, and the University of West Florida. The principal industrial users include: Champion International Corporation, Monsanto Company, Gulf Power Company, and Reichold Chemicals, Inc. Figure 1.21-1 shows the location of all six-inch diameter or greater withdrawal wells in Escambia County.

The three largest public supply systems in the County are the Escambia County Utilities Authority (ECUA), the U.S. Navy, and Peoples Water Service Company. By far, the largest of these systems is ECUA. At present, ECUA operates 32 water supply production wells, all located in the southern half of the County. The ECUA supplies, on an average day, approximately 30 million gallons (Mgal/d) of water to its customers. The next largest public supply system in the county is the U.S. Navy. The Navy systems supply water to the Naval Air Station (NAS), Corry Field, and Saufley Field. Average pumpage by these systems is about five Mgal/d. The Navy currently maintains a total of 18 production wells: three on NAS, 10 at Corry Field, and five at Saufley Field. Peoples Water Service supplies about two and a half Mgal/d to a

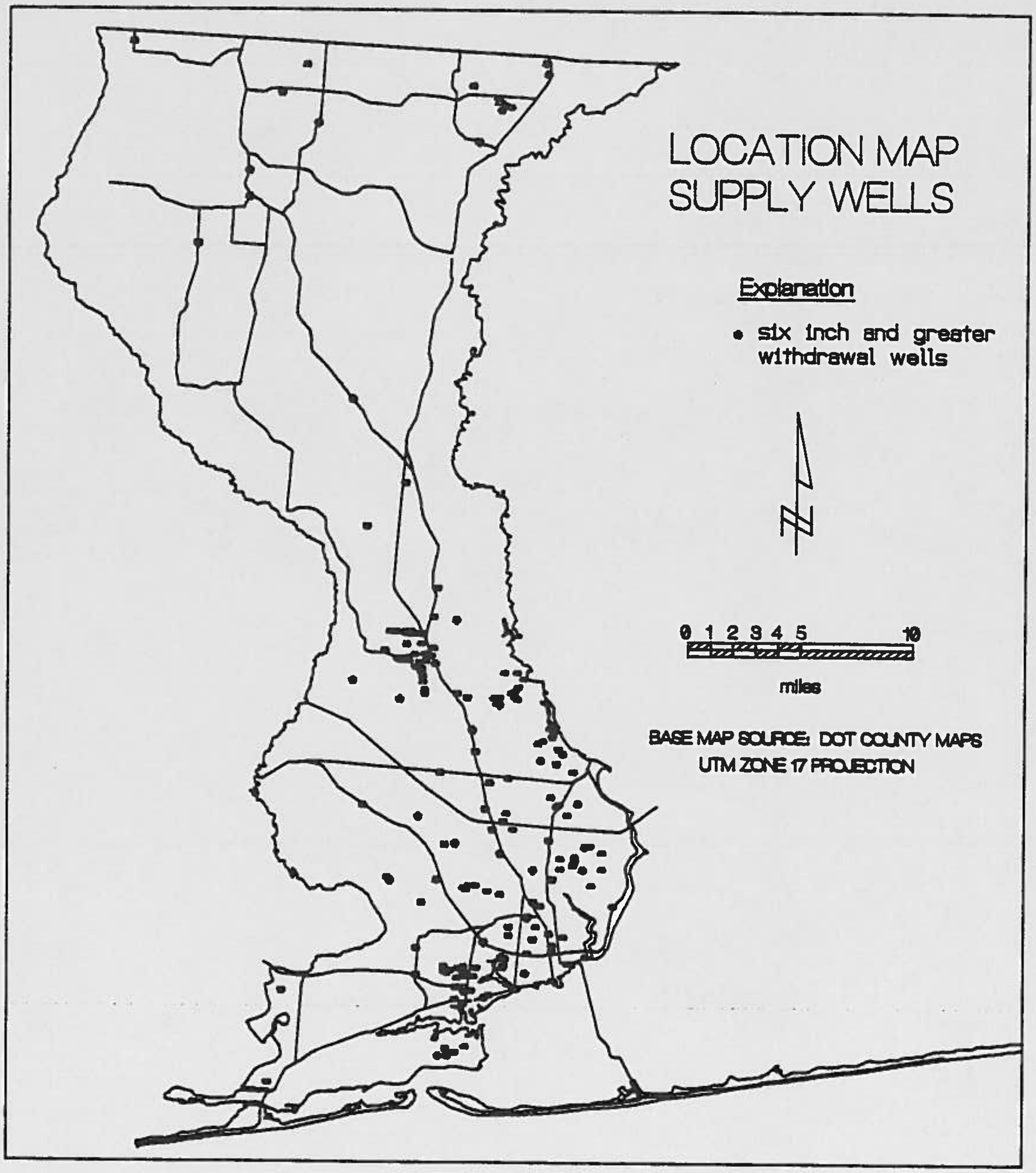


Figure 1.21-1. Location of Six-inch Diameter and Greater Supply Wells in Escambia County.

service area which includes the Town of Warrington, located between the City of Pensacola and the Naval Air Station. The Peoples system includes six active production wells.

The remaining principal public supply systems are located north of the urbanized portion of Escambia County and include: the University of West Florida with two production wells, Gonzalez Utilities with two production wells, Cottage Hills Utilities with two production wells, Farm Hill Utilities with three production wells, Molino Utilities with three production wells; and Town of Century with three production wells. Average daily production from these six systems is approximately 1.5 Mgal/d.

There are four major industrial users of water from the Sand-and-Gravel Aquifer in Escambia County. The largest of these, in terms of production, is Champion International Corporation, with an average production of approximately 22 Mgal/d obtained from 23 production wells. Monsanto Company is another large user, producing about eight Mgal/d from 11 production wells. Gulf Power Company operates six wells at the Crist Electric Generating Plant that produce approximately two Mgal/d. Finally, Reichold Chemical, Inc. produces about 0.2 Mgal/d from two wells. All of these facilities are located in the southern half of the county. Champion is the northernmost user, with production facilities located in Cantonment. Reichold Chemicals is located on Bayou Chico within the City of Pensacola.

1.22 Summary of Consumptive Use Permits in Escambia County

The Northwest Florida Water Management District regulates the utilization of the Sand-and-Gravel Aquifer through the issuance of Consumptive Use of Water permits. To-date, the District has issued approximately 325 Consumptive Use permits in Escambia County for public supply, industrial, irrigation and other uses. A summary of the number of permitted wells, and average daily and maximum daily withdrawals of the largest public supply and industrial facilities is given in the following two tables.

Table 1.22-1 - Principal Public Supply Consumptive Use Permits in Escambia County

System	Number of Permitted Production Wells	Permitted Average Daily Withdrawal (Mgal/d)	Permitted Maximum Daily Withdrawal (Mgal/d)
ECUA	37	44.7	76.1
U.S. Navy - Corry/NAS	16	7.87	12.1
Peoples Water Service	7	3.30	7.00
Molino Utilities	3	0.53	1.16
Town of Century	3	0.47	1.07
Farm Hill Utilities	3	0.39	0.61
Gonzalez Utilities	2	0.32	0.49
UWF	2	0.31	0.50
U.S. Navy - Saufley	5	0.19	0.40
Total	78	58.08	99.43

Table 1.22-2 - Principal Industrial Consumptive Use Permits in Escambia County

System	Number of Permitted Production Wells	Permitted Average Daily Withdrawal (Mgal/d)	Permitted Maximum Daily Withdrawal (Mgal/d)
Champion International	23	27.5	31.6
Monsanto Company	11	8.80	11.0
Gulf Power Co.	6	2.20	5.60
Reichold Chemicals, Inc.	2	0.49	1.00
Total	42	38.99	49.2

1.23 Ground Water Withdrawals at Corry Field

The U.S. Navy operates three public water supply systems, supplying water to NAS, Corry Field and Saufley Field. These systems are NTTC Corry Field (PWSID Number 1170548), NAS Pensacola (PWSID Number 1170814), and Saufley Field (PWSID Number 1170899). As currently configured, the NTTC Corry Field system supplies water to both NAS and to Corry Field. This system includes 10 potable supply wells, all located at Corry Field. The majority of the water produced on Corry Field is utilized at NAS. The NAS Pensacola system (three wells) is currently utilized as an emergency backup supply only. Based on consumptive use permit documents provided by the Navy, water from these wells is of poor quality, being high in iron, hydrogen sulfide, and carbon dioxide. The Saufley Field system supplies this area only and consists of five wells.

Construction details and well capacities for the Corry Field and NAS wells are summarized in Table 1.23-1.

Table 1.23-1 - Construction Details for Corry Field and NAS Wells

Well Number	Well Depth (feet)	Casing Depth (feet)	Screen Length (feet)	Capacity (gpm)	Diameter (inches)
NAS					
1	175	105	55	na	24
2	178	110	50	na	24
1802	240	185	40	na	16
Corry Field					
MW07	226	146	80	620	24
MW08	239	145	80	412	26
MW09	239	145	80	800	26
MW10	208	115	80	572	26
MW11	251	162	75	726	26
MW12	238	143	75	737	26
MW13	232	137	80	na	26
MW14	230	140	80	680	26
MW15	230	150	80	na	26
MW16	242	177	65	na	26

1.30 Hydrogeologic Setting in the Vicinity of Corry Field

In the immediate vicinity of Corry Field, sand dominates the lithology of the entire thickness of the Sand-and-Gravel Aquifer. Very little clay occurs in the subsurface and no locally significant confining units are present. The surficial zone and the main producing zone are separated by an extremely leaky low permeability zone which affords only a minimum degree of confinement to the main producing zone. For this reason, the main producing zone is particularly susceptible to contamination.

Due to the extremely high sand content of the low permeability zone, only subtle changes in lithology and permeability occur between the various zones. These subtle changes are often difficult to accurately identify during a typical well installation. Accurate delineation of the zones is best accomplished by analysis of geophysical logs used in conjunction with detailed lithologic logs.

Figure 1.30-1 shows the location of geophysical logs in the Corry Field area and the location of a local cross section prepared for the purposes of this proposal. Figure 1.30-2 shows the zonation and general lithology of the Sand-and-Gravel Aquifer across Corry Field. The thickness of the surficial zone increases from 50 feet west of Corry Field to over 75 feet south and east of the field. This zone is a relatively homogeneous layer of fine to medium sand with some coarse sand and minor amounts of clay. No significant clay or sandy clay layers are present within the zone.

The low permeability zone consists of poorly sorted, predominantly fine to medium sand with silt and minor amounts of clay. Layers of moderately sorted medium to coarse sand also occur within the zone. The elevation of the top of the low permeability decreases to the south and east as the overlying surficial zone thickens. Although the overall permeability of this zone is lower than adjacent zones, the low permeability zone is extremely leaky.

The main producing zone is approximately 150 feet thick in the vicinity of Corry Field. It is composed of moderate to well sorted, medium to coarse sand along with thin layers of poorly sorted sand and silt containing minor amounts of clay. Individual clayey sand layers within the main producing zone thicken to the south and east across Corry Field. As thickening of these layers occurs toward the southeast, these clayey layers reduce the productive thickness of the main producing zone. To the southeast of Corry Field, much of the upper portion of the zone contains poorly sorted sand with minor amounts of clay.

As noted above, the Intermediate System is a thick, regionally extensive confining bed that effectively isolates the Sand-and-Gravel Aquifer from the underlying Floridan Aquifer. Aside from forming the base of the Sand-and-

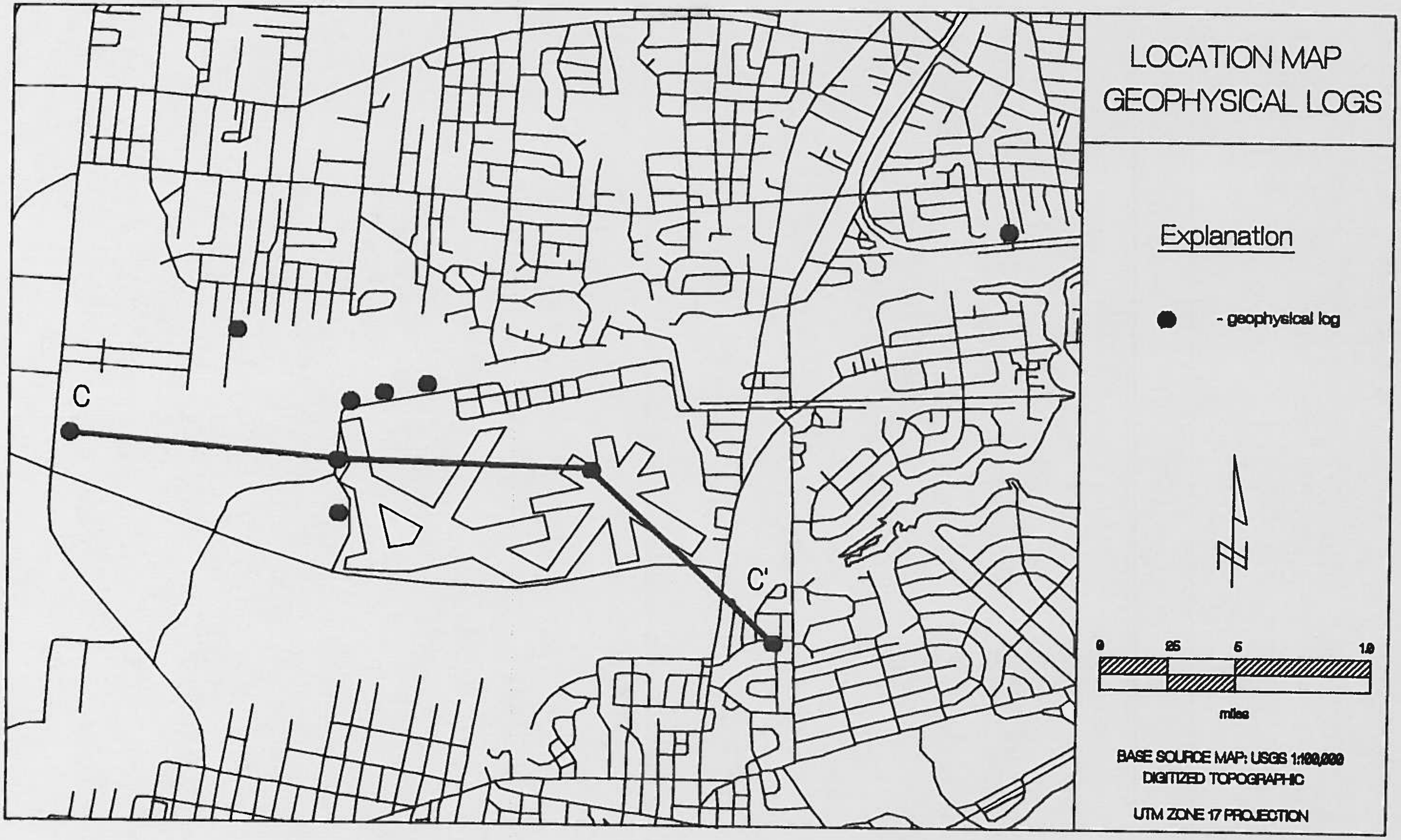
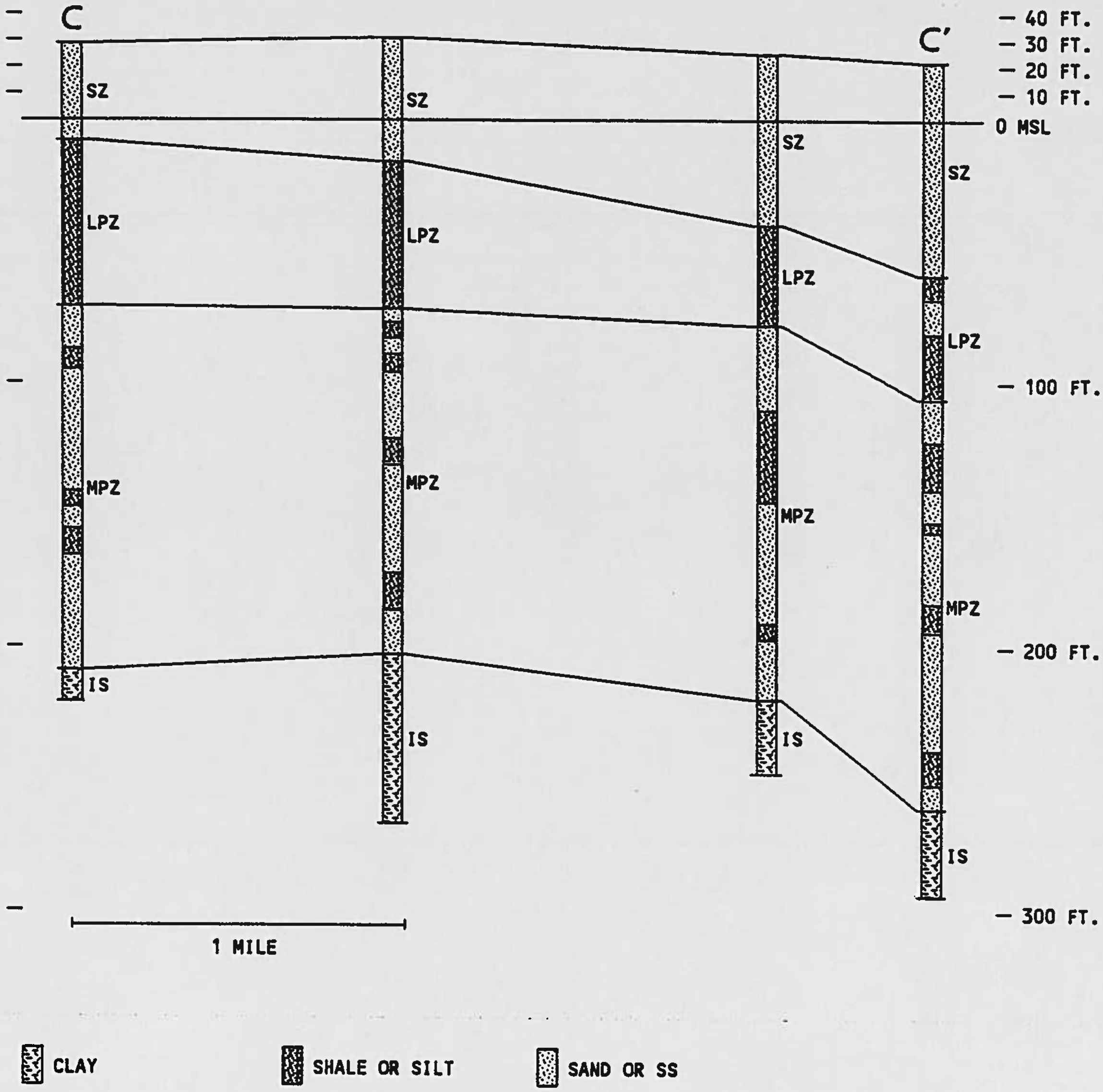


Figure 1.30-1. Location of Geophysical Logs and Hydrogeologic Section C-C′ Through Corry Field.



SZ - SURFICIAL ZONE
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Figure 1.30-2. Hydrogeologic Section C-C'.

Gravel Aquifer, the sediments below the top of this unit are not a significant consideration in addressing the dieldrin contamination at Corry Field.

1.31 Recharge, Discharge, and Movement of Ground Water

Virtually all fresh water in the Sand-and-Gravel Aquifer is derived from rain that falls on Escambia County between the Perdido and Escambia rivers. A portion of the rainfall infiltrates under the influence of gravity through the unsaturated soils to the water table. The Corry Field area averages nearly 60 inches of rainfall annually; much of which replenishes the Sand-and-Gravel Aquifer beneath the Corry Field area.

The surficial zone of the Sand-and-Gravel Aquifer in the Corry Field area contains the water table, which is estimated to range from 15 to 25 feet above sea level. When the ground water flow is not affected by pumpage, the dominant direction of flow in this zone is laterally to points of natural discharge. Points of discharge include creeks, drainage ways, wetlands, bayous and bays. For the Corry Field area, the northeast portion of the area is assumed to drain north-northeast to Jackson Branch, a tributary to Bayou Chico. In the northwest part of the area, the flow is in a northerly direction toward a wetland area and sandpit area just north of the field. The surficial zone in the remaining portion of the area is expected to drain in a southerly direction toward Jones Creek, another tributary to Bayou Chico. That portion of the flow system that does not move laterally and discharge to the surface water bodies, flows vertically downward to recharge the underlying main producing zone. It is assumed that under the influence of pumping, a greater percentage of the lateral flow is captured and diverted to the main producing zone.

The predominantly downward vertical gradient is illustrated by the head differences among the three zones underlying the Corry Field area. Under static conditions, the hydraulic head in the surficial zone ranges from 3 to 11.5 feet higher than the main producing zone in the Corry Field area (Wiegand and others, 1990). Testing to the south of Corry Field indicates that the difference in head between the surficial zone and the low permeability zone ranges from about 1.5 to 11 feet, and the difference between the low permeability zone and the main producing zone is about 0.2 to 2 feet. The non-pumping head in the main producing zone is estimated to range from 10 to 4 feet above sea level across Corry Field (from a north to south direction).

Movement in both the low permeability zone and the main producing zone is in a southerly direction toward Bayou Grande/Pensacola Bay under static conditions. However, due to pumping at Corry Field and in the vicinity of Peoples Water Service and Pensacola Junior College - Warrington Campus, flow directions can be significantly altered in these zones. There are nearly a dozen major production wells in the immediate vicinity of Corry Field (Figure 1.31-1). These wells are capable of producing a cone of depression at the pumping wells that extends from 30 to 70 feet below sea level. These individual cones of depression can reverse the natural flow gradient in the direction of the pumping wells. Where the individual cones of depression overlap, a composite cone of depression is developed which will have a greater areal extent. Results of testing near Corry Field (Wiegand and others, 1990) indicate, however, that areally, the magnitude of the decline resulting from the composite cone of depression is relatively small. Whereas up to 70 feet of decline may occur in a pumping well, only about 2 feet of decline may be expected 0.5 miles from the well.

Wells pumping at Corry Field control the direction of ground water flow within the immediate vicinity of the field. Off-site to the east and south, wells owned by the Peoples Water Service also impact the ground water flow system at Corry Field. The nearest major pumping well (ECUA-West Pensacola) to the northeast is nearly 1.4 miles distant from Corry Field. To the northwest and west are other ECUA wells which are about 1.5 and 1.0 miles, respectively, from the area of interest. These distant major wells are not expected to have a significant impact on the ground water flow at Corry Field. These wells will, however, be important for establishing boundary conditions for the flow model analysis.

In summary, at Corry Field there is a natural downward hydraulic gradient interconnecting all the zones of the Sand-and-Gravel Aquifer. Pumping influences this interconnection and enables contaminants entering the water table to be transported into the main producing zone. The flow pattern

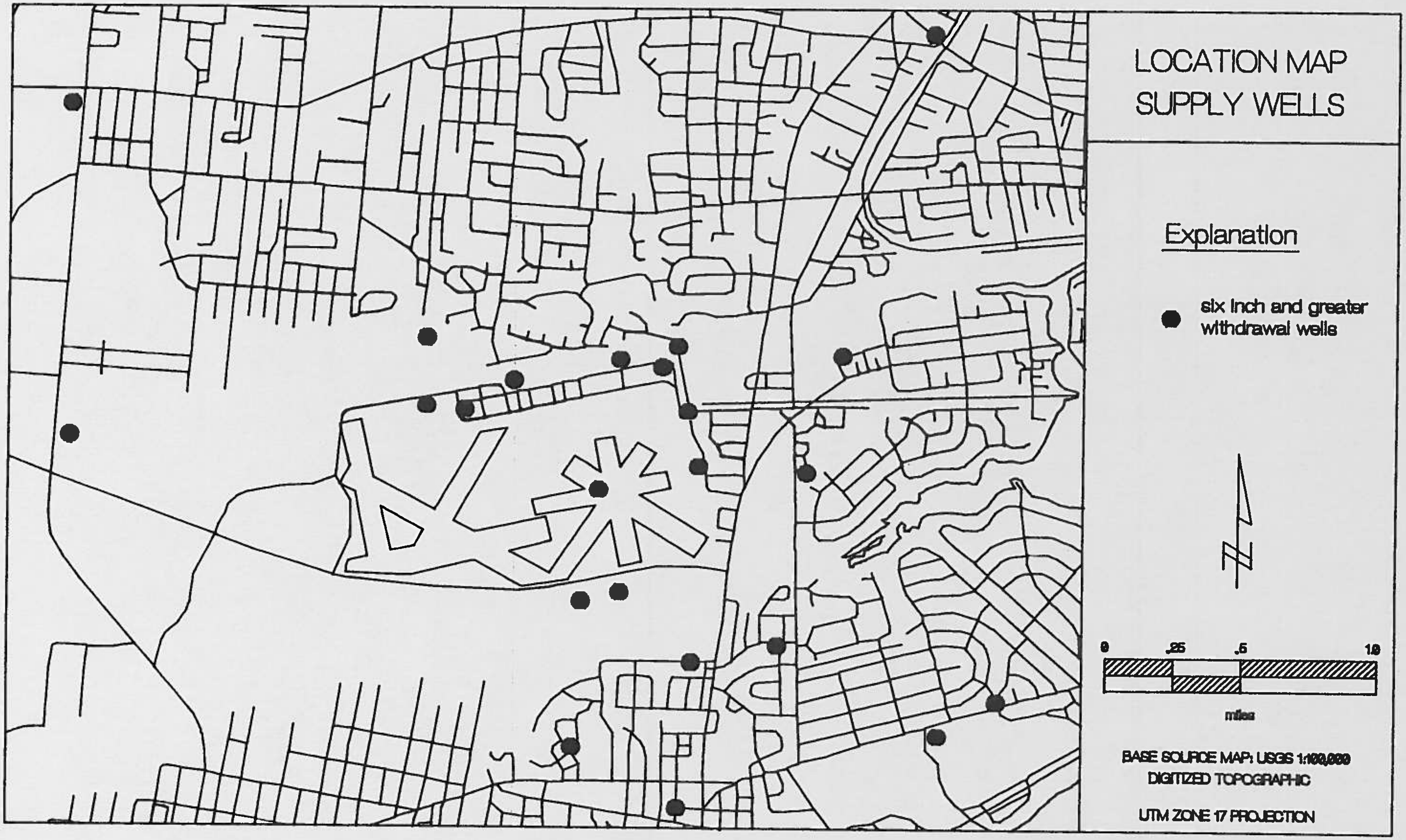


Figure 1.31-1. Location of Six-inch Diameter and Greater Supply Wells on or Near Corry Field.

within the main producing zone is such that a contaminant can be spread throughout the entire thickness of the Sand-and-Gravel Aquifer.

1.32 <u>Ground Water Hydraulics</u>

An understanding of the hydraulic properties of the Sand-and-Gravel Aquifer is critical in the development of the ground water flow and contaminant transport model, and more generally, in assessing the transport and ultimate fate of the dieldrin contamination at Corry Field. For example, application of the numerical model will require information on the permeability and storage characteristics of each of the multiple layers incorporated into the model, including both the producing zones and confining beds. To a large degree, the aquifer flow regime and contaminant transport characteristics are a function of the aquifer and confining bed hydraulic properties. Consequently, the accuracy of any model simulations will be largely controlled by the accuracy of the information available on the properties of the surficial, low permeability, and the main producing zones of the Sand-and-Gravel Aquifer.

In the vicinity of Corry Field, specific capacity tests have been conducted on several of the major public supply wells (Figure 1.32-1). These tests entail pumping the well for a specified period of time and measuring the drawdown at the end of the pumping period. The specific capacity is then obtained by simply dividing the well discharge by the drawdown. Several analytical techniques can then be applied to compute an approximate aquifer transmissivity from the specific capacity. Values obtained in this manner in the vicinity of Corry Field range from 5,000 to 13,000 feet squared per day. Although these values have not been corrected for partial penetration, they are indicative of the magnitude of lateral variation of at least one of the principal hydraulic properties of the Sand-and-Gravel Aquifer in the vicinity of Corry Field.

Wiegand and others (1990) provide the results of two multi-well aquifer tests conducted on the main producing zone in southern Escambia County. The test results yielded values of aquifer transmissivity ranging from 5,800 to 7,800 feet squared per day with a storage coefficient of 2.9E-04 to 5.7E-04

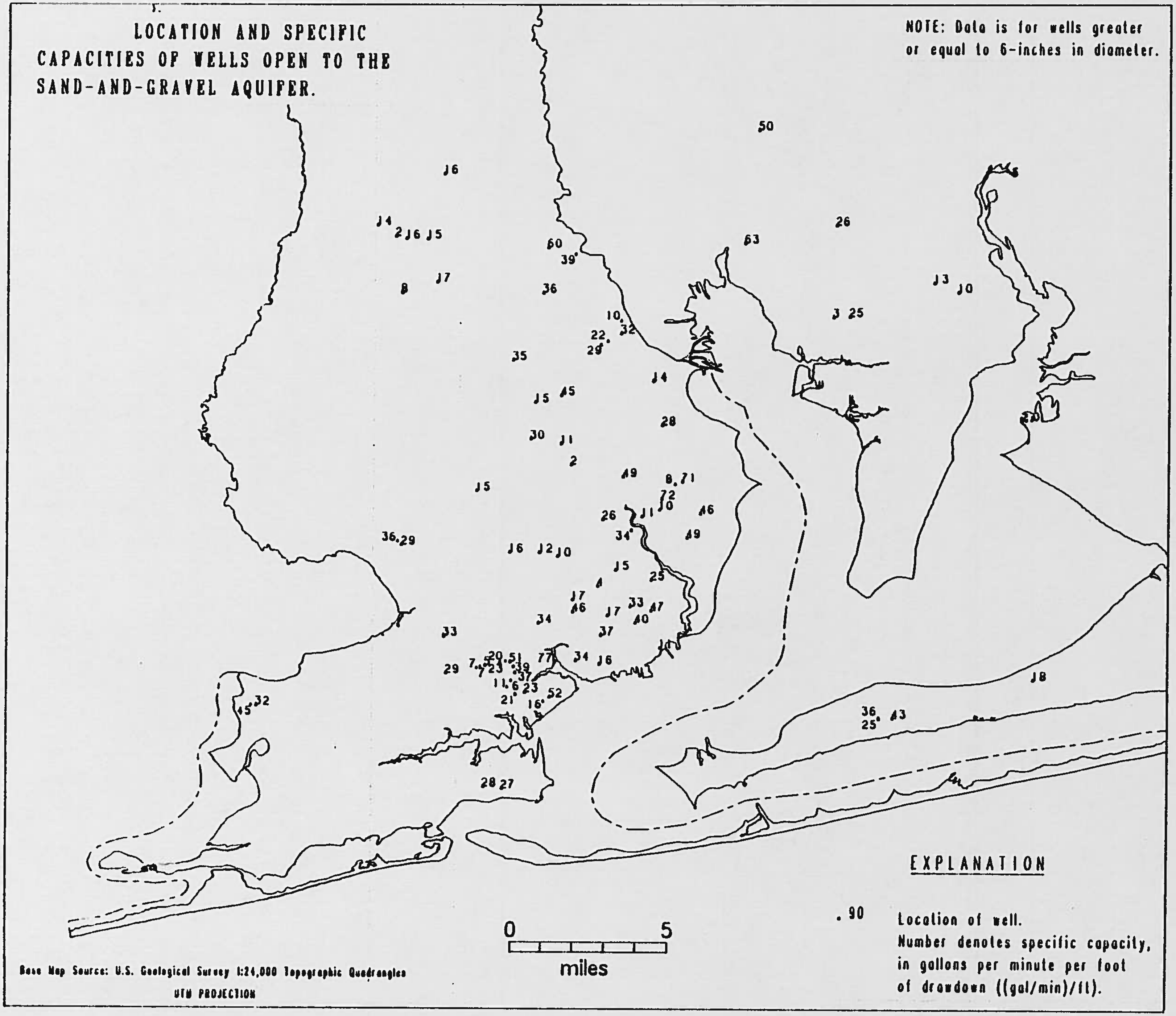


Figure 1.32-1. Location and Specific Capacities of Wells Open to the Sand-and-Gravel Aquifer.

(dimensionless). The response curves for the observation wells were typical of the drawdowns to be expected from a "leaky" confined aquifer, and similar conditions are to be expected at Corry Field. An additional multi-well test was performed on the main producing zone by the District at a site west of Bayou Texar and northeast of Corry Field. This test yielded an aquifer transmissivity of approximately 10,000 feet squared per day. The results of these tests, and the available specific capacity information, indicate that the transmissivity of the main producing zone is somewhat variable over the southern area of the County, but probably ranges from approximately 5,000 to 20,000 feet squared per day. Some previous studies have suggested, based on the lithologic characteristics of the main producing zone, that the permeability and transmissivity of the unit may be higher in the "downtown" area of Pensacola, in comparison to areas to the west and southwest.

Relatively little information is available on the hydraulic properties of the surficial zone. No multi-well aquifer tests have been performed on this zone, and relatively few specific capacity tests are available. Some laboratory permeabilities have been conducted on core samples from the surficial zone and "slug" tests have been performed on occasion by various investigators. The values obtained by these means, however, are approximations and are not considered a reliable source of information on the hydraulic properties of the surficial zone.

Although a considerable number of specific capacity tests have been performed on the major production wells in southern Escambia County, relatively few reliable multi-well aquifer tests have been performed on the main producing zone. In addition, relatively little information is available in the Corry Field area regarding the hydraulic properties of the low permeability zone and the surficial zone. Given the nature of the Corry Field investigation and the need to develop a reliable predictive model for assessing ground water flows and the transport of dieldrin, the sparsity of information on the hydraulic properties of the aquifer is considered a major data deficiency. Based on the available information, however, it appears that there is some variation in the hydraulic properties of the main producing zone and low permeability zone over the southern area of the County. This factor, coupled with the complex patterns of ground water withdrawals in the area, would suggest that a ground water flow and contaminant transport model for Corry Field should be developed within the framework of a regional model that accounts for the variability of the aquifer parameters.

1.33 Geochemical Characterization

Understanding the hydrochemical character and the hydraulic factors that make the Sand-and-Gravel Aquifer susceptible to contamination is a necessary prelude to constructing an adequate conceptual model for flow and contaminant transport simulations. To this end, the District has two principal sources of information regarding the quality of water in the Sand-and-Gravel Aquifer in Escambia County: its own on-going sampling programs, and information on existing ground water contamination developed by other agencies. The District has collected water quality samples from the aquifer at numerous sites in Escambia County in conjunction with several projects. Sampled well site locations are shown in Figure 1.33-1. Many of these locations represent well nests, with at least two wells per site. Sites for which other agencies have developed ground water contamination information are given in Figure 1.33-2. Table 1.33-1 lists these sites and the type of contamination associated with them. Both of these sources of information are available to the District to utilize in the development of an appropriate conceptual model of the Sand-and-Gravel Aquifer in the Corry Field area. The following section provides a discussion of one pertinent aspect (for the purposes of this proposal) of ground water contamination in Escambia County, as well as an overview of the aqueous geochemical behavior of the Sand-and-Gravel Aquifer. The information presented on the geochemical aspects of the aquifer was developed through analysis of data collected by the District from its on-going programs.

Dieldrin in the Sand-and-Gravel Aquifer

The District's previous ground water investigations in Escambia County have detected dieldrin at sites other than Corry Field. In southern Escambia County, seven out of 43 wells contained levels of dieldrin ranging from 0.02 μg/L to 0.41 μg/L. Two additional wells contained between 0.019 μg/L and 0.029 μg/L of aldrin. The presence of aldrin in ground water holds special significance because dieldrin can be a transformed product of aldrin. The

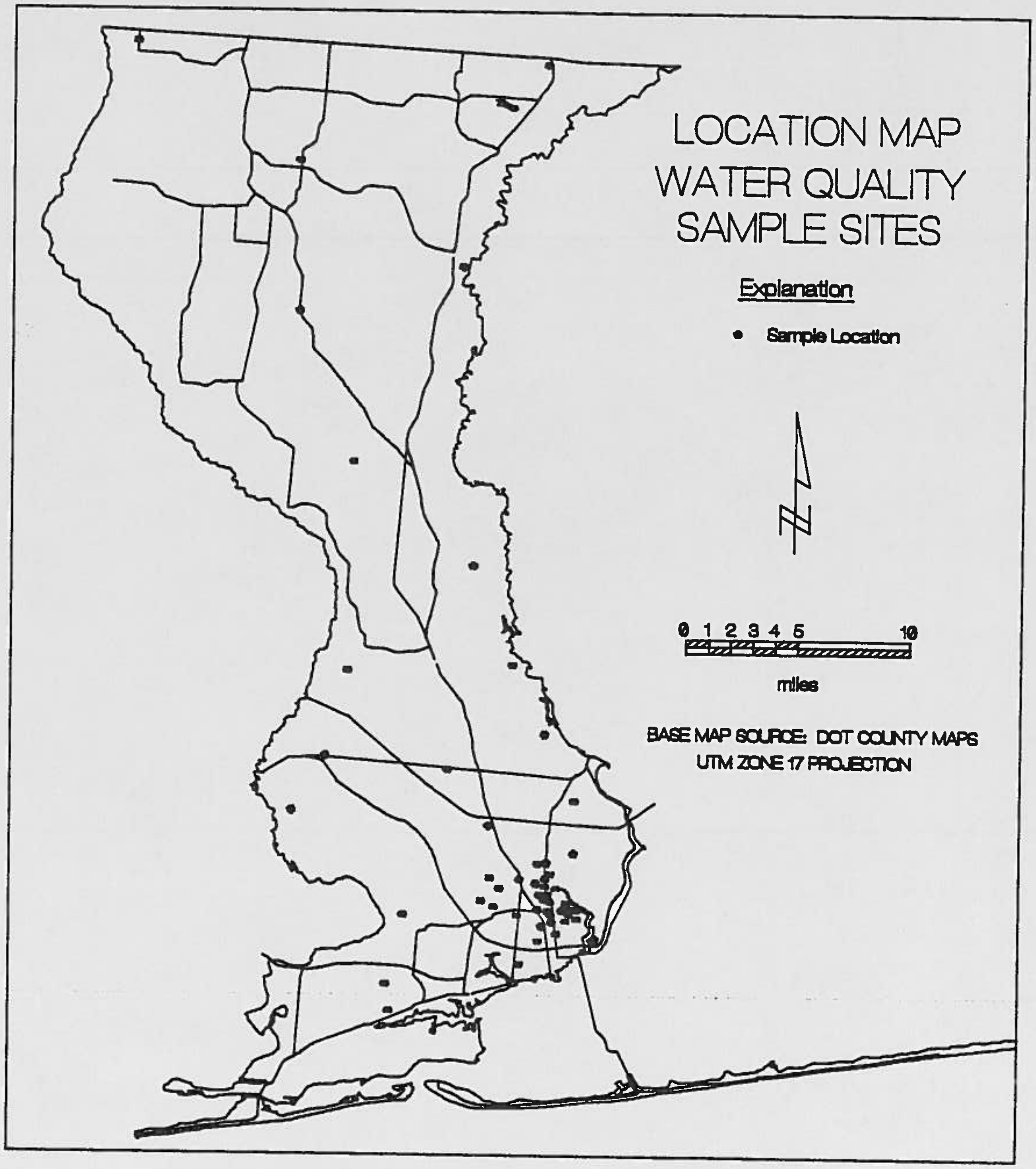


Figure 1.33-1. Location of District Ground Water Quality Monitoring Sites.

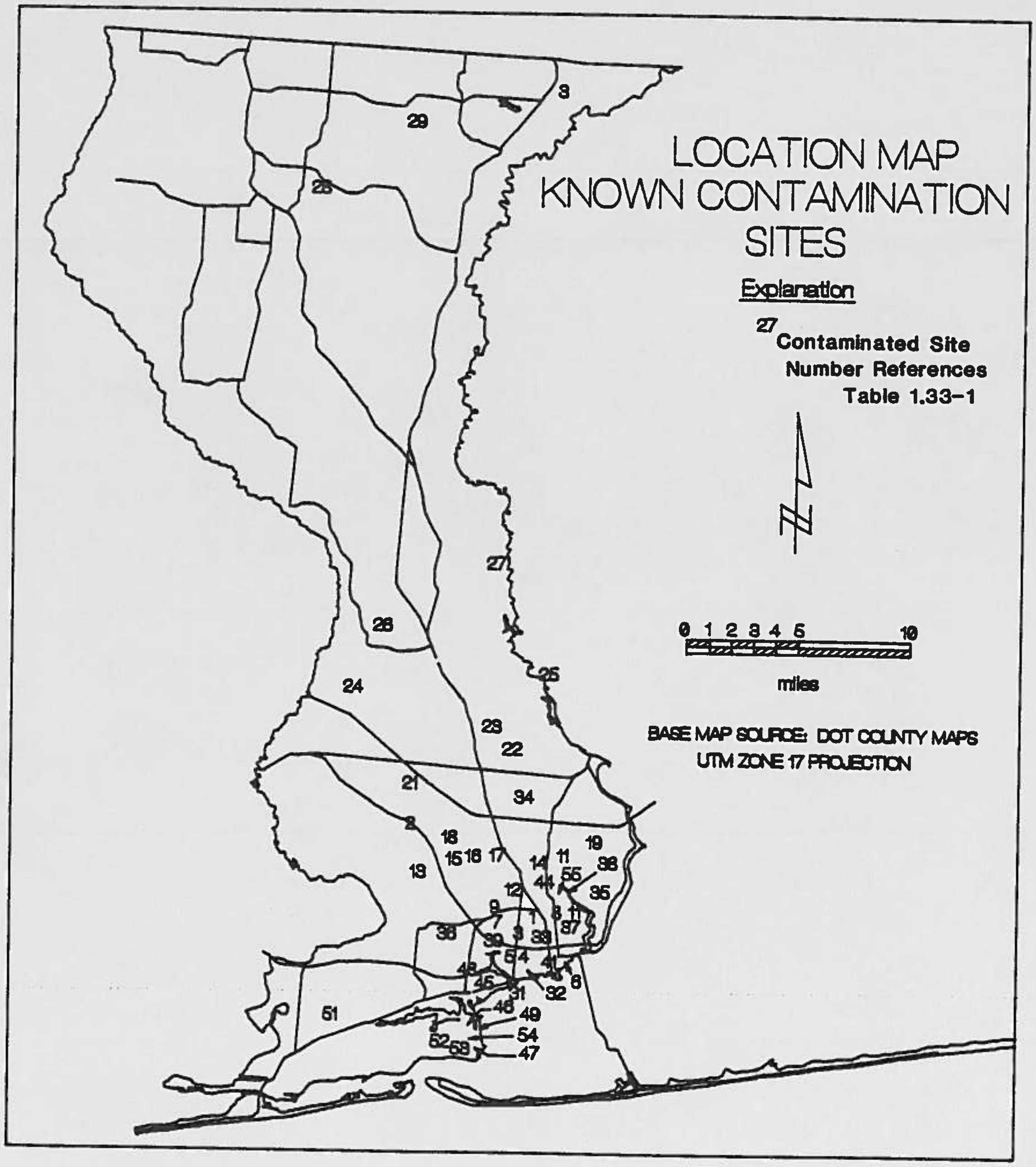


Figure 1.33-2. Location of Known Ground Water Contamination.

Table 1.33-1 - Known or Suspected Contamination Sites in Escambia County

MAP ID	LAT	LONG	SITE NAME	COMMENTS
1	302144	841720	Pensacola Naval Air Station	industrial and municipal wastes;cyanide;phenol
2	302030	842007	Pensacola Naval Air Station (5)	PCB;jet fuel;phenols;cyanide;oil;radium
3	302515	871438	Newport Landfill (Omni-Vest)	Site closed. Class II waste.
4	302428	871434	Reichold Chemical and Textron	ongoing cleanup. Phenol, toluene, organics.
5	302425	871445	American Creosote	phenolic compounds in soils, surface water and gw
6	302440	871245	Port of Pensacola	suspected soil and gw contam from creosote tanks
7	302545	871610	4300 Block Mobile Highway Dump	dump
8	302620	871320	Downtown Pensacola;American Linen	ongoing investigation
9	302620	871620	4518 Mobile Highway Dump Site	dump
10	302640	871400	1200 Block West Leonard Street	dump
11	302650	871215	Isolated petroleum spills	Petroleum spills
11	302825	871310	Isolated petroleum spills	Petroleum spills
12	302714	871359	Escambia Treating Co. and Agrico	Indust. waste;2 adj. sites;Agrico plume 1 mi SE.
13	302730	872005	Pioneer Sand	On EPA list of open dumps. Class III waste.
14	302805	871345	Royce Street Dump Site	ECUA well at Royce Street shows gasoline.
15	302805	871830	Hogan Road Dump Site	dump
16	302810	871710	Memphis Avenue Dump	dump
17	302820	871630	Fenwick Road Dump	dump
18	302855	871845	Mobile Highway Landfill	Primarily construction/demolition wastes.
19	302905	871210	Fashion Cleaners	PCE. Land_net is sections 32 and 33.
20	302920	872025	Klondike Landfill	Class I wastes. TCE, PCE, metals, solvents.
21	303054	872041	Beulah Landfill	Interim sludge facility;Class I;EPA open dump list
22	303230	871615	Herman Street Dump	dump
23	303320	871715	10 Mile Road Dump	dump
24	303430	872340	Perdido Landfill	North of I-10
25	303530	871450	Monsanto Textiles Co.	Industrial wastes
26	303658	872230	Dubose Oil Products	Phenolic compounds, benzene,solvents.
27	303940	871730	Quintette Dump	Class I waste.

Table 1.33-1 - Known or Suspected Contamination Sites in Escambia County -- continued

MAP ID	LAT	LONG	SITE NAME	COMMENTS
28	305350	872640	Oak Grove Dump	Class II waste.
29	305640	872230	Camp Five Landfill	Class II waste.
30	305815	871545	WDC Doors (Jim Walter Doors)	Phenolic compounds.
31	302355	871445	Pensacola Terminals Inc.	VOAs, Organics, Heavy metals?
32	302405	871435	Circle K Convenience Store	2800 gallon loss - not recovered
33	302540	871310	Inactive Service Station	several hundred gallon loss-status unknown
34	303040	871535	Delta/G Bar Station	gasoline loss-status unknown
35	302715	871125	Springdale Exxon	gasoline loss-status unknown
36	302520	871840	Tom Thumb Food Store	TCE, BTEX.
37	302550	871300	All Seasons Inc.	gasoline loss-status unkown
38	302715	871235	Private Irrigation Wells-Dunford	Dinitrotoluene
39	302500	871630	Navy Corry Field	dieldrin
40	no exact loc.		Southern Chemical and Storage	ammonia-status unkown
41	302415	871330	Union Bulk Oil Co./Bulk Chemical	Mineral spirits leak in 1983. recovery underway.
42	305300	871317	University Chevron Gas Station	400 gallon leak recovery underway
43	no exact loc.		7-Eleven Food Store	400 gallon loss- status unknown
44	302725	871330	Union 76 Service Station	2100 gallons of lost product
45	302315	871640	Kayo Gasoline Station	1000 gallons loast product
46	302138	871631	Naval Air Station	radium dial shop. low level radioactivity
47	302113	871611	Naval Air Station	Unknown soil contaminant. Produced skin burns.
48	302340	871645	Warrington Village Center	PCE (dry cleaner)
49	302151	871555	Naval Air Station	solvents, electroplating wastes, paint sludges
50	302144	871720	Naval Air Station	Sanitary landfill. metals, phenol, cyanide
51	302141	872336	Naval Air Station	N Chevalier Field disposal und. waste, oils
52	302110	871726	Naval Air Station	Transformer storage area. PCBs
53	302024	871725	Naval Air Station	Sludge disposal at fuel tank area.
54	302124	871631	Naval Air Station	Fuel disposal. 19,000 gallons of waste fuel
55	302711	871325	Agrico Chemical Fertilizer Plant	closed in 1975. F, SO4, CL, NO3 contam.

distribution of the "hot" dieldrin sites is aerially sporadic and includes sites located several miles from Corry Field. A well-defined dieldrin plume in these areas does not seem to exist. Dieldrin was observed in both the surficial zone and main producing zone monitoring wells. No obvious vertical pattern of dieldrin occurrence was seen at nested well sites. Preliminary retrievals of data from the United States Environmental Protection Agency (USEPA) STORET data base indicate that other ground water sites in Escambia County also have detectable dieldrin concentrations.

Aqueous Geochemistry of the Sand-and-Gravel Aquifer

Data from sites sampled as part of the District's ground water monitoring network in Escambia County provides a basis for identifying dominant geochemical processes and evaluating hydrochemical patterns in the Sand-and-Gravel Aquifer. These processes and patterns reveal the character of the aquifer system and provide an understanding of the normal range of parameter concentrations. This baseline of concentration ranges can be used to compare analytical results from the proposed project with results from nearby "non-contaminated" areas, thus aiding in contamination delineation. An overview of the hydrochemical system is presented below, followed by a detailed discussion of the data.

From an analysis of the available data, several general observations can be made. Sand-and-Gravel Aquifer samples have a consistently low ionic strength. The total dissolved solids (TDS) for these samples shows a median value of 71.5 milligrams per liter (mg/L). None of the major ions display clear spatial trends, nor do they show a definitive increase with depth which implies heterogeneity of the ground water chemistry. Flow path length and residence time do not have a large influence on the major ion ground water chemistry.

The processes most influential in shaping the geochemistry of the water samples include dissolution of trace minerals from the aquifer matrix, aerosol deposition of ocean spray components, and mixing with saline waters. Andesine, chlorite, and muscovite provide the primary soluble minerals from the aquifer matrix (Katz and Choquette, 1991).

Point value concentration maps have been constructed for the southern extent of Escambia County. Values plotted on these maps were selected to indicate the range of values observed and are not intended to be a comprehensive representation of the District's data base. Due to the localized nature of flow and the local mineralogical variability in this aquifer system, geochemical analysis for large scale trends appears to be difficult at best. For reference, maps of selected constituents are presented in Figures 1.33-3 through 1.33-4.

The predominate anion and cation species can provide basic information about the gross evolution and behavior of a ground water system. Major ion facies were delineated based on natural groupings observed in piper trilinear diagrams. Figure 1.33-5 shows the position of representative data points from the mixed sodium-chloride facies in southern Escambia County. The southern portion of Escambia County, where the densest concentration of monitor wells is located, has a mixed population of water types. Although many different water types exist in this area, a low ionic strength sodium-chloride type is the most prevalent.

Selected representative stiff diagrams for the Sand-and-Gravel Aquifer are displayed in Figure 1.33-6. The primary features of these diagrams provide insight into the low ionic strength of these solutions and the lack of a strongly dominant water type.

The visual and graphical methods of analysis discussed above demonstrate the nature of aqueous geochemistry within the Sand-and-Gravel Aquifer, but the most useful information may be the range of observed values. Conductivity values in the Sand-and-Gravel Aquifer generally are less than 70 micromhos per centimeter. PH values are generally strongly acidic, with a mean of 4.8. All the major ions are observed to be generally less than 10 mg/L, with isolated values exceeding this value on a sporadic basis. The specific ranges of values for fifteen selected parameters are available in Table 1.33-2. Statistical means should be used cautiously due to the wide local variability of values.

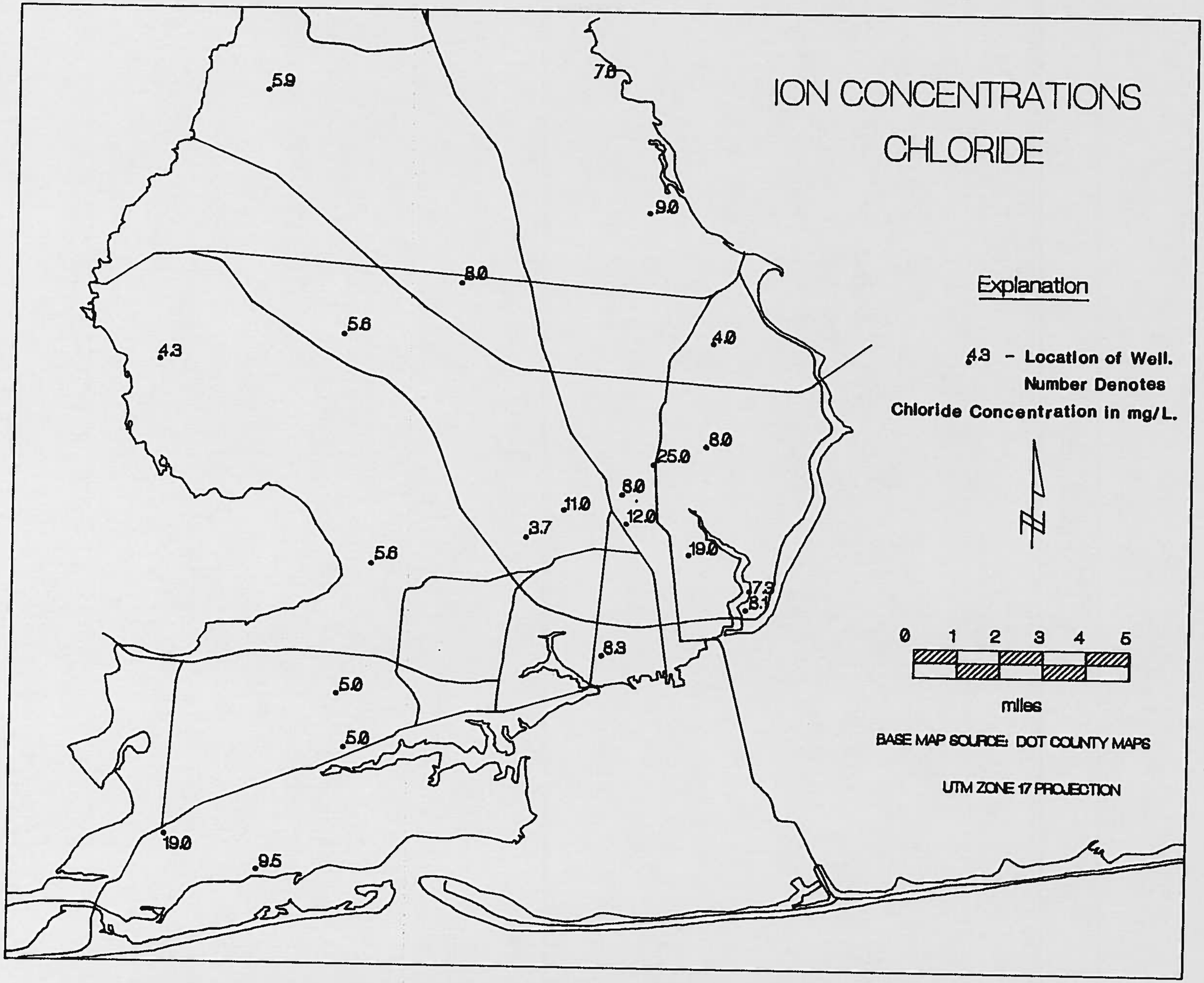


Figure 1.33-3. Representative Sand-and-Gravel Aquifer Chloride Concentrations.

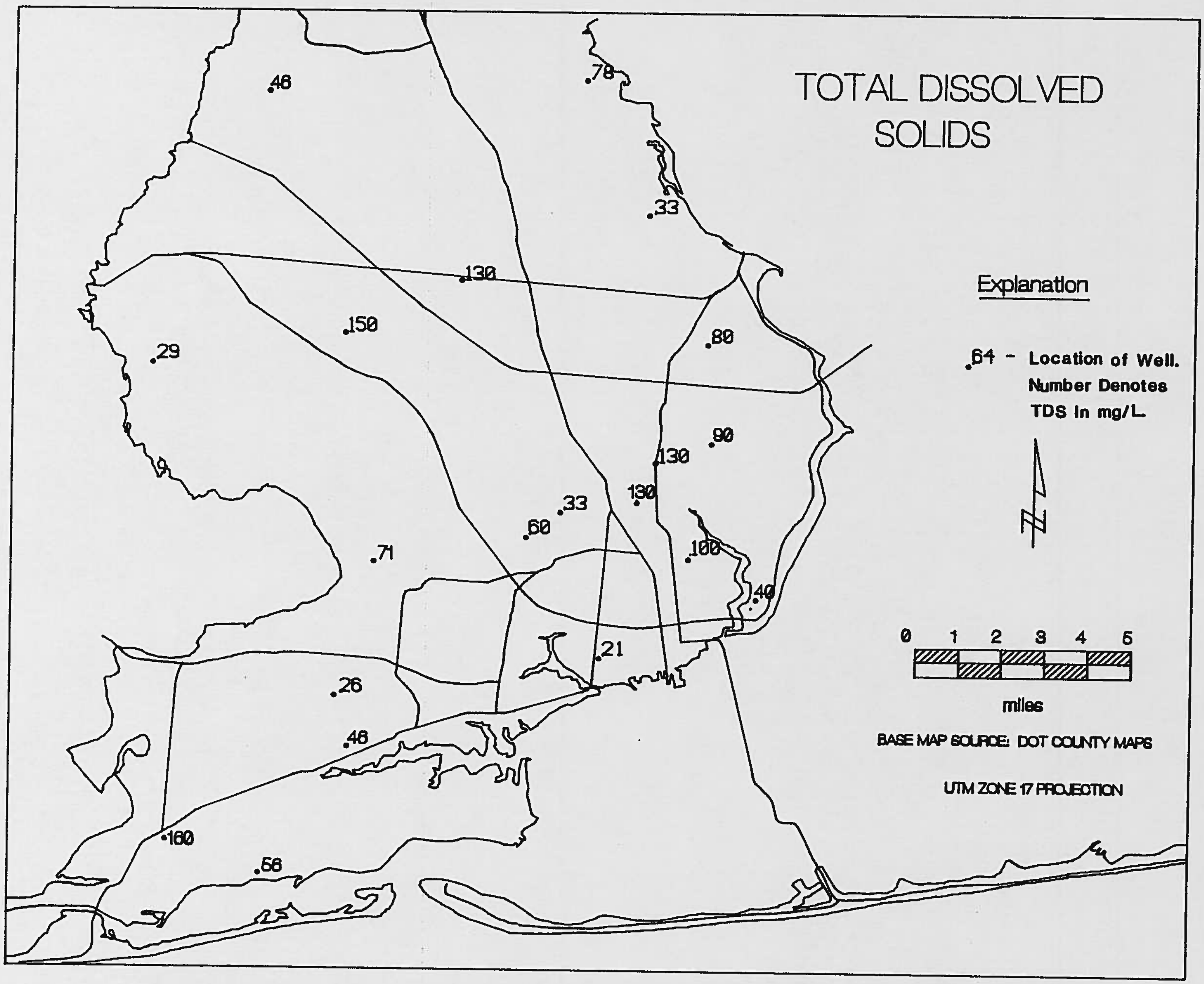
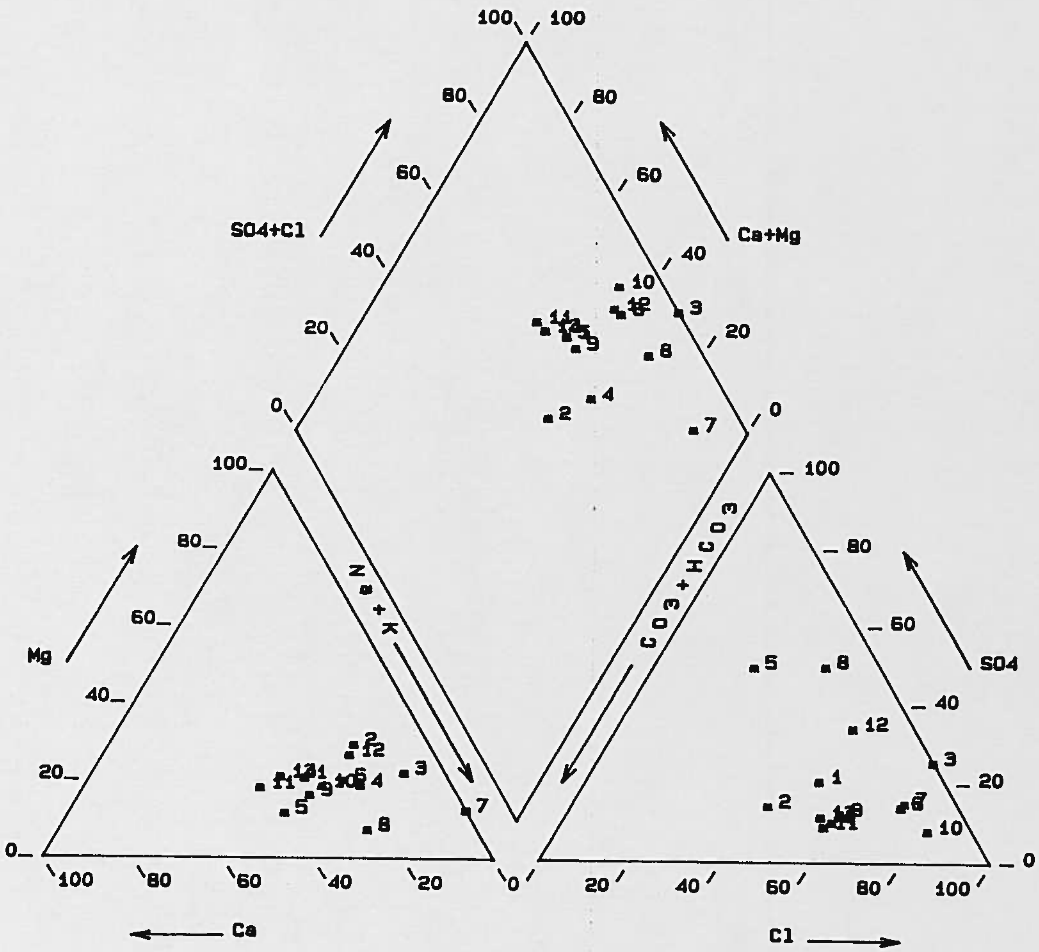


Figure 1.33-4. Representative Sand-and-Gravel Aquifer Total Dissolved Solids Concentrations.



#	Date YYMMDD	Zone	Well I.D.
1	861015	1, 4, 9	6302900087120701
2	861015	2, 4, 7	6302900087120702
3	860319	2, 4, 7	6302929087235502
4	860327	2, 4, 7	6303047087204202
5	860326	1, 4, 9	6303102087121402
6	860324	2, 4, 7	6303158087180501
7	860318	2, 4, 7	6303333087134602
8	860325	2, 4, 7	6303532087224201
9	860325	2, 4, 7	6303532087224202
10	860325	2, 4, 7	6303532087224203
11	860319	1, 4, 9	6303610087152602
12	861208	2, 4, 7	6303946087173002
13	860319	1, 4, 9	6303946087173003
14	860319	1, 4, 9	6303946087173003

NORTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Figure 1.33-5. Representative Piper Diagrams from Southern Escambia County.

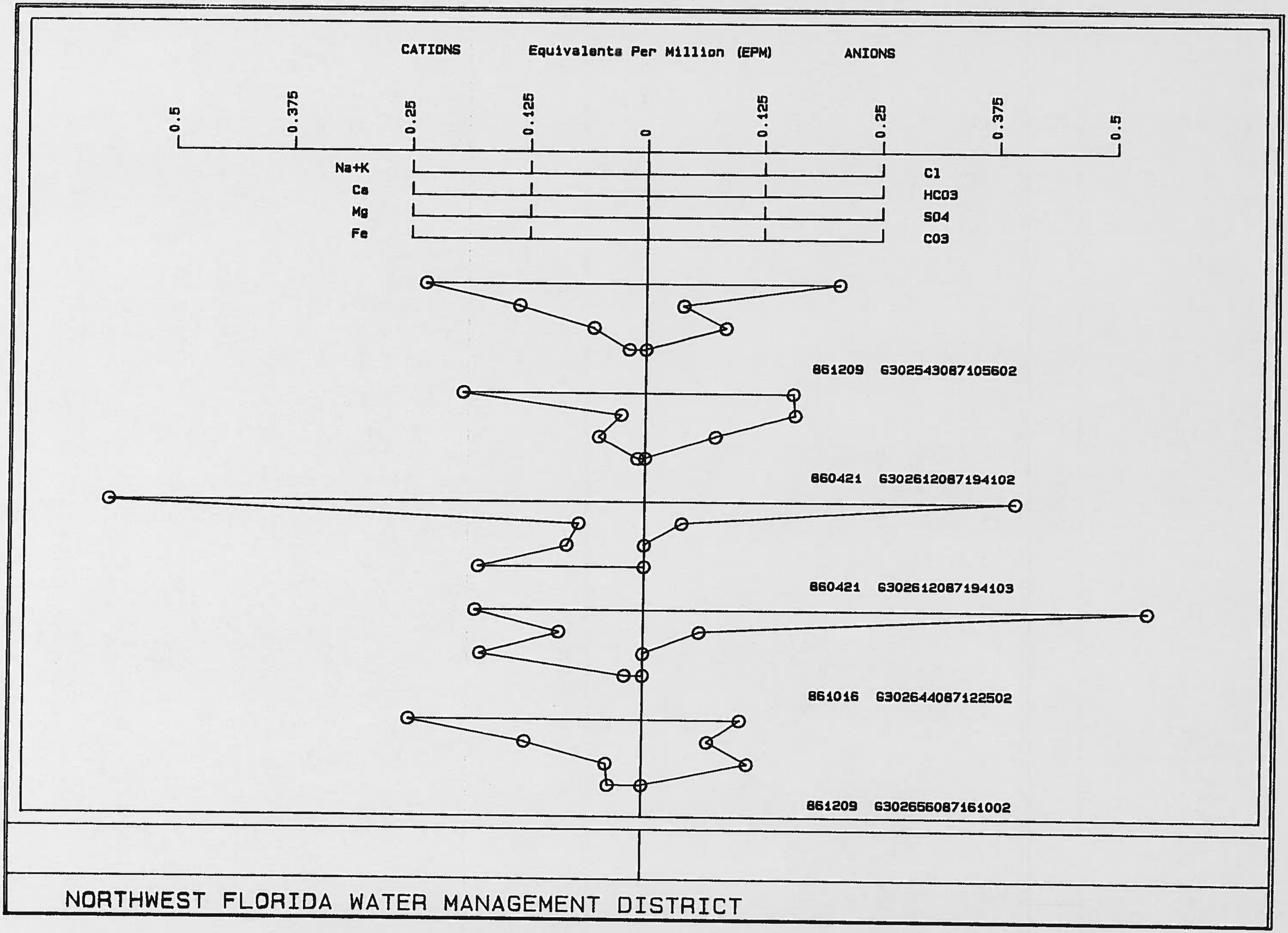


Figure 1.33-6. Representative Stiff Diagrams from Southern Escambia County.

Table 1.33-2 - Statistics for Sand-and-Gravel Aquifer, Southern Escambia County

	ph	cond	tds	temp	hco3
N used :	32	36	36	36	35
N missing :	4	0	0	0	1
Mean :	4.766	51.861	73.111	21.939	7.993
Variance :	.657	910.523	1783.644	2.741	76.369
Std. Dev. :	.810	30.175	42.233	1.656	8.739
Minimum :	3.350	15.000	15.000	18.000	1.219
Median :	4.775	47.000	71.500	22.000	4.876
Maximum :	6.350	161.000	160.000	25.100	34.132

	no3	ca	mg	na	k
N used :	33	33	35	36	33
N missing :	3	3	1	0	3
Mean :	.831	2.746	.973	5.403	1.087
Variance :	.705	16.547	.514	9.651	.654
Std. Dev. :	.840	4.068	.717	3.107	.808
Minimum :	.070	.050	.290	1.300	.160
Median :	.600	1.700	.760	4.450	.760
Maximum :	4.100	24.000	4.200	15.000	3.000

	cl	so4	f	toc	po4
N used :	36	34	36	34	36
N missing :	0	2	0	2	0
Mean :	8.036	3.085	.080	7.161	.119
Variance :	25.146	4.335	.009	19.774	.011
Std. Dev. :	5.015	2.082	.093	4.447	.104
Minimum :	2.400	.800	.020	1.910	.010
Median :	7.200	2.450	.040	6.200	.085
Maximum :	25.000	9.800	.350	18.300	.400

This data suggests that, within the Sand-and-Gravel Aquifer, sampling and analysis of a smaller study area, with close attention to local flow systems and variable hydrogeologic conditions, may yield a better understanding of the coupling between aquifer characteristics and the resulting aqueous geochemical regimes.

Ground Water Quality Data Screening

Water quality data must be closely examined before it is used as a basis for interpreting conditions within an aquifer. The standard examination procedures used by the District are outlined below. Similar methods would be used on data from the proposed project. The data set from the District's monitoring network in Escambia County discussed in this section was screened using a charge balance approach in order to identify and eliminate analyses which may not be truly representative of ground water conditions. Non-hydrochemical conditions which may influence charge balances in an adverse manner include inaccurate laboratory procedures and field sample collection errors. Site related factors which influence charge balances in an undesirable way may include the adsorption of ions to the surfaces of clay particles or organic complexes.

Two standards are used as the criteria for excluding unreliable data points. Samples in which the total dissolved solids exceed 100 mg/L are flagged as potentially invalid if the charge balance error is greater than 20 percent. Samples which have total dissolved solids of less than 100 mg/L are flagged as potentially invalid if the charge balance error was greater than 30 percent.

In order to identify potential outlying non-representative points, a quartile analysis is performed. The benefits from this analysis are two-fold. First, it identifies points which appear to be unrepresentative of the monitored unit. Secondly, it serves as a supplementary tool in identifying groups of wells that exhibit differing geochemical signatures.

Descriptive Statistics

Populations for the statistics presented in Table 1.33-2 were based on facies for Escambia County as determined by piper diagram groupings. All values that exceeded the outer fence quartile outlier test were discarded before beginning the calculations. The USEPA Geo-EAS software package was used to generate statistics. Mean, median, variance, standard deviation, minimum, and maximum were calculated. The sample population was relatively small, and as a result, the determination of normalcy and the calculation of statistical parameters are less certain. Extreme values may unduly influence small populations. It is also important to recognize that those statistical parameters that require the data to be normally distributed, in order to be valid, may yield spurious results when calculated from non-normal data.

In summary, each geochemical analysis method presented here leads to the same conclusion; strong areal variability is the dominant character of hydrochemistry of the Sand-and-Gravel Aquifer in southern Escambia County.

The occurrence of ground water recharge in the immediate vicinity of points of production and the leaky nature of the aquifer make the Sand-and-Gravel Aquifer extremely vulnerable to contamination via inappropriate (from the perspective of preventing ground water contamination) land use practices. The chaotic pattern of dieldrin contamination in areas away from corry Field serves to point out the possible nonpoint nature of such contamination and the potential complexity of locating the sources of dieldrin at Corry Field.

Given the variability of hydrochemical indicators and the apparently random pattern of known contamination sites in Escambia County, it is suggested that an understanding of contaminant occurrence and transport within the Sand-and-Gravel Aquifer in general, and within the bounds of Corry Field in particular, will require a very detailed investigation of the local hydrogeologic conditions responsible for this variability. The location, delineation, and modeling of dieldrin contamination at Corry Field will require water quality sampling and geological information acquisition on a fine spatial resolution with close attention to local detail.

1.40 Current And Previous Studies

The Northwest Florida Water Management District is currently involved in the development of a ground water flow and contaminant transport model which will encompass all of Escambia County. This modeling effort has incorporated all identified model deficiencies of previous modeling attempts within Escambia County. The District's project is being performed in cooperation with the Escambia County Utilities Authority. Other cooperators include the U.S. Navy, Monsanto Company, Champion International Corp., Gulf Power Company, University of West Florida, Peoples Water Service, and all other major water users within the county.

ECUA and the other major municipal and industrial water systems account for more than 70 million gallons per day (Mgal/d) of fresh ground water withdrawn from the Sand-and-Gravel Aquifer. ECUA alone has a present permitted average day capacity to withdraw 45 Mgal/d. Population projections indicate that by the year 2000 an additional 55,000 persons will reside in the County, further increasing the water demands. Additionally, the Sand-and-Gravel Aquifer is highly susceptible to contamination from surface sources and from coastal saltwater intrusion, both of which decrease the freshwater availability. Also, the aquifer itself does not have equally distributed water-yielding properties and some areas have low availability and naturally occurring poor quality water problems (i.e. high iron concentrations). All of these factors limit the amount of water that can be safely withdrawn from the Sand-and-Gravel Aquifer.

The regional model will be developed in discrete phases. First, a conceptual model will be developed that represents a transition between the physical system and the numerical model representation. The conceptual model generalizes the aquifer's hydraulic and physical properties. The generalized parameters are then transferred to a ground water flow model data base to simulate flow. The assumptions and values of the parameters used to describe the subsurface are adjusted within reasonable limits, until the simulated results match the observed values. After the flow model is developed, the solute-transport model with density dependent options can be developed using many of the hydrogeologic and hydraulic parameters previously tested and confirmed with the ground water flow model. The density dependent options allow for understanding how saltwater intrusion relates to the hydraulics and the hydrogeology in the subsurface.

The overall objective of the regional aquifer model study is to provide the Escambia County Utilities Authority with a computer model that simulates the movement of ground water through the entire Sand-and-Gravel Aquifer and provide for the continued successful development and management of the freshwater resource of the area.

The model will be designed so that the data base can be maintained as modifications and new data becomes available. In addition to describing the ground water flow system, the model will also be used for simulating water quality and saltwater intrusion problems. Also, areas of ground water availability will be delineated, as well as, areas to avoid in the development of the ground water resource. These model results, therefore, will provide a sound foundation to develop management policies regarding the Sand-and-Gravel Aquifer.

The model chosen for the ECUA study was developed by GeoTrans, Inc., and is a three-dimensional, finite-element model (SWICHA) that is designed to simulate variable density flow and solute transport within the saturated zone of the aquifer. The model has numerous capabilities that include: prediction of the extent of contaminant plumes and the rate of plume migration; design of monitoring plans; assessment of remedial schemes and designs; performance of risk analysis by assessing the ground water flow and potential for migration of contamination; simulation of transport of saltwater and upconing of saltwater toward pumping wells; resource evaluation by predicting responses to different well pumping schemes and operations and to variable recharge conditions; and analysis of ground water flow in the vicinity of pumped wells.

1.41 <u>Relationship between ECUA Model and Proposed Efforts at Corry Field</u>

The ECUA program relies greatly on geographical information system (GIS) techniques in managing the data compiled and collected for the program. The proposed study relating to Corry Field will incorporate data associated with the site into the GIS spatial and attribute coverages previously created for the ECUA study. Likewise, with the existing model framework already established, the simulations for Corry Field will be accomplished by using telescoping mesh refinement methods that will integrate the local (Corry Field) mesh to the existing ECUA calibrated regional flow mesh. The solute transport simulations developed as part of the proposed Corry Field program would be transferable for similar contamination problems throughout Escambia County. Thus, the proposed modeling effort would be a cooperative effort, in that information and techniques gathered under the proposed study are directly transferable to the ECUA modeling program encompassing the entire county. The integration of the two efforts will allow for future simulations regarding other ground water issues on Corry Field. Thus, minimal start-up efforts would be required to solve matters regarding pumping or contamination issues.

1.42 Previous Studies

The Northwest Florida Water Management District has conducted numerous hydrogeologic studies in Escambia County on an almost continuous basis since 1983. As part of the State of Florida's Water Quality Assurance Act of 1983, the District initiated a study to collect basic hydrogeologic data in southern Escambia County. As a part of this effort, 65 monitor wells were installed and water quality and water level data were collected on a routine basis. This program later evolved into a larger program referred to as the Ground Water Quality Monitoring Program (Ambient) which is starting its eighth phase of investigation. In Escambia County, results from the Ambient program have defined the hydrogeologic framework and basic hydrogeologic conditions of the Sand-and-Gravel Aquifer. Furthermore, the program has established a baseline of water quality data for the Sand-and-Gravel Aquifer. Other goals of the program are to detect and predict changes in ground water quality resulting from the effects of various land uses and potential sources of contamination. The monitoring network established in Escambia County, as a result of this program, consists of more than 90 wells distributed throughout the county. The Ambient program, for the first time in the state's history, has established a realistic, manageable ground water data collection network.

Water resources investigations within Escambia County first began in the early 1900s. Many of these early reports described water supply systems and emphasized the surface geology. These early reports were regional in scope, and details, pertaining to the county were often missing. Beginning in the early 1960s, more information became available on the subsurface geology and water-bearing potentials.

With the advent of increased environmental awareness and advances in technology, studies during the past 10 years have focused on site-specific problems and contamination issues. Table 1.42-1 summarizes the major hydrogeologic reports that have been completed within Escambia County. Each report provides information that enhances our understanding of the Sand-and-Gravel Aquifer underlying Escambia County.

Very few past investigations have incorporated ground water modeling techniques within the scope of work of the project. For example, no studies have developed transport modeling capabilities other than from a preliminary effort. The following is a summary of the significant previous modeling attempts in Escambia County.

Trapp (1978) developed a two-dimensional, finite-difference model of Escambia County that simulated pre-development, steady state, ground water flow conditions in the main producing zone of the Sand-and-Gravel Aquifer. This effort did not attempt to simulate transient conditions involving existing pumping conditions. The model concentrated on the southern portion of the county and provided some insight into some of the potential problems with simulating the aquifer. One of Trapp's recommendations was that with a fluctuating water table in the surficial zone, it may be necessary to apply a three-dimensional model.

Pratt and Barr's (1982) model study was conducted in the vicinity of Gulf Breeze in southern Santa Rosa County. Although this modeling effort was not in Escambia County specifically, it provides some additional insight due to the similar nature of the Sand-and-Gravel Aquifer in Santa Rosa County to that of Escambia County. A two-dimensional, finite-difference model was applied and used to study a number of pumping scenarios for the surficial zone

Table 1.42-1 Previous Investigations

	General
Sellards and Gunter (1912)	Describes the water resources of Escambia County. Also, discusses the water supply of west-central and west Florida. This report describes the physiography, drainage, water wells, and soils of the county. The report presented chemical analyses of water from several wells and contained a map showing areas of free flowing wells.
Matson and Sanford (1913)	Described the geology and ground water of the entire state. Briefly included a discussion on the physiography, geology, and water supply of the county. Data on typical wells and general information on water resources of selected towns were tabulated.
Escambia River (1934)	Initiation of streamflow records.
Jacob and Cooper (1940)	Conducted the first detailed ground water investigation for Escambia County. The report contains a section on geology by Sidney A. Stubbs. The study included pumping tests for the Sand-and-Gravel Aquifer. They also had chemical analyses made of water from several wells and studied the encroachment of saltwater from Bayou Chico into wells of the Newport Industries and the U.S. Navy.
Ground water levels (1940)	Continuous and periodic ground water levels measurements were started in 1940 for selected sites in the southern half of the county.
Perdido River (1941)	Initiation of streamflow records
Applin and Applin (1944)	Recorded the presence of beds of Oligocene and older age sediments beneath the western panhandle.
Cooke (1945)	Briefly described the Citronelle Formation in Escambia County. He also mentioned the occurrence of Pleistocene marine terraces a several places and noted how far the Pamlico sea extended up the major rivers and bays.
MacNeil (1950) and Carlston (1950)	Described the Pleistocene marine shore lines and terraces.
Puri and Vernon (1959)	In a summary of the geology of Florida, reviewed the formations of the panhandle.
Carlisle, V. W. (1960)	Published a comprehensive report on soils of Escambia County.
Barraclough and Marsh (1962)	Presented a study of aquifers and quality of ground water along the Gulf Coast of western Florida in Escambia, Santa Rosa, Okaloosa and Walton counties.

TABLE 1.42-1 PREVIOUS INVESTIGATIONS -- CONTINUED

MUSGROVE, BARRACLOUGH, AND GRANTHAM (1965)	INVESTIGATED THE WATER RESOURCES OF ESCAMBIA AND SANTA ROSA COUNTIES. THE INVESTIGATED WAS DESIGNED TO OBTAIN DATA OVER A FOUR YEAR PERIOD. IT DESCRIBES THE OCCURRENCE, QUALITY, AND QUANITY OF SURFACE AND GROUND WATER. IT CONTAINS A BRIEF DISCUSSION ON CLIMATE AND GEOLOGY OF THE AREA. INFORMATION WAS GIVEN ON STREAMFLOW CHARACTERISTICS, PRINCIPALS OF GROUND WATER OCCURRENCE AND MOVEMENT AND PROPERTIES OF THE AQUIFER AS WELL AS WATER QUALITY CHARACTERISTICS OF BOTH RESOURCES. IT DISCUSSES WATER USE, EXISTING PROBLEMS AND POTENTIAL WATER SUPPLIES OF COUNTY.
MARSH (1966)	DESCRIBED THE STRATIGRAPHY, STRUCTURE AND ECONOMIC GEOLOGY OF SANTA ROSA AND ESCAMBIA COUNTIES. THE LOWER EOCENE THROUGH PLEISTOCENE STRATA WERE DISCUSSED.
BARRACLOUGH (1967)	PUBLISHED A MAP WHICH ILLUSTRATES RAINFALL, GEOLOGIC CROSS SECTIONS, STRUCTURAL TOPS AND THICKNESSES OF VARIOUS SUBSURFACE FORMATIONS, MINERAL CONTENT OF GROUND WATER, AND GROUND WATER AVAILABILITY.
TRAPP (1972, 1973, 1975)	THE FIRST PHASE (1970-1973 CONCENTRATED ON WELL INVENTORY, WATER SAMPLING, TEST DRILLING, AND PRELIMINARY INTERPRETATION.
TRAPP (1978)	THE SECOND PHASE (1973-1976) CONCENTRATED ON CONSTRUCTION AND CALIBRATION OF A PRELIMINARY TWO-DIMENSIONAL MODEL FOR THE AQUIFER, TEST DRILLING, AND MONITORING EFFECTS OF SPRAY DISPOSAL OF TREATED SEWAGE.
TRAPP (1976-1979) AND COFFIN (1982)	THE THIRD PHASE (1976-79) INCLUDED ATTEMPTS TO REFINE THE TWO-DIMENSIONAL MODEL, CONTINUATION OF TEST DRILLING AND MONITORING ACTIVITIES, AND THE CONSTRUCTION OF A THREE DIMENSIONAL MODEL.
TRAPP (1979-1982) AND TRAPP AND GEIGER (1986)	THE FOURTH PHASE (1979-1982) INCLUDED CONTINUED MONITORING OF THE SPRAY DISPOSAL OF TREATED SEWAGE AND FURTHER TESTING OF THE THREE DIMENSIONAL MODEL.
COE (1979)	AS PART OF HIS MASTER'S THESIS WORK, REPORTED ON THE GEOLOGY OF THE PLIO-PLEISTOCENE SEDIMENTS IN ESCAMBIA AND SANTA ROSA COUNTIES.
PRATT AND BARR (1982)	INVESTIGATED THE AVAILABILITY AND QUALITY OF WATER FROM THE SAND-AND-GRAVEL AQUIFER IN SOUTHERN SANTA ROSA COUNTY. DATA INCLUDED IN THIS REPORT ARE WELL INVENTORY, WATER LEVELS, AND WATER QUALITY. THE STUDY INCLUDED A NUMBER OF PUMPING SCENARIOS AND DEMONSTRATED SOME OF THE CONSTRAINTS SUCH AS WELL INTERFERENCE AND SALTWATER INTRUSION THAT AFFECT AQUIFER DEVELOPMENT.
FRANKS (1982)	PRESENTED GENERALIZED MAPS DEPICTING THE EXTENT, BASE, AND THICKNESS OF THE SAND-AND-GRAVEL AQUIFER.

Table 1.42-1 Previous Investigations -- continued

Wagner, Allen, Clemens and Dalton (1984)	Constructed structural surface and isopach maps of all hydrogeologic units occurring within the Northwest Florida Water Management District. Additionally, hydrogeology was correlated to stratigraphy for the District. Units found within Escambia County were included in this mapping.
Wilkins, Wagner and Allen (1985)	Presented basic hydrogeologic data for the southern half of Escambia County. Data included well inventories, listings of major wells and monitor wells, known contamination sites, geophysical data, lithologic descriptions, aquifer property information, water level data, hydrographs showing seasonal and long-term changes for selected sites and defined the hydrogeologic framework.
Johnson (1989)	Presented revised water quality data originally reported in Clemens, Dalton and Fendick (1987). The data includes selective sites in Escambia County where analysis results were used to define background concentrations in ground water for the Sand-and-Gravel Aquifer.
Johnson (1990)	Reports seasonal water quality variations for ground water within northwest Florida. Included are data for the Sand-and-Gravel Aquifer for selected sites in Escambia County. The results are for the period July 1988 to May 1989.
Contamination Assessments	
Clark and Martin (1985)	Conducted a ground water investigation in response to contamination at the Dubose Oil Products facility.
Clark, Glasscock and Wiegand (1987)	Conducted a ground water investigation in downtown Pensacola in association with high concentrations of PCE found within many of the public water supply wells.
Clark, Glasscock and Wiegand (1987)	Conducted an investigation of the area surrounding a public supply well on Ninth Avenue and related PCE contamination.
Hicks, Martin and Stodghill (1988)	Conducted a ground water investigation in the vicinity of the Escambia Treating Company facility to assess contamination from the site.
Watts, Busen, Wilson and Colona (1988)	Conducted a ground water investigation in the vicinity of the Agrico Chemical Company facility to assess ground water contamination from the site.

TABLE 1.42-1 PREVIOUS INVESTIGATIONS -- CONTINUED

WIEGAND, ALLARD, MELKOTE AND RIOTTE (1990)	INVESTIGATED GROUND WATER CONTAMINATION IN THE WARRINGTON AREA IN ASSOCIATION WITH HIGH PCE CONCENTRATIONS FOUND IN THE GROUND WATER FROM A PEOPLES WATER SERVICE PUBLIC SUPPLY WELL.
KATZ AND CHOQUETTE (1991)	CHARACTERIZED THE GEOCHEMISTRY OF THE SAND-AND-GRAVEL AQUIFER IN ESCAMBIA, SANTA ROSA AND OKALOOSA COUNTIES. A DESCRIPTION OF BACKGROUND MAJOR-ION CHEMISTRY AND AN EVALUATION OF MAJOR GEOCHEMICAL PROCESSES THAT CONTROL THE OBSERVED CHEMISTRY OF THE WATER WAS PRESENTED.

INDUSTRIAL WASTE INJECTION INTO THE
THE LOWER LIMESTONE OF THE FLORIDAN AQUIFER

GOOLSBY (1971)	DISCUSSED THE GEOCHEMICAL AND HYDRAULIC EFFECTS OF ACIDIC INDUSTRIAL WASTES BEING INJECTED INTO THE LIMESTONE OF THE LOWER FLORIDAN AQUIFER.
FOSTER AND GOOLSBY (1972)	DISCUSSED DETAILS OF INJECTION WELL CONSTRUCTION AND SUBSURFACE GEOLOGY FOR MONITORING THE MONSANTO INJECTION FACILITY.
FAULKNER AND PASCALE (1975)	PRESENTED MONITORING RESULTS FROM THE INJECTION FACILITY AT MONSANTO AND THE REGIONAL EFFECTS OF HIGH PRESSURE INJECTION OF THE INDUSTRIAL WASTER WATER INTO THE LOWER LIMESTONE OF THE FLORIDAN AQUIFER.
PASCALE AND MARTIN (1977)	REPORTED DATA COLLECTED AT THE MONSANTO INJECTION FACILITY FOR THE PERIOD JUNE 1975 TO DECEMBER 1976.
EHRLICH, GODSY, PASCALE AND VECCHIOLI (1979)	DISCUSSED THE CHEMICAL CHANGES OF THE WASTE WATER BEING INJECTED AT THE MONSANTO FACILITY. RESULTS OF DOWNGRADIENT CHANGES WITHIN THE LOWER LIMESTONE OF THE FLORIDAN AQUIFER WERE EVALUATED.
HULL AND MARTIN (1982)	REPORTED THE DATA COLLECTED AT THE MONSANTO INJECTION FACILTY FOR THE PERIOD 1963 THROUGH 1980.
MERRITT (1984)	DEVELOPED A DIGITAL SIMULATION OF THE REGIONAL EFFECTS OF SUBSURFACE INJECTION OF LIQUID WASTE NEAR PENSACOLA.

AMERICAN CREOSOTE WORKS SITE

U.S. ENVIRONMENTAL PROTECTION AGENCY (1983)	HAZARDOUS WASTE SITE INVESTIGATION REPORT.
CAMP, DRESSER, AND MCKEE, INC. (1983)	REMEDIAL ACTION MASTER PLAN.
NUS CORPORATION (1984)	REMEDIAL INVESTIGATION REPORT.

Table 1.42-1 Previous Investigations -- continued

Troutman, Godsy, Goerlitz and Ehrlich (1984)	Reported the magnitude and extent of ground water contamination and discussed the processes affecting the transport of contaminants in the subsurface for the American Creosote Works site.
Mattraw and Franks (1984)	Reported on processes that affect the occurrence, transport, transformations, and fate of toxic contaminants associated with a site assessment study of the old American Creosote Works site.
Goerlitz, Troutman, Godsy and Franks (1985)	Discussed the migration of the contamination from the site within the subsurface.
NUS Corporation (1985)	Feasibility study of alternatives.
Pereira and Rostad (1986)	Conducted a geochemical investigation of the organic contaminants at the site.
Baedecker and Lindsay (1986)	Conducted an assessment on the unstable constituents of the contamination for the site.
Goerlitz, Godsy, Troutman and Franks (1986)	Presented the chemistry of the ground water at the site.
Ecology and Environment, Inc. (1986)	Provided an assessment of the remedial investigation and a draft feasibility study.
Franks, Goerlitz and Pruitt (1987)	Evaluated the reproducibility of organic contaminant concentrations within the ground water at the site.
Bodine (1987)	Discussed authigenic nontronitic smectite associated with the creosote waste plume.
Clark (1987)	In a master's thesis studied the sedimentological and depositional environments at the site.
Cozzarelli, Baedecker and Hopple (1987)	Evaluated the effects of creosote products on the geochemistry of unstable constituents found in the aquifer at the site.
Franks (1988)	Presented the hydrogeology at the site and assessed ground water flow from the site.

Regional Investigations

Bartel and Barksdale (1985)	Conducted a hydrogeologic assessment of solid waste landfills in northwest Florida. Escambia County was included in this assessment.
Bielby (1987)	Presented a compilation of water use for 1985. Data was presented for Escambia County.

TABLE 1.42-1 PREVIOUS INVESTIGATIONS -- CONTINUED

BLACK BROWN AND PEARCE (1953)	DISCUSSED SALTWATER INTRUSION IN FLORIDA. EXAMPLES INCLUDED THE SAND-AND-GRAVEL AQUIFER IN ESCAMBIA COUNTY.
BUSH (1982)	EVALUATED THE PREDEVELOPMENT FLOW FOR THE FLORIDAN AQUIFER FOR THE SOUTHEAST UNITED STATES. THE AREA OF ESCAMBIA COUNTY WAS CONTAINED WITHIN THE STUDY AREA.
CHEN (1965)	PRESENTED A REGIONAL LITHOSTRATIGRAPHIC ANALYSIS OF THE PALOCENE AND EOCENE ROCKS OF FLORIDA.
DYSART, PASCALE, TRAPP, ET AL (1977)	PRESENTED AN INVENTORY OF THE WATER RESOURCES OF NORTHWEST FLORIDA. ESTIMATES OF AVAILABILITY FROM THE SAND-AND-GRAVEL IN ESCAMBIA COUNTY WERE STATED.
JOHNSON (1986)	PRESENTED STRATIGRAPHIC CORE DATA WHICH INCLUDED CORES TAKEN FROM ESCAMBIA COUNTY.
KENNEDY (1982)	PRESENTED RAINFALL SUMMARIES FOR NORTHWEST FLORIDA. THIS DATA WAS COLLECTED BY THE NATIONAL OCEAN AND ATMOSPHERIC ADMINISTRATION AND INCLUDED THE SITE AT THE PENSACOLA AIRPORT.
KRANZER (1983)	EXAMINED CURRENT AND PAST WATER USE IN NORTHWEST FLORIDA INCLUDING WATER USE IN ESCAMBIA COUNTY.
ROSENAU AND MEADOWS (1986)	MAPPED THE POTENTIOMETRIC SURFACE FOR THE FLORIDAN AQUIFER IN NORTHWEST FLORIDA AS OF MAY 1985.
SCHMIDT (1978)	MAPPED THE SURFICIAL SEDIMENTS AS PART OF AN ENVIRONMENTAL GEOLOGY SERIES. THE PENSACOLA SHEET INCLUDED ALL OF ESCAMBIA COUNTY.
WAGNER (1989)	MAPPED THE POTENTIOMETRIC SURFACE OF THE FLORIDAN AQUIFER SYSTEM IN NORTHWEST FLORIDA AS OF MAY 1986.
WAGNER, HODECKER AND MURPHY (1980)	EVALUATED INDUSTRIAL WATER AVAILABILITY FOR SELECTED AREAS OF NORTHWEST FLORIDA. THE PENSACOLA AREA WAS ONE OF THE SELECTED SITES.
MILLER (1986)	PRESENTED THE REGIONAL HYDROGEOLOGIC FRAMEWORK OF THE FLORIDAN AQUIFER SYSTEM IN THE SOUTHEAST UNITED STATES. ESCAMBIA COUNTY WAS PART OF THE STUDY AREA.
BUSH AND JOHNSON (1988)	PRESENTED THE REGIONAL GROUND WATER HYDRAULICS, FLOW AND DEVELOPMENT FOR THE FLORIDAN AQUIFER SYSTEM IN THE SOUTHEAST UNITED STATES. ESCAMBIA COUNTY WAS PART OF THE STUDY AREA.
SPRINKLE (1989)	PRESENTED THE REGIONAL GEOCHEMISTRY FOR THE FLORIDAN AQUIFER SYSTEM IN THE SOUTHEAST UNITED STATES. ESCAMBIA COUNTY WAS PART OF THE STUDY AREA.

of the Sand-and-Gravel Aquifer and demonstrated some of the constraints on aquifer development, such as well interference and saltwater intrusion. Pump test analyses conducted and results of water quality analysis collected for this study indicated differences in the aquifer's capacity due to the presence or absence of confining clay layers.

Trapp and Geiger (1986) applied a two-layer, three-dimensional, finite-difference ground water flow model. This model is actually quasi-three dimensional in that the properties associated with the x and y coordinates may vary but the z coordinate remains constant. The aquitards are treated using analytical solution approximations. This study addressed ground water flow, and the mesh design chosen for the simulations was relatively coarse. This report concluded that in order to simulate flow in a manner that meets more versatile objectives, a finer model mesh would be required.

Franks (1988) conducted an assessment of the American Creosote Works contamination site. A three-dimensional, finite-difference model was used to simulate ground water flow in the vicinity of the site and to account for impacts of a drainage ditch on the localized area of the contamination. Franks concluded that applications of the results from the flow model in evaluation of solute transport would require further discretization of the contamination area including more sub-layers than what was needed for calibration of the flow model.

1.43 Ground Water Modeling Studies

The Northwest Florida Water Management District relies on the use of numerical modeling techniques for the many necessary management decisions related to water resources of Northwest Florida. Both surface water and ground water modeling is performed on a regular basis as part of investigations to assess the water resources of the District. To accomplish this, the Resource Management Division of the District employs numerous hydrogeologists and hydrologists with many years of numerical modeling experience. Selected ground water modeling efforts conducted by the Resource Management Division are outlined below. These efforts involve application of models to a wide variety of hydrogeologic problems and environments and include simulation of the Sand-and-Gravel Aquifer and evaluation of several contamination problems.

<u>Hydrogeology and Nonpoint Source Contamination of Ground Water by Ethylene Dibromide in Northwest Jackson County (Roaza, Pratt and Moore, 1989)</u>

This project entailed the calibration of a two-dimensional, finite-difference flow model to more fully understand the relationship between sample results and the hydrologic behavior of the Floridan Aquifer. The principal tasks associated with the model effort included model selection, definition of boundary conditions, steady state model calibration, sensitivity analysis and wet/dry season transient simulations. The area of model encompassed 1,224 square miles, and the model mesh consisted of 1,224 cells. The results of the model provided an understanding of the variability of parameters that control the hydrologic behavior and ultimate fate of the agrichemical EDB contamination.

<u>Design of Dewatering System (1989)</u>

This project entailed the application of a three-dimensional, finite-difference flow model in the design of a construction site dewatering system. The hydrogeologic aspects of the problem involved dewatering a portion of the surficial zone of the Sand-and-Gravel Aquifer at a barrier island construction site. The dewatering system was installed as designed and successfully dewatered the site for the duration of construction. Problem analysis included the performance and evaluation of an unconfined aquifer pump test.

<u>Tetrachloroethene (PCE) Contamination, Downtown Pensacola (Bartel, 1986)</u>

The District, in response to a request for technical assistance to the Escambia County Utilities Authority and the Florida Department of Environment Regulation (FDER), conducted a modeling effort to incorporate results from a 48-hour aquifer test conducted by the District. The two-dimensional, finite-difference ground water flow model results were used to estimate flow directions based on various pumping scenarios. Additionally, these results aided ECUA and FDER in assessing the source(s) and extent of PCE contamination in the vicinity of downtown Pensacola.

<u>The Movement of Contaminants from Landfills to Ground Water in Northwest Florida (Bartel and Benoit, 1988)</u>

This applied research program evaluated the impact of municipal solid waste landfills on the ground water. The study considered the influence of hydrogeologic and climatological conditions on the extent of contamination and evaluated various environmental security measures for the detection and containment of pollutants.

Data from landfills were used to test a two-dimensional, finite-element model simulation of contaminant transport. Model results predicted the dilution of leachate as it moves through a cross section of unsaturated soils and the potential impacts on the water table. The investigation was designed to permit calculation of the emission rate of contaminants to ground water and their distribution in the unsaturated zone. This approach provided a better quantification of the concentration and movement of contamination in the saturated zone.

<u>Availability and Quality of Water from the Sand-and-Gravel Aquifer in Southern Santa Rosa County (Pratt and Barr, 1982)</u>

On the basis of information from this investigation, the amount of good quality water that could be obtained from the aquifer was assessed. The variations in aquifer recharge and the complex boundary conditions imposed by the irregular shoreline required the use of a ground water flow model to determine the effects from aquifer pumping.

A modified form of a two-dimensional, finite-difference model was used to predict water changes resulting from ground water development. The 37-square mile study area consisted of a mesh composed of 860 cells. The results also provided data for flow directions and movement of saltwater that could be expected.

Water Resources of Southern Okaloosa and Walton Counties (Barr, Maristany, and Kwader, 1981)

Using a finite-difference numerical flow model, this study assessed the effectiveness of different ground water development scenarios. Simulating several pumping rates and well distribution patterns, the aquifer response was evaluated. The primary objective was to simulate the upper limestone of the Floridan Aquifer in southern Okaloosa and Walton counties. The simulation process allowed for the prediction of water level declines in the aquifer based on projected pumpage and well distribution. The predicted water level declines provided a means for evaluating the ability of the upper limestone of the aquifer to meet anticipated water needs within the study area.

The model utilized for the study had a grid with variable spacing and consisted of 3,780 cells. The cells ranged from about 2,000 feet x 2,000 feet near pumping centers to 12,500 feet x 12,500 feet near the model boundaries.

1.44 Data Collection Activities

Ground water data has been collected in Escambia County since the early 1940s. Most of the early information was collected at observation wells established by the U.S. Geological Survey (USGS) to monitor seasonal and long-term fluctuations as well as pumping influences. Data collection has been primarily water level observations at varying frequencies. However, miscellaneous water quality analyses, geologic, geophysical, hydraulic and water use data have also been compiled through the years. Systematic water level data collection at selected sites within the county has been on-going since 1940.

In 1990, the District assumed the water level monitoring data collection responsibilities formerly conducted by the USGS. Water level data currently is being collected continuously at two sites, monthly at two sites and quarterly at about 20 sites within the county. Additionally, beginning in 1985, a water quality network was established within the county by the District, in cooperation with the Florida Department of Environmental Regulation, to define background water quality, assess seasonal variability and to evaluate water quality impacts due to land use. Water quality data is collected in Escambia County at 2 sites monthly, 8 sites quarterly and at yearly intervals for 85 sites. Water quality analyses for these sites includes major ions, nutrients, trace metals, base-neutral extractable organics, acid extractable organics, volatile organics, herbicides, pesticides, total dissolved solids and total and dissolved organic carbon. Currently, the District maintains more than 150 monitor wells within the county for ground water data collection activities.

Data collection associated with District programs includes compilation of pumpage records for each major production well within the county where data is available; water level measurements at about 130 sites for which the results are used to construct water level maps for the various zones of the aquifer; an additional 30 wells located adjacent to the coastline from Perdido to Escambia bays are sampled for specific conductivity, temperature, pH, and chloride concentrations to monitor for saltwater intrusion.

Additionally, all ground water data pertinent to Escambia County (from U. S. Geological Survey, Florida Geological Survey and Florida Department of Environmental Regulation) has been compiled and incorporated into the District data bases. Also, information has been compiled from miscellaneous consultant reports, local public and industrial water supply systems and other local agencies.

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PROJECT SCOPE OF WORK

2.00 ASSESSMENT OF DIELDRIN CONTAMINATION AT CORRY FIELD

An accurate assessment of a subsurface contamination problem necessitates consideration of the important elements which outline the scope of the problem from a general mass balance approach. Specifically, the total amount of the contaminant in subsurface residence must be equivalent with contaminant loading (input) and intermediate losses through various degradative and adsorption processes. The crux of a contamination assessment lies in the identification of the contaminant source(s) and how it operates. Knowledge of the contaminant source(s) is necessary to understand how much contaminant is entering the ground water system, the modes of transport, and the longevity of the contamination. Secondly, the ability to delineate and gain insight into the contaminant concentrations and transport in the ground water is important to understand, among many issues, which areas are at risk as well as testing various remediation scenarios in the area of concern.

The current knowledge of the scope of the contamination at Corry Field is limited to the dieldrin concentrations observed within the immediate vicinity (Oak Ridge National Laboratory, 1989). However, the presence of dieldrin in the ground water at Corry Field is not unique relative to the surrounding region. Recent ground water quality results from the District sampling efforts in the City of Pensacola have shown detectable dieldrin and aldrin concentrations at a significant number of sites (see Section 1.33). In light of these results and the observations made at the Corry Field, a multiplicity of dieldrin sources in the region cannot be discounted.

The probability of multiple dieldrin sources in the region, even in a conceptual sense, complicates assessment of the contamination problem. For instance, the assessment must attempt to identify both recent and historical sources, whether the ground water impact is from nonpoint (collective point sources) and/or specific point sources, which sources are likely to contaminate ground water and which sources are responsible for the current ground water contamination.

In addition to source(s) identification, it is important to understand the physico-chemical interaction of dieldrin in the subsurface. Although the proposed investigation is not a thorough geochemical study, per se, the assessment will strongly rely on existing knowledge of dieldrin behavior to assist in the data collection and the interpretive work.

Dieldrin belongs to the cyclodiene group (diene-organochlorine insecticide) which was developed in the late 1940s and widely used thereafter (Ware, 1983). However, due to suspected health concerns, all uses of dieldrin were cancelled on a voluntary basis in 1987 (USEPA, 1990). The primary concern from an environmental standpoint is the long-term persistence of dieldrin, stability in soils, very low solubility, very low volatility, and high density (Ware, 1983; USEPA, 1980; Goring, 1967).

These characteristics allow dieldrin to be a prime ground water contaminant once it enters the ground water system. If applied as a concentrated liquid formulation (regular application and/or spills) at the surface, there is a possibility of an immiscible nonaqueous front of dieldrin moving through the soil and the aquifer profile. In essence, this conceptualization, which is a worst-case scenario, allows for the vertical transport of the source itself, whereby, the dissolved phase can contaminate the vertical extent of the aquifer as well as some lateral extent, according to the specific ground water flow path (Mackay et al., 1985). To compound the complexity of the problem, the extremely low solubility of dieldrin allows it to contaminate a large volume of water from a relatively small initial input. As an analogy, PCE (tetrachloroethylene), which has a higher solubility and a density similar to dieldrin, may contaminate as much as 10,000 times its own volume to its solubility limit (Mackay et al., 1985). Therefore, a small mass of dieldrin in the ground water system may represent a significant source of contamination, in light of the current allowable maximum contaminant level of 0.05 μg/L in the State of Florida.

In summary, the focus of the dieldrin assessment in the proposed investigation is to identify the source(s), understand how the source operates, and gain insight into dieldrin concentrations and transport in the ground water. The identification of possible source(s), spatially and historically, in the area of investigation will aid in evaluating the type of dieldrin input into the subsurface. For instance, the contamination may be from regular applications, spills at discard or disposal sites, slow leaks from storage areas, spills from mix/loading sites and/or combinations of these. Information on the type of dieldrin input, in conjunction with additional field data collection, may shed light as to how the source operates, e.g. immiscible nonaqueous phase movement, solute transport, continuous transport, pulse transport and/or combinations thereof. Finally, the delineation of dieldrin concentrations in the ground water complimented with hydrogeology/hydraulics information will provide the foundation for computer modeling applications in assessing risk analyses, remediation techniques and the longevity of this problem.

In order to address the above issues, this study is designed to be implemented in three major phases. There are specific objectives, methodologies and data interpretations in each phase of the study. This will allow the conclusions and finding from each phase to be used as a guide for subsequent efforts. An overview of each phase and the tasks involved are discussed in the following sections.

2.10 Scope of Work

2.11 Phase I - Reconnaissance and Problem Conceptualization

The primary purpose of Phase I is to survey existing information sources, including literature review, and integrate the information into an initial conceptualization of the study area and the dieldrin contamination problem. The problem conceptualization addresses the physical, hydraulic and the ambient chemical setting of the region, existing ground water contamination, pesticide use, pesticide physico-chemical interaction with the environment and important information gaps.

In order to facilitate this process, the study will incorporate information from on-going monitoring programs conducted by the Northwest Florida Water Management District, complemented with additional data as needed, from other sources outlined below in the tasks list. The District currently maintains and routinely samples three monitoring networks in Escambia County and the Pensacola area; two of which are to monitor ground water in the surficial zone, low permeability zone and the main producing zone.

The Pensacola Ambient monitoring network consists of 52 wells. The purpose of the network is to monitor background levels of water quality on a routine basis. The water quality analysis includes 37 parameters of the major ions, nutrients, trace metals and field parameters. The Pensacola VISA (Very Intensive Study Area) monitoring network consists of 43 wells. The VISA network, which is emplaced in the Pensacola area, routinely monitors specific parameters associated with certain landuse (i.e., light industry) in addition to the standard water quality parameters. The water quality analysis of the VISA network includes 228 parameters (carbamate pesticides, organophosphorus pesticides, triazine pesticides, carbamate and urea pesticides, organohalide pesticides, chlorinated herbicides, fumigants (pesticides), purgeable organics, extractable organics, major ions, nutrients, trace metals and field parameters). The Pensacola SWIM (Surface Water Improvement and Management) monitoring network has monitored streamflow and water quality of the two streams located north and south of Corry Field. The information from the existing monitoring programs will establish the foundation for establishing the water chemical facies, as well as the presence of dieldrin and other pollutants in the area of investigation.

In order to characterize the physical and the hydraulic setting of the study area, existing information from various data bases at the District will be utilized. The District is responsible for permitting the construction of water wells and major water usage. One requirement of the permitting process is the submission of a post-construction well completion record and intended water use. These records are kept on file and are the best available data regarding such information in the area of investigation. In addition, the District maintains a detailed geophysical log inventory which will be used as an initial characterization of the hydrogeology in and around the study area.

One of the most important tasks of Phase I is to compile and analyze all cyclodiene pesticide (dieldrin and aldrin) usage in the region. The information should include where the pesticide was stored, where it was mixed/loaded, where it was applied, how it was applied, how often it was applied, how much was stored/applied, and where it was discarded. It is the intent of the study to include the U.S. Navy's pesticide inventory, which is currently in progress, as the major source of the information.

To gain insight into the physico-chemical behavior of dieldrin in the subsurface, a detailed literature review will be conducted. The major emphasis in the review is to acquire knowledge on dieldrin contamination problems elsewhere in the country and the specific dieldrin chemical characteristics.

Generally, the reliability of using existing information, and especially chemical data, decreases when the information is generated by multiple collecting agencies and through multiple programs. The lack of data confidence is attributed to a number of factors which may include interagency differences in the sampling protocols, analytical methodologies, quality control, data reporting, and in the particular objectives of the monitoring efforts. Because of these and other factors, there are inherent biases within the collective data. Fundamentally, the data bias becomes problematic when composite interpretations are made without ascertaining the degree of data compatibility. Therefore, the collective information acquired throughout Phase I will be screened for accuracy and compatibility. The important information will be entered into a geographic information system (GIS) as spatial and attribute coverages.

The data interpretations in Phase I will focus on the spatial and temporal characteristics of the information collected. For instance, one application will evaluate the relationships of dieldrin and other pollutant observations, certain landuse/possible sources identified, major pumping centers, soil types and the hydrogeology. Such preliminary overlay analyses (spatial modeling) may shed light to certain correlations, if any, and allow for the refinement of the initial problem conceptualization. The primary tool for the relational data analyses conducted in Phase I is the GIS.

The primary function of a GIS is to describe and relate multiple topologies. Because, in essence, all data collected in the investigation has an associated spatial component, the GIS functions adequately as an analytical tool in addition to being a relational data base. Figure 2.11-1 demonstrates one application of a GIS. The uniqueness of the specific application, as presented in the schematic, lies in the GIS storage of every analyses made through spatial modeling for later reference when the need arises for cross examination of analyses and/or refinement of analyses.

In summary, the principle purpose of Phase I is to develop an initial conceptualization of the area of investigation and the ground water contamination due to dieldrin. The intent is to provide a template for data collection and refine the direction of data collection (Phase II) by identifying important characteristics of the contamination problem and critical data deficiencies. There are seven major tasks in Phase I. Phase I concludes with a preliminary report defining the objectives, results of data collection, data interpretations and conclusions.

<u>Phase I: Reconnaissance and Problem Conceptualization</u>

Task 1. Compile the existing, pertinent water quality and dieldrin chemistry and utilization data from the following sources: U. S. Navy, Northwest Florida Water Management District, Florida Department of Environmental Regulation, USEPA, U. S. Geological Survey, Florida Department of Health and Rehabilitative Services (FHRS), Florida Department of Agriculture and Consumer Services (FDACS), Escambia County, and published literature.

Task 2. Enter and convert important water quality data into geographic information system spatial/attribute coverages.

Task 3. Compile existing data on the following subjects: Corry Field and vicinity hydrogeology and aquifer hydraulics, ground water production data, well construction details, and pesticide use (including storage sites and history, mix/load sites, application sites and history, and discard sites).

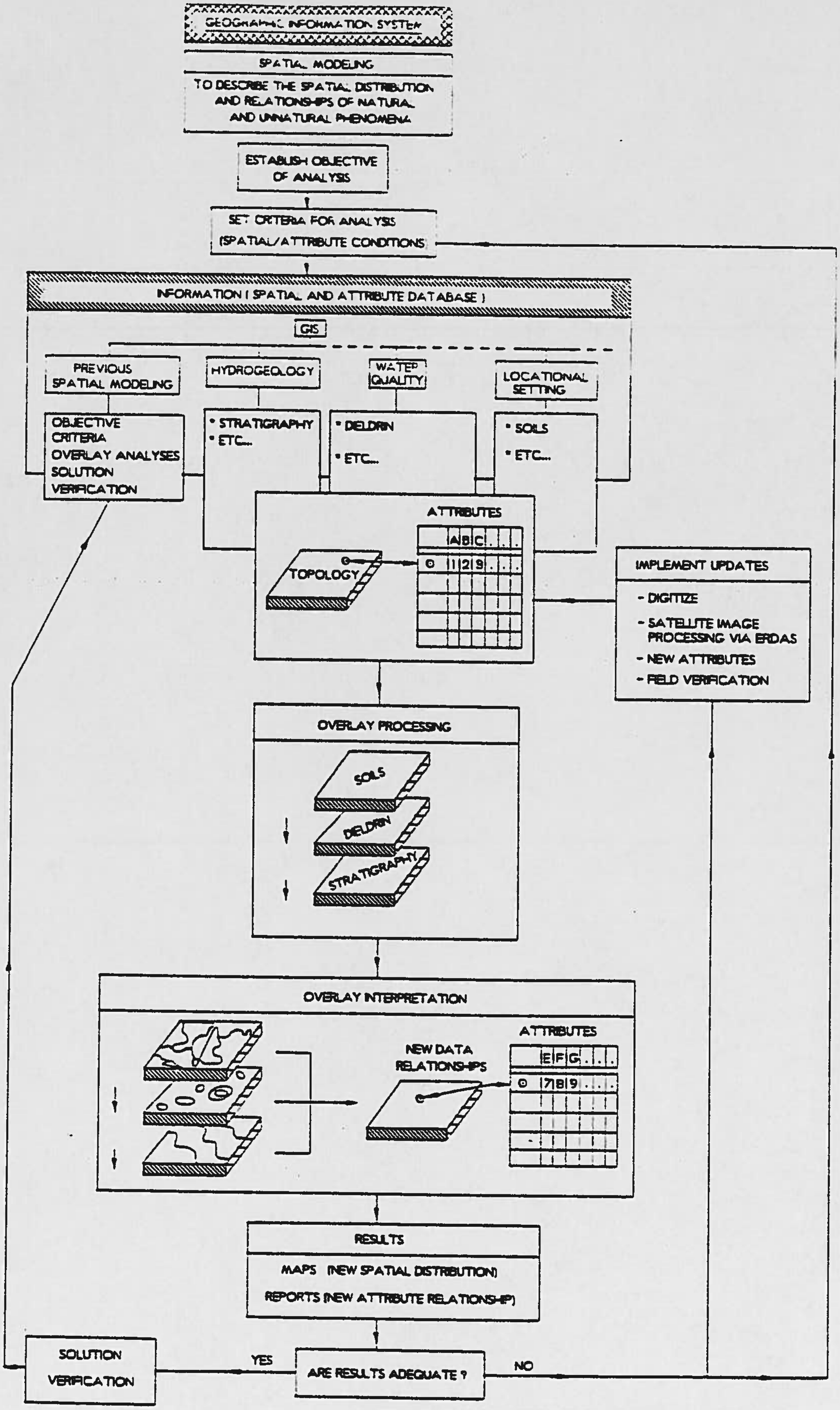

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Figure 2.11-1. GIS Spatial Modeling Logic Chart.

Task 4. Enter pertinent hydrogeologic, hydraulic, and pesticide data into GIS spatial/attribute coverages.

Task 5. Compile and review existing ground water quality data for contaminants other than cyclodiene pesticides in the vicinity of Corry Field. Review previous hydrogeologic and contamination investigations conducted in the vicinity of Corry Field. Review published literature on cyclodiene pesticides and their physico-chemical behavior in the subsurface.

Task 6. Perform preliminary GIS spatial modeling and statistical analyses based on data developed in previous tasks.

Task 7. Based on the available data, conceptualize the extent and history of ground water contamination and identify those areas to be subjected to the initial field data collection. Identify important data gaps and deficiencies. Prepare Phase I deliverable.

Phase I: Deliverable - Preliminary report on the conceptual extent and history of the contamination problem, summary of pertinent existing data and interpretations of that data, identification of probable contaminant source areas (if possible, based on existing data), data deficiencies, and prioritized list of sites for first phase of field data collection.

2.12 Phase II - Field Data Collection

The field data collection program is the key element in efforts to identify the extent of dieldrin contamination at Corry Field. Subsequent identification of the preferred restoration/remediation options depends on a meaningful field data collection program. Below, the District has outlined a field data collection program designed to meet the U.S. Navy's objectives regarding the assessment of dieldrin at Corry Field. This field program has five principal elements: Reconnaissance Level Investigation, Preliminary Drilling Program, Site Monitoring Plan Implementation, Aquifer Testing, and Well Abandonment. Together, these elements are designed to identify and characterize the extent of dieldrin contamination and the hydraulic properties of the Sand-and-Gravel Aquifer on Corry Field. The boring, drilling, and sampling will be conducted to screen potential sites for contamination and to characterize, in detail, those sites shown to have contamination. It should be recognized that, as the program develops and information is obtained on the extent of dieldrin contamination, it will be necessary to modify the project approach outlined below. In designing and scheduling this program, consideration was given to the need to have a structured project approach, while at the same time maintaining the flexibility to respond to conditions as they arise in the field.

(1) Reconnaissance Level Investigation. The first element of the field data collection program has two components. One component is a reconnaissance investigation of the surficial soils on Corry Field. This will entail sampling and analysis of the surficial soil profile at a number of pre-determined sites. These sites will be identified in the course of the analysis of existing data and will include sites expected to have dieldrin in the soil profile, possibly as a result of application and/or storage. This sampling program will be aimed at locating sites where dieldrin presently exists in the soil profile. One obvious location for this type of examination is the vicinity of Corry Well MW08, which has had the highest observed dieldrin concentrations.

This component will be conducted in at least two stages. Following a first round of soil sample collection and analysis, a second round will be undertaken. The purpose of the second round is to further confirm first-round detections, or (in the event of no first-round detections) continue the process of examining the surficial soils for "hot spots." No surficial soil analyses are planned for sites off Corry Field, due to an anticipated problem obtaining easements for such work.

The second component of the first element is the installation and sampling of a limited number of surficial zone and main producing zone wells. This component is aimed at examining the apparent dieldrin concentration gradient in the vicinity of MW08. Work associated with this component would include installation and sampling of two to three surficial zone and main producing zone wells. These wells would be constructed both on and off Corry Field. Concentration data from these wells would be used to answer questions regarding the apparent dieldrin concentration gradient around MW08. For instance, is the dieldrin concentration gradient in the main producing zone to the north and northeast of Corry Field increasing or decreasing? Answers to this and similar questions would guide the design of the remaining elements of the field data collection program.

(2) Preliminary Drilling Program. If the Reconnaissance Level Investigation reveals one or more sites with significant dieldrin in the soil profile, a preliminary drilling and sampling program will be undertaken. The objective of this element will be to assess the extent of contamination in the unsaturated and surficial zones beneath and around sites with demonstrated dieldrin in the soil profile. This element will include soil borings, monitor well installation, and analysis of soil and water samples. The limit of investigation in the vertical direction will be the base of the surficial zone (estimated to be 60 feet below land surface).

(3) Site Monitoring Plan Implementation. Based on the results of the previous two program elements, a site monitoring plan for the Corry Field site will be developed and implemented. This will include construction and monitoring of head and water quality wells in the surficial zone, the low permeability zone, and the main producing zone. This element is designed to fully characterize the extent of deildrin contamination of the Sand-and-Gravel Aquifer in and around Corry Field, to assist in the implementation of the ground water flow and transport model, and ultimately, to facilitate the development of a remediation program for the Corry Well Field.

(4) Aquifer Testing. An aquifer testing program is also planned for the Corry Field dieldrin investigation. To implement this testing program, an aquifer test array will be required. The hydraulic properties of the Corry Field area should be adequately defined, for the purposes of this investigation, by conducting two multi-well aquifer tests. These would be conducted in both the surficial zone and the main producing zone. Completion of the main producing zone aquifer test array would entail construction of a minimum of three clusters of observation wells. It is assumed that an

existing Corry Field main producing zone production well can be incorporated into the test design to serve as the main producing zone aquifer test production well. Cluster observation wells would be completed in the surficial zone, the low permeability zone, and the main producing zone (three to six wells per cluster). The surficial zone aquifer test array would include a ten-inch diameter production well, three to six fully penetrating observation wells, and up to six piezometers.

(5) Well Abandonment. Subsequent to the completion of these investigations, a number of these wells will be properly abandoned. The wells actually selected for abandonment will depend on the future monitoring needs of the Navy.

Field Data Collection Methodologies

The Northwest Florida Water Management District's data collection methodologies and anticipated data collection requirements in the areas of soil borings, well installation, and ground water quality sampling are outlined below. Specific quality assurance procedures will be described in the Corry Field Dieldrin Investigation Quality Assurance Project Plan (QAPP). QA/QC samples are anticipated to comprise approximately fifteen percent of the total samples for soil sampling and split-spoon analysis, and approximately twenty percent of the total samples for water quality analysis. No field data collection (other than a preliminary reconnaissance of the existing wells at Corry Field) will commence until QAPP approval is received from the Navy. All field data collection activities will be supervised by qualified individuals. Detailed notes will be maintained during all field data collection activities.

Field Data Collection Methodologies - Soils and Wells

Soil Sampling: Surface soils will be sampled utilizing trowels, soil sampling probes and hand augers. Stainless steel implements will be used and decontaminated as required to insure sample integrity. It is anticipated that approximately 20 to 30 surface soil samples will be required to characterize the surficial soils and locate any "hot spots" that exist on Corry Field. For screening purposes, composite samples may be collected at selected locations.

For soil sample collection from deeper depths, soils will be sampled utilizing the hollow-stem auger drilling method and 2-inch diameter by 24-inch long split barrel sampler. Standard field methodologies will be used for sample collection. Borings greater than 20 feet, or those that penetrate a confining unit, will be plugged with cement grout. Subsurface soil borings will consist of continuously cored profiles to a maximum depth of 50 feet. This depth corresponds, approximately, to the base of the surficial zone. Individual soil samples will be selected out of the entire boring profile for chemical and physical analysis. It is anticipated that between 15 and 30 soil borings will be required to characterize the extent of dieldrin in the soils of the surficial zone. Vertical soil sampling intervals of five to ten feet are anticipated for chemical analysis, yielding a total of approximately 120 to 190 soil samples to be analyzed. All soil sampling work will be field supervised by a qualified geologist. Organic vapor analysis of the samples will be performed in the field as deemed necessary.

Cuttings generated by the boring operations will be treated as non-hazardous waste and left on site. Decontamination of the drilling rig will follow protocols outlined in the approved QAPP and will consist of steam cleaning with approved detergent and pressure rinsing with tap water from an approved source. In addition, all downhole equipment will be field rinsed with deionized water, followed by an isopropyl alcohol rinse and allowed to air dry.

Well Installation: Construction of water quality monitoring wells, water level observation wells and a production well will be required. Wells will be installed using both hollow-stem auger and hydraulic rotary methods. A qualified geologist will supervise all drilling operations, collect samples, and maintain a detailed field lithology log. Organic vapor analysis will be conducted in the field as deemed necessary. Water, which is sufficiently free from organic contamination, will be used for hydraulic rotary drilling operations and will be obtained from the Corry Field well field or distribution system. At the end of the investigation, all wells not needed for long-term monitoring will be plugged according to the requirements of Chapter 40A-3, Florida Administrative Code, Regulation of Wells.

Water Quality Monitoring Wells: Drilling of 25 to 36 water quality monitor wells is anticipated. In general, all water quality monitor well construction will follow the Southern Division Naval Facilities Engineering Command Guidelines for Groundwater Monitoring Well Installation. Monitoring wells will be completed in each of the three zones present (surficial, low permeability, and main producing zones). Wells less than 65 feet will utilize the hollow-stem auger construction method, while wells greater than 65 feet will be installed utilizing the hydraulic rotary method. Surface casing will be used when drilling and constructing monitor wells through contaminated zones. When required, surface casing will be fully grouted and consist of eight-inch schedule 40 PVC casing.

All water quality monitor wells will be four inches in diameter and constructed of PVC materials. Screened intervals of 20 feet are anticipated for most of these wells. Wells will be filter packed, fully grouted and developed. Given the specialized sampling requirements of this project, care will be taken to fully develop hydraulic rotary wells immediately after construction. Well heads will be completed as outlined in the guidelines for monitor well construction. Cuttings generated by the drilling operations will be treated as non-hazardous waste and left on-site. Decontamination of the drilling rig will follow protocols outlined in the approved QAPP and will consist of steam cleaning with approved detergent and pressure rinsing with tap water from an approved source. In addition, all downhole equipment will be decontaminated according to the approved QAPP and will be rinsed with deionized water, followed by an isopropyl alcohol rinse and allowed to air dry.

Water Level Observation Wells: It is anticipated that approximately 17 to 25 temporary, water level observation wells and piezometers will be required for aquifer testing. Installation will be similar to water quality monitor well construction. Observation wells greater than 30 feet will be constructed of 4-inch PVC materials. Shallower observation wells will be constructed of 2-inch PVC materials. Screened intervals will be specified in order to obtain the hydraulic characteristics of the Sand-and-Gravel Aquifer. Well head completion of water level observation wells will accommodate subsequent data collection and be appropriate for the temporary nature of the these wells. Where these observation wells are installed away from areas of contamination, no decontamination of the drilling equipment is scheduled between installation of these wells.

One ten-inch PVC production well will be constructed for the surficial zone aquifer test. Total depth of this well will be approximately 60 feet. The production well will be constructed with solvent-bonded PVC materials, including wrapped screen and bell-end casing. The production well will be installed by the hydraulic rotary method.

Geophysical Logging: Geophysical logs will be run at each site where wells are constructed, however, where nests of wells are located, only the deepest well will be geophysically logged. The minimum logging program will consist of a natural gamma ray log. Where drilling methods allow, a formation resistivity log will also be recorded. Decontamination of downhole instruments will consist of detergent wash, approved tap water rinse and final rinse with deionized water.

Split Barrel Sampling: All soil samples collected while boring and drilling will be collected by the split barrel method utilizing a 2-inch by 24-inch long split barrel sampler. Standard methods for penetration test and split barrel sampling will be followed. Continuous split barrel sampling will be employed while boring for subsurface soil samples. In addition to the previously described soil borings, approximately 20 split barrel samples will be collected in the course of water quality monitoring well construction.

Soil Physical Parameters: Selected split barrel core samples will be analyzed for physical parameters including grain size, laboratory hydraulic conductivity, moisture content, dry density, and atterberg limits. A qualified lab will be selected for this portion of the analysis. It is anticipated that approximately 30 samples will be analyzed for physical parameters.

Well Survey: The elevation of each well constructed will be surveyed to within an accuracy of 0.01 foot relative to the NGVD data. Both top of casing and ground level will be surveyed and recorded. Elevation surveys will be conducted by qualified individuals. Areal locations of wells will be plotted by the supervising geologist on USGS 1:24,000 maps and facility site maps. Well heads and soil boring sites will be labeled in the field in such a manner as to allow accurate identification.

Water Levels: Routine water level measurements will be made to determine gradients, establish flow directions and calibrate flow and transport models. All water levels will be measured to an accuracy of 0.01 foot using a steel tape. Date, time, held and wet measurements, measuring point utilized, and the individual making the measurement will be recorded. A minimum of two consistent measurements will be made and recorded each time a water level measurement is recorded.

Aquifer Testing: It is anticipated that two aquifer tests will be required to adequately characterize the hydraulic properties of the Sand-and-Gravel Aquifer at Corry Field. The proposed aquifer test arrays for both tests will be submitted to the District's independent quality assurance consultant for review, prior to well construction.

One test will involve pumping the main producing zone in order to determine hydraulic characteristics of the main producing zone and the overlying low permeability zone. For this test, it is planned that one of the Corry Field supply wells will be utilized as a production well. Three nests of observation wells, each containing three to six wells, will be constructed for the purpose of measuring water levels during this test. During the test duration, water levels will be measured within an accuracy of 0.01 feet. Continuous recording water level recorders will be utilized as necessary during the aquifer testing program.

An aquifer test of the surficial zone will also be performed. One ten-inch diameter production well will be constructed to a total depth of approximately 60 feet (corresponding to the base of the surficial zone). A total of 8 observation wells and piezometers will be installed in the vicinity of the production well. The four observation wells will be four inches in diameter and approximately 50 feet in depth. Four additional 2-inch diameter piezometers will be installed to a depth of 20 feet. The anticipated pumping rate is 500 gallons per minute. It is expected that some of the water level observation wells may be utilized for both the main producing zone and surficial zone aquifer tests, reducing the total number required.

Field Data Collection Methods - Ground Water Sample Collection

Qualified personnel will be on-site during all ground water sampling activities. The subcontractor conducting the water quality sampling will be subject to QA/QC audits by the District. Complete QA/QC is required during all sampling activities. Approved procedures and equipment will be fully described in the QAPP. Field notes will be collected at each sample location and will include location name, sample identification number, date and time of sample collection, initials of sample team members, identification of sampled well, water level prior to sampling, calculated purge volume, purge rate, and start and stop time of purging pump.

Field parameters will be recorded at frequent intervals during well purging. Appropriate notes will be recorded to document appearance and odor characteristics of the discharge water during purging. Field parameters to be recorded during purging include pH, conductivity and temperature. Copies of the field books will be provided to the District by the subcontractor. Sample collection may begin when the appropriate volume has been purged and when the physical parameters have stabilized to within specified limits. Purge water will be treated as non-hazardous material and disposed of on-site.

All organic samples will be collected with a laboratory-cleaned teflon bailer. Trip blanks, duplicates, equipment blanks, and field blanks will be collected according to guidelines in the QAPP. Inorganic sample fractions may be collected with a peristaltic pump or with an alternate QAPP-approved system. Samples requiring filtration will be filtered through a 0.45-micron filter. Samples will be preserved before shipment to the laboratory. Chain-of-custody will be observed at each step of sample transfer. Decontamination of equipment will follow EPA or QAPP standards, whichever is more stringent.

Soil and Ground Water Sample Parameters

The final parameter list for this project will be developed in conjunction with the U.S. Navy. However, for the purposes of this proposal, a preliminary list of chemical parameters is given below. This list was developed on the basis of previous sampling results at Corry Field and in Escambia County. Soil and ground water samples will be analyzed for up to three different suites of parameters, based on the project data needs during different phases of the project. It is anticipated that the different suites will be subsets of a "comprehensive parameter list". The comprehensive list may include the following constituents:

- Organohalide pesticides
- Carbamate pesticides
- Carbamate and Urea pesticides
- Chlorinated herbicides
- Extractables
- Nutrients
- Total dissolved solids
- Dissolved organic carbon
- Organophosphorus pesticides
- Triazine pesticides
- Specialized fumigants analysis
- Purgeables
- Major ions
- Trace metals
- Total organic carbon

A preliminary "screening list" will be used to screen for the presence of contaminants and would include a subset of the comprehensive parameter list (most probably organohalide pesticides, purgeables, and extractables). This screening list may be modified during the course of the project as data warrants.

Phase II: Field Data Collection

Task 1. Complete design and implement a reconnaissance level surface soils sampling and analysis program. It is anticipated that this task will be conducted in at least two field phases and will entail the collection and analysis of from 20 to 30 surficial soil samples.

Task 2. Conduct a limited drilling program in the northeast corner of Corry Field to assess the extent of dieldrin in the surficial zone and main producing zone.

Task 3. Based on the results of the first two tasks, complete design and implement a preliminary soils and ground water sampling program. This task includes the collection of soil borings and the installation of a number of surficial zone water quality monitoring wells.

Task 4. Based on the results of the first three tasks, complete design and implement a ground water monitoring plan for Corry Field. Conduct a program of water quality sample collection and analysis on monitoring wells.

Task 5. Design, install, and perform two multi-well aquifer tests on Corry Field. Analyze the results from these two tests.

Task 6. Update GIS data base using field-collected data and laboratory analyses. Perform GIS modeling/statistical data analyses and interpretations.

Task 7. Complete preliminary interpretation of field data and prepare Phase II deliverable.

__Phase II: Deliverable__ - Basic data report describing the sample collection network and field program, as well as the sample analytical data and preliminary interpretation of data results.

2.13 Phase III - Data Analysis and Application of Ground Water Flow and Contaminant Transport Model

In Phase III, the principal objectives are to integrate the detailed field information collected in the previous phase, perform thorough data analysis, refine the problem conceptualization, and apply ground water modeling techniques. The analytical emphasis is devoted to establishing the source(s) of the contamination, understanding the movement of the contaminant, the extent within the hydrogeologic framework and a conceptual understanding of the fate of the dieldrin problem under current conditions. In addition, a detailed understanding of the hydrogeologic framework will be established. The primary tool for the data analysis is the GIS through cross examination of previous spatial modeling attempts with new information, and refinement of previous modeling attempts. Statistical analysis will also complement the data interpretive tasks.

From the results of the data analyses, a ground water flow and transport problem domain will be formulated for ground water modeling applications (conceptual model). The conceptual model defines the mathematical specifications of the region to be simulated numerically. The specifications include boundary conditions, hydraulic properties, physical dimensions, pumpage, ground water recharge, contaminant source and the current extent of the contaminant within the simulated domain. In developing the conceptual model, key hydraulic and transport processes will be identified. The numerical model must incorporate the appropriate governing equations of the key processes in order to perform an accurate simulation. For instance, the current design is to use the SWICHA numerical code developed by GeoTrans, Inc. A synopsis of the SWICHA capabilities is discussed in Section 1.40 under Current and Previous Studies. However, in the event the dieldrin source is in the soils, a secondary model may be incorporated to gain insight in the dieldrin movement through the unsaturated zone until it impacts the saturated zone. There are numerous so called "root zone" models available for such an analysis. The selection of such models is contingent upon the results of the field collected data and the conceptual model.

The numerical modeling involves the generation of a mesh (grid) which delineates the problem domain, retrieval of the appropriate hydraulics data, simulations for a specific problem and calibration of the simulated results to observed conditions. The general logic of the modeling system is shown schematically in Figure 2.13-1. Because the finite-element grid generation is a complicated and a tedious task, the grid will be generated through a computer-assisted grid generator developed by the District. One advantage in developing the mesh through computer-assisted automation is in the flexibility

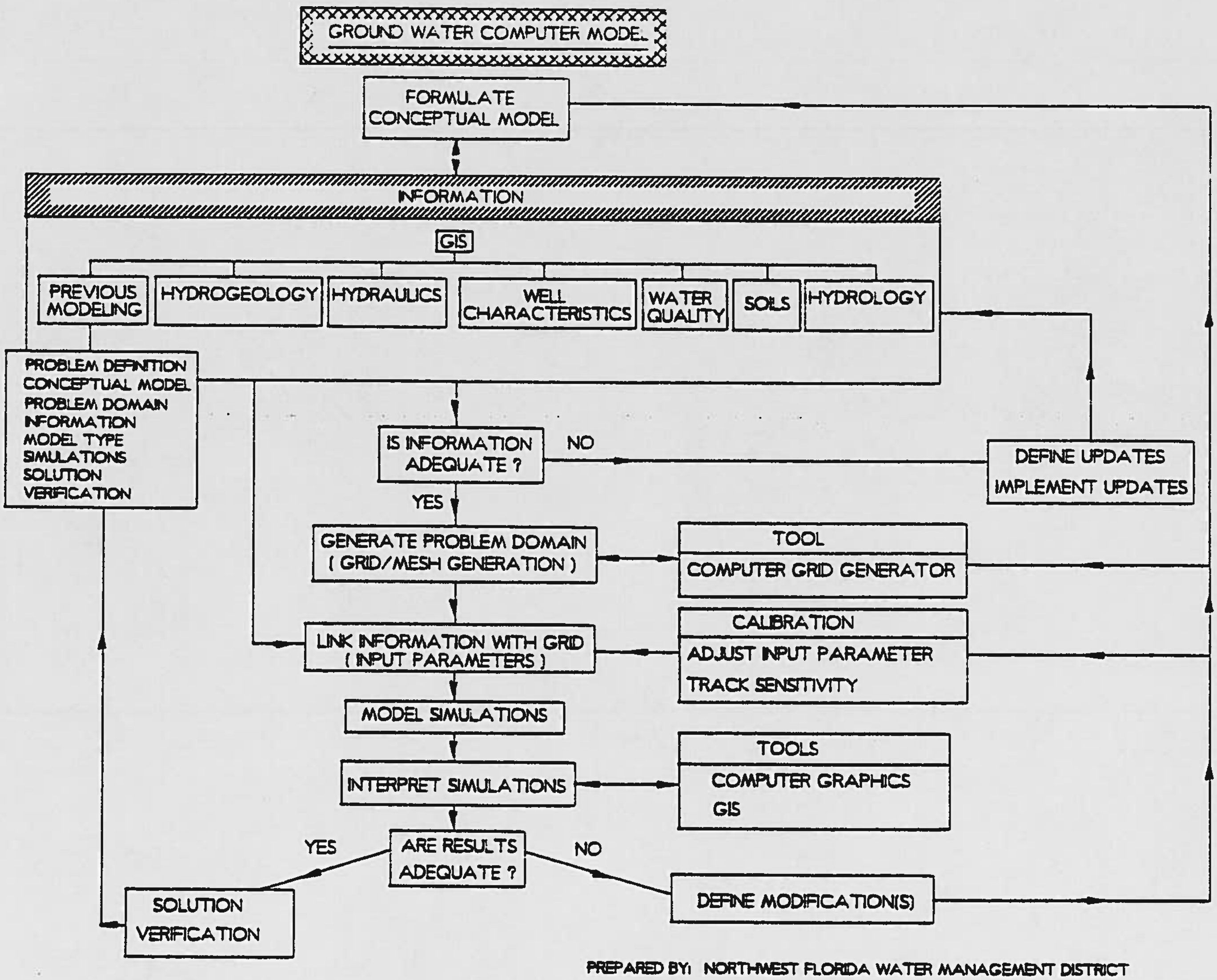

Figure 2.13-1. Ground Water Modeling Logic Chart.

of designing the grid according to the specific boundary conditions. In addition, the grid can be modified, if the need arises, in a relatively rapid manner. After the final grid development, the pertinent information retrieval for the simulation will be performed through the GIS, as well as the interpretation of the simulated results.

One advantage in any contamination assessment similar to the dieldrin problem is the need for localized data collection and, therefore, the generation of large amounts of data within the area of concern (i.e. "hot spots"). Such data collection are adequate in conceptualizing the scope of the problem in a "real world sense". However, the inevitable disadvantage of localized data collection is the lack of detailed ground water flow information in the surrounding region, which may influence contaminant transport in the specific area of concern.

This disadvantage becomes evident in numerical modeling attempts of the local region (area of concern). The problem lies in the inadequate information in formulating the boundary conditions of the local mesh. Therefore, a common rule of thumb is to extend the problem domain outward towards existing natural boundary conditions (i.e. rivers, ground water divides, etc.). In extending outward towards natural hydrologic boundaries, the calibration process becomes more accurate since the efficacy of the simulation can be compared to field measurements such as streamflow discharge. In addition, major stresses applied to the aquifer (i.e. pumpage) outside the local area are incorporated. The inherent disadvantage to the method is the inevitable enlargement of the modeling grid. Because iterative solutions must be calculated at each node of the grid, a large grid presents an inefficiency in terms of long simulation time and extensive use of computer resources. This inefficiency is most apparent during the calibration process, when repetitive simulations are made by finely adjusting the input parameters.

To rectify the problem, a telescopic mesh refinement technique (TMR) will be used in the model grid development. The TMR method was developed by GeoTrans, Inc. and verified through field studies (Ward et al., 1987; Anderson et al., 1986). Briefly, the TMR method allows for an efficient and detailed ground water/transport modeling in a localized area by incorporating the calibrated results from an existing regional flow model to initialize the boundary conditions of the local grid. By formulating the boundary conditions of the local grid through the TMR technique, the influential external stresses (outside the local area) are taken into account in addition to ensuring confidence of the controlling factors influencing the hydraulics of the local area. The primary benefit lies in the efficient manner in which the model is applied since each simulation is performed within the local grid. In the proposed investigation, information from the regional model currently being developed for the Escambia County Utilities Authority by the District will be integrated into the local grid (at Corry Field).

The primary purpose of the modeling efforts in the study is to calibrate ground water flow and simulate contaminant solute transport in three dimensions. However, prior to the full allocation of resources towards a fully three-dimensional modeling effort a preliminary analysis will be performed on the simulated sensitivity to input parameters from a two-dimensional model. The boundary conditions of the local grid developed through the TMR technique will also be tested.

Upon completion of the calibration processes, specific modeling applications will be performed through scenario modeling. The principal emphasis will be in gaining insight into the contamination problem for risk assessments and to evaluate the efficiency of certain remediation techniques. For instance, model applications may include the testing of remediation techniques via varying pumpage from existing wells and/or from an optimized purging well(s), identifying the feasibility of alternate well sitings for future ground water development (if any), identifying contaminant movement (direction/velocity), approximating the range of expected concentrations and the longevity of the contamination problem (predictive modeling) under current hydraulic conditions and through natural attenuative processes (i.e. decay, adsorption, dilution, etc.).

In summary, the efforts of Phase III incorporate the final data interpretations into a working conceptualization of the contamination problem. From this conceptualization, the provisions for the numerical modeling effort are established. The numerical model provides the means to analyze the dynamic interaction of the dieldrin contaminant to both natural and man-induced ground water flow. Specific concepts can be tested through scenario modeling applications and a relative insight to the persistence of the problem may be construed through predictive modeling efforts. There are 12 principle tasks in Phase III. The principal deliverable at the conclusion of Phase III is the final report of the investigation. The final report documents all the tasks performed in each of the three phases of the investigation. The documentation includes the problem conceptualization, objectives, data collection/results, data interpretations, methodologies used, conclusions and recommendations.

Phase III: <u>Data Analyses and Application of Ground Water Flow and Contaminant Transport Model</u>

Task 1. Prepare an appropriate conceptual model of the Sand-and-Gravel Aquifer to serve as the initial point of model development.

Task 2. Corry Field local scale flow model setup, including integration of study area mesh with existing calibrated regional flow model.

Task 3. Calibrate the local scale model with information collected at Corry Field. Perform appropriate sensitivity analyses of the Corry Field model.

Task 4. Perform steady state and transient flow simulations with the calibrated model.

Task 5. Complete setup of the Corry Field contaminant transport model. Calibrate model, perform sensitivity analysis and transport simulations.

Task 6. Complete interpretative analysis of flow and transport simulations.

Task 7. Prepare Phase III deliverable.

Phase III: Deliverable Final report. The final report will document all the tasks performed in each of the three phases of the investigation. The data interpretations, methodology, results, conclusions and recommendations will be presented accordingly.

2.14 References Cited

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2.20 Project Budget

The project budget is based upon an initial estimate of the level of field data collection, data analysis, and staff effort required to develop and apply the ground water flow and contaminant transport model. The preliminary design of the field data collection program is scheduled for completion at the conclusion of the Reconnaissance and Problem Conceptualization Phase (Phase I). Since a substantial percentage of the total program costs will be devoted to the data collection activities, it was deemed advisable to estimate the costs based on a reasonable, assumed range of the number of soil borings, monitor wells and sample analyses necessary to provide the level of information required to successfully complete the project. Likewise, the costs associated with data analyses and development of the model are, in part, a function of the level of data collection that is ultimately required, and have been estimated based on the range of effort required for data collection. Consequently, the total project budget represents the likely range of costs based on the assumptions regarding the data collection program. Based on further discussion with Navy staff, the budget can be modified to reduce or increase the data collection and other associated costs. For reference, the number of soil borings, monitor wells, and sample analyses utilized in preparing the budget are listed under the appropriate headings in Section 2.10.

The budget is presented below for each of the major project expenditure cost centers. These include: field data collection, District personnel costs for each phase of the project, capital outlay for field and data processing equipment, travel, and costs associated with the ground water flow and contaminant transport model quality control. As noted above, the estimated project expenditures are subject to modification based on discussions with U. S. Navy staff and the final field data collection program.

Expenditure Category/ Cost Center	Estimated Budget Range Low	High
I. <u>Field Data Collection</u>		
A. Surface Soils Sampling and Analysis		
1. Drilling	$ 19,000	$ 39,000
2. Sample Collection	$ 14,300	$ 27,600
3. Laboratory Analysis	$128,700	$202,000
B. Well Installation, Sampling and Testing		
1. Drilling	$159,000	$245,000
2. Geophysical Logging	$ 7,000	$ 14,000
3. Surveying	$ 2,800	$ 4,000
4. Soil Analyses (Physical Testing)	$ 6,000	$ 7,000
5. Coring (Split Barrel)	$ 1,100	$ 1,400
6. Sample Collection and Drilling Supervision	$ 38,800	$ 56,400
7. Pump Rental (Aquifer Tests)	$ 9,000	$ 12,000
8. Well Abandonment	$ 11,800	$ 17,000
C. Water Quality Sampling and Analysis		
1. Sample Collection and Preservation	$ 24,100	$ 35,100
2. Laboratory Analysis	$117,000	$168,000
II. <u>District Personnel Charges and Staff Travel</u>		
A. Phase I - Reconnaissance and Problem Conceptualization	$ 75,000	$113,000
B. Phase II - Field Data Collection	$138,000	$199,000
C. Phase III - Data Analysis and Application of Ground Water Flow and Contaminant Transport Model	$194,000	$227,000
D. Staff Travel (Includes Travel to Project Site and Quarterly Meetings in Charleston, South Carolina)	$ 17,000	$ 21,000

Expenditure Category/ Cost Center	Estimated Budget Range Low	High
III. Capitol Outlay		
A. Field Equipment (Water Level Recorders)	$ 24,000	$ 27,000
B. Data Processing Hardware and Software	$ 80,000	$ 82,500
IV. GeoTrans, Inc., - Ground Water Flow and Contaminant Transport Model Quality Control	$ 35,000	$ 55,000
PROJECT TOTAL	$1,101,600	$1,553,000

Project Year One		
A. Direct Charges	$ 574,320	$ 873,350
B. Indirect Charges	$ 44,280	$ 65,350
Subtotal	$ 618,600	$ 938,700
Project Year Two		
A. Direct Charges	$ 359,720	$ 460,340
B. Indirect Charges	$ 62,980	$ 79,460
Subtotal	$ 422,700	$ 539,800
Project Year Three		
A. Direct Charges	$ 42,400	$ 53,560
B. Indirect Charges	$ 17,900	$ 20,940
Subtotal	$ 60,300	$ 74,500
PROJECT TOTAL	$1,101,600	$1,553,000

PROJECT MANAGEMENT PLAN

3.00 PROJECT MANAGEMENT PLAN

The District recognizes that each phase and component of the project must be organized, managed and controlled to ensure the timely completion of each element in a cost-effective manner. In addition, there must be a substantial level of quality control not only for the field data collection but also for the calibration and application of the ground water flow and contaminant transport model. Consequently, the District's proposed project team and plans for the utilization of subcontractors is designed to provide the technical expertise, quality control, and administrative and management controls required to deliver sound technical recommendations within the specified time frame and project budget.

Over the past eight years, the District has completed a wide range of projects under contract for federal and state agencies and local governments. Projects completed by the District have covered a wide range of water resources management issues including ground water contamination, water supply planning, implementation of major ground water monitoring and data collection programs, stormwater master planning, and estuarine hydrodynamics, among others. The District staff, therefore, have extensive experience dealing with the ground and surface water resources of northwest Florida and in managing and completing projects performed under contract with other state and federal agencies. Based on this experience, the District has developed a project management structure that includes: (1) a project director/administrator, (2) a project manager, (3) project principal investigators responsible for the performance of discrete project tasks, (4) support staff as needed for field data collection and data analysis, and (5) subcontractors retained to provide specific services such as soil borings, drilling services, laboratory services, and independent quality control.

For purposes of this project, the District will utilize the following District Staff to administer and manage the project, supervise the field data collection, and perform the required technical analyses. The latter includes development and application of the ground water flow and contaminant transport model of the Corry Field area. Since the District is currently working to develop and apply a regional ground water flow and contaminant transport model for Escambia County Utilities Authority (ECUA), it is essential that the two projects be closely coordinated to prevent duplication of effort and make maximum use of the information obtained in conjunction with the ECUA Project. For this reason, it was deemed advisable to utilize the same senior project management staff for the proposed Corry Field Project.

3.10 Project Management Team and Organization

The Corry Field project will be completed using a combination of District staff and subcontractors retained by the District to provide specific services. These will include laboratory analysis, drilling services, field data collection and quality control/quality assurance on specific project elements. Figure 3.10-1 depicts the project organizational structure proposed by the District and includes the project management team, subcontractors, and independent quality control consultants.

The role and responsibilities of each of the key District staff are briefly summarized below. This is followed by discussions of the principal subcontractors to be retained by the District in completing the project. Resumes of the District's project team members and the independent quality control consultants are provided at the end of this section.

3.11 Project Management Team

- Douglas E. Barr, Deputy Executive Director and Director, Resource Management Division, will serve as the District's Project Director and Administrator for the duration of the project. In addition to extensive experience specific to the ground water resources of northwest Florida, Mr. Barr has served as project director and administrator on over 40 contractual projects performed by the Northwest Florida Water Management District. In addition to providing general supervision of the project, he will also serve in an administrative capacity regarding the contract,allocation of staff, project billing, securing the necessary subcontractors, and project scheduling. As Deputy Executive Director,

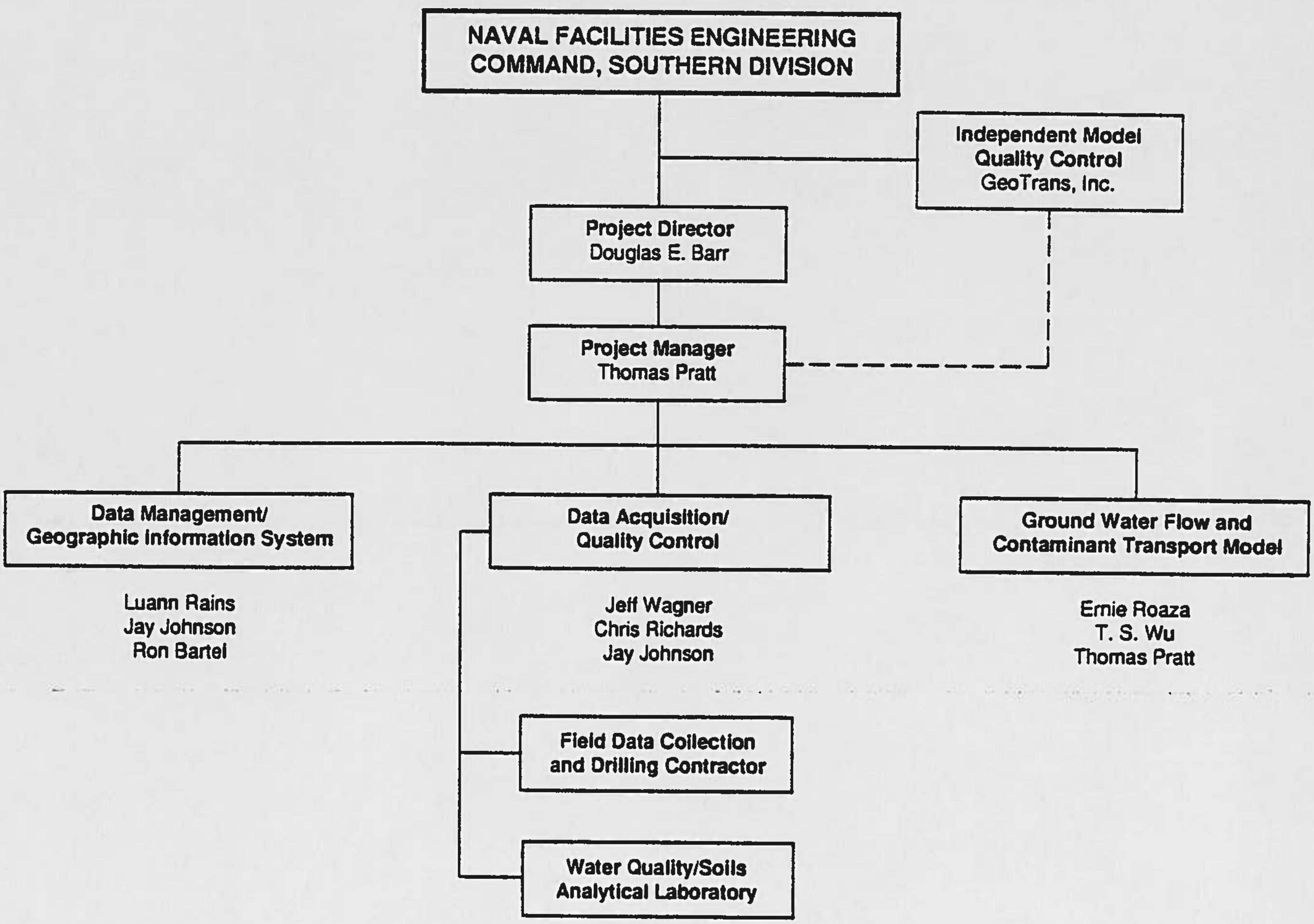

Figure 3.10-1. Project Organization Structure.

Mr. Barr will also ensure that the project receives whatever District staff and resources are necessary to successfully complete the work and provide any District policy directives that may be required with respect to the work schedules, purchasing, and performance of subcontractors. As needed, Mr. Barr will also report directly to the Navy's Project Manager, and meet regularly with the Navy staff to maintain clear lines of communication and discuss major decisions affecting the project.

- Thomas Pratt, District Senior Hydrologist, will be assigned as the District's Project Manager and will provide direct supervision of all tasks associated with completion of the project. Mr. Pratt has served as the Project Manager on numerous projects including, for example, an analysis of Ethylene Dibromide (EDB) contamination of ground water over a large segment of Jackson County, Florida, a three-year technical study of the hydraulics, hydrology and ecology of the Choctawhatchee River system, and a detailed hydrogeologic assessment and computer model analysis of the Sand-and-Gravel Aquifer in southern Santa Rosa County, Florida. In addition, he is currently serving as project manager for the on-going ground water modeling project being performed for the Escambia County Utilities Authority, and will provide coordination between the two projects. Mr. Pratt will be responsible for planning the schedule of work for all project tasks, effectively controlling the project costs and technical quality of the work, and meeting regularly with Navy staff concerning the project. He will also provide direct supervision of the development of the flow and contaminant transport model, with special emphasis on the model applications.

- Honesto (Ernie) Roaza, District Hydrogeologist, will serve as the Project Principal Investigator for the application, calibration and verification of the ground water flow and contaminant transport model. Mr. Roaza is currently the Project Principal Investigator for the development of the regional ground water model for the Escambia County Utilities Authority and previously served in this same capacity in the development of a regional model for analyzing Ethylene Dibromide contamination of ground water over a wide area of Jackson County, Florida. In addition to his responsibilities in development and application of the ground water model, Mr. Roaza will also aid in the design of the data collection program, and ensure that all necessary information is obtained for development of the model.

- Jeffry Wagner, Ground Water Bureau Chief, Division of Resource Management, will serve as Principal Investigator for project tasks related to field data collection, and defining and mapping the hydrogeology of the project area. In addition, all maps and cross sections depicting the subsurface geology of the area, including the major producing zones and confining beds will be produced under Mr. Wagner's direct supervision. Mr. Wagner has extensive experience related to the hydrogeology of the Sand-and-Gravel Aquifer in Escambia County and is currently a senior advisor on the ECUA Project, and Project Manager for implementation of a district-wide ground water quality monitoring network.

- Ron Bartel, Surface Water Bureau Chief, Division of Resource Management, will serve as senior advisor on the project in regard to computer modeling, data management, and analysis of information regarding the hydrology and hydraulics af the Sand-and-Gravel Aquifer. As Chief of the Bureau of Surface Water, Mr. Bartel will be instrumental in providing information on rainfall, runoff, and surface infiltration that provides direct recharge to the Sand-and-Gravel Aquifer. In addition, Mr. Bartel has served as project manager on numerous District projects regarding ground water contamination and the application of ground water flow and contaminant transport models.

- Other District staff with highly specialized areas of expertise will be assigned to carry out specific project elements or serve as advisors for selected technical components of the Corry Field analysis. A listing of these is provided below along with a brief description of the assigned role of each individual.

- Luann Rains, Director, Geographic Information Section, will provide support in the digitizing and production of maps and use of the Geographic Information System as an aid in the development of the ground water model and display of the model simulations. In addition, Ms. Rains has specialized experience and expertise in water resources planning, and the integration of Geographic Information Systems into highly complex projects entailing the application of computer models for water resources planning and management.

- T.S. Wu, District Hydrologist, is a computational hydrologist in the Resource Management Division. His area of expertise is in the design and development of numerical models (including finite-element and finite-difference) and their application to problems in water resources management. Dr. Wu will assist in the implementation of any necessary modifications to the finite-element code (SWICHA) and provide quality control on the testing and verification of any code modifications.

- Jay Johnson, District Hydrogeologist and Quality Control Officer, will prepare the District's Quality Control Plan for all field data collection and review and approve the Quality Assurance and Quality Control Plan submitted by the analytical laboratory selected by the District for analysis of the water samples. Mr. Johnson will also be responsible for the review of all data submitted by the analytical laboratory and associated QA/QC.

- Chris Richards, District Hydrogeologist, will provide specialized expertise in the interpretation of geophysical logs and preparation of all maps and cross sections of the geology and hydrogeology of the study area. Mr. Richards will also be responsible for preparation of the drilling specifications for soil borings, test wells and monitor wells, in addition to providing oversight of all drilling activities associated with the project.

All work associated with the project will be performed or managed by the District's Division of Resource Management. This Division is the primary technical branch of the Water Management District and currently employs 44 professional and support staff. These include hydrogeologists, hydrologists, Geographic Information System analysts, engineers, environmental scientists, biologists, water resources planners, and cartographic, secretarial and field data collection support staff. In addition to the staff identified above, other staff members, with a wide range of highly specialized expertise, are available to perform specialized functions and assist the project staff in completing the Corry Field assessment.

3.12 Ground Water Flow and Contaminant Transport Model Quality Control

At this stage, it is anticipated that development and application of the ground water flow and contaminant transport model will be a critical component in the development of conclusions regarding the source, transport, and ultimate fate of the dieldrin contamination at Corry Field. In addition, the model will be utilized to examine various well field pumping schemes for minimizing the spread of contamination to other supply wells, and potentially will be used to aid in the development of a remediation plan for the area.

As noted in the Scope of Work, the Corry Field model will be developed within the framework of the regional model currently being developed by the Water Management District for the Escambia County Utilities Authority. To ensure, however, that the Corry Field model will be of maximum utility to the Navy in addressing the issues identified above, the District would propose to retain an independent consultant to provide quality control for the development and application of the model for Corry Field. For this purpose, the District will utilize the services of GeoTrans, Inc. located in Sterling, Virginia.

GeoTrans, Inc. is an internationally recognized firm specializing in the development and application of ground water models for simulating the movement of contaminants through the subsurface. In addition, GeoTrans, Inc. developed the model (SWICHA) that will be utilized for the present project.

The District believes, therefore, that GeoTrans, Inc. is ideally suited to assist the District with the model and will provide the Navy with an independent source of quality control on the model development and application.

GeoTrans, Inc. has identified the following key staff members who will assist the District in the development and application of the ground water model. Resumes for these individuals are included at the end of this section.

- Dr. James W. Mercer, President and Principal Hydrogeologist
- Peter F. Anderson, Vice-President and Principal Engineer
- Barry H. Lester, Senior Hydrogeologist

As noted above, the role of GeoTrans, Inc. is to provide independent quality control and expert review regarding the development and application of the ground water model. Specifically, the District will utilize GeoTrans, Inc. for the following tasks.

A. Review and approval of the model approach for Corry Field based on the site hydrogeology, model conceptualization and existing information.

B. Review and approval of the site data collection program to help ensure that sufficient data is obtained to provide a reliable calibration and verification of the model.

C. Review and approval of the selected boundary and initial conditions for the model, parameter arrays, and model set-up.

D. Assistance in formulating the model sensitivity analyses intended as a check on the model input and to identify any inherent uncertainty in the model results.

E. Review and assistance in the calibration and verification of the model.

F. In conjunction with District and Navy staff, assist in the formulation of the model simulations that will be undertaken to accomplish the project objectives.

At each step in the development and application of the model, District staff will prepare technical memoranda for submittal to GeoTrans, Inc. and the U. S. Navy for review and approval. For example, early in the model development District staff will prepare a technical memo outlining the conceptualization of the site hydrogeology and a detailed description of proposed model representation of the ground water system. This will be provided to GeoTrans, Inc. for review and comment, modified as necessary, and re-submitted for final review and approval. In this manner, each phase of the modeling effort is planned in advance, subjected to independent expert review, and subsequently finalized. Likewise, following completion of each of the principal modeling tasks, an interim work product (technical memorandum) will be prepared providing a detailed summary of the modeling activity and results. This will be submitted for review and approval prior to initiation of the next modeling task.

3.13 Drilling Services, Field Data Collection, and Laboratory Services

Field data collection, drilling services, and laboratory services will be provided by subcontractors retained by the District. As an agency of the State of Florida, the District will utilize statutory procedures for the certification and selection of the subcontractors. These procedures are intended to provide for a competitive process in securing professional services and will provide the Navy with assurances that competent contractors will be obtained in the most cost-effective manner possible. It is recognized, however, that cost is only one consideration in the selection of a contractor, and Florida statutes provide for the consideration of the professional expertise, experience, and capabilities of a firm in the selection process.

Field data collection activities will be performed by an engineering firm selected under the provisions of Chapter 287.055, Florida Statutes, entitled the "Consultants Competitive Negotiations Act." The selected contractor will be responsible for the collection of soil samples and subsurface cores obtained as part of the soil boring and monitor well drilling programs, performance of physical testing of the cores (grain-size distributions, permeability, atterberg limits, etc.), performance of field permeability tests, and collection and preservation of water samples obtained from monitor wells. Outlined below is a brief description of the procedures the District will utilize in selecting the subcontractor for this component of the project.

A. The District will prepare a "Request For Proposals" (RFP) that outlines the work to be accomplished, the schedule for completion of the project, the information to be provided in the proposal, certification criteria, and the procedures to be followed in the certification and selection of the consultant. Copies of the RFP will be provided to all firms on the District's consultant mailing list and notice will be published in the "Florida Administrative Weekly." Firms will be provided with 30 days to submit their proposals.

B. Following receipt of the proposals, a certification and selection committee will be formed, comprised of the Project Director, Project Manager, and one additional member of the District's project management team. The committee will evaluate the proposals based on the pre-established certification criteria to ensure that all firms submitting proposals are qualified to perform the work.

C. Once the proposals have been certified, the committee will evaluate the statements of qualifications, performance data and other information submitted by interested firms and shall conduct discussions with no less than three firms regarding their qualifications, approach to the project and ability to furnish the required services.

D. The selection committee will then rank no less than three firms in order of preference, deemed to be the most highly qualified to perform the required services. In ranking the firms, the following criteria will be utilized:

1. Demonstrated specialized technical expertise of the firm in performing field data collection programs including soil borings, monitor well construction, and field sampling procedures.

2. Size and professional qualifications of the staff assigned to the project. Proposals will be accompanied by a resume for each of the personnel assigned to the project. The role of each individual in relation to the project shall also be outlined in the proposal.

3. The geographic location of the firm relative to the project area.

4. Past experience and record of the firm in field data collection programs associated with ground water contamination.

5. Present workload of the firm and capability of commencing work within 15 days of the date of contract award.

E. When authorized by the Navy, the Project Director and Project Manager will negotiate a contract and fee with the number one ranked firm at compensation determined to be fair, competitive, and reasonable. Should the negotiations with the selected firm be unsuccessful, the District will enter into negotiations with the second ranked firm.

F. The final negotiated fee and contract will be subject to the approval of the Navy and the Governing Board of the Northwest Florida Water Management District.

The water quality and soil chemistry laboratory will be selected under the provisions of Chapter 287.057, Florida Statutes, "Procurement of Contractual Services." These provisions provide for the selection of contractors based on competitive sealed proposals which include a base bid for the services required and a unit price bid for any additional services.

In selecting the water quality and soil chemistry laboratory, the District staff will prepare a Request for Proposals (RFP) which includes a statement of the services required, all applicable contractual terms and conditions, and bid schedule. The RFP will also outline criteria including but not limited to price, to be used in selecting the contractor. The RFP will be provided to all contractors on the District's Laboratory Services Mailing List and advertised in the "Florida Administrative Weekly."

Review of the proposals will be performed by a selection team comprised of the Project Director, Project Manager, and District QA/QC Officer. The award will be made to the responsible offerer whose proposal is determined to be in the best interests of the U.S. Navy and District. The final contract will be subject to approval by the U. S. Navy and the Governing Board of the Northwest Florida Water Management District.

3.20 Procedures for Controlling Project Schedule and Expenditures

Proper scheduling and timely completion of all project tasks is essential to the completion of the Corry Field project. It is anticipated that frequent workshops will be held with U. S. Navy staff to review progress on the various phases and tasks associated with the project. These workshops will afford an opportunity to review the status of all field data collection activities, and technical work completed to date, and to discuss modifications to the project schedule and work plan that may be desirable based on the results of the earlier tasks. For these purposes, the District would recommend quarterly workshops attended by the key project management staff and appropriate U. S. Navy staff.

The initial project schedule for the Corry Field project is illustrated on Figure 3.20-1, and includes each of the major project tasks and principal work elements associated with each task. The schedule takes into consideration the following factors:

- The anticipated time frame for completion of each task.

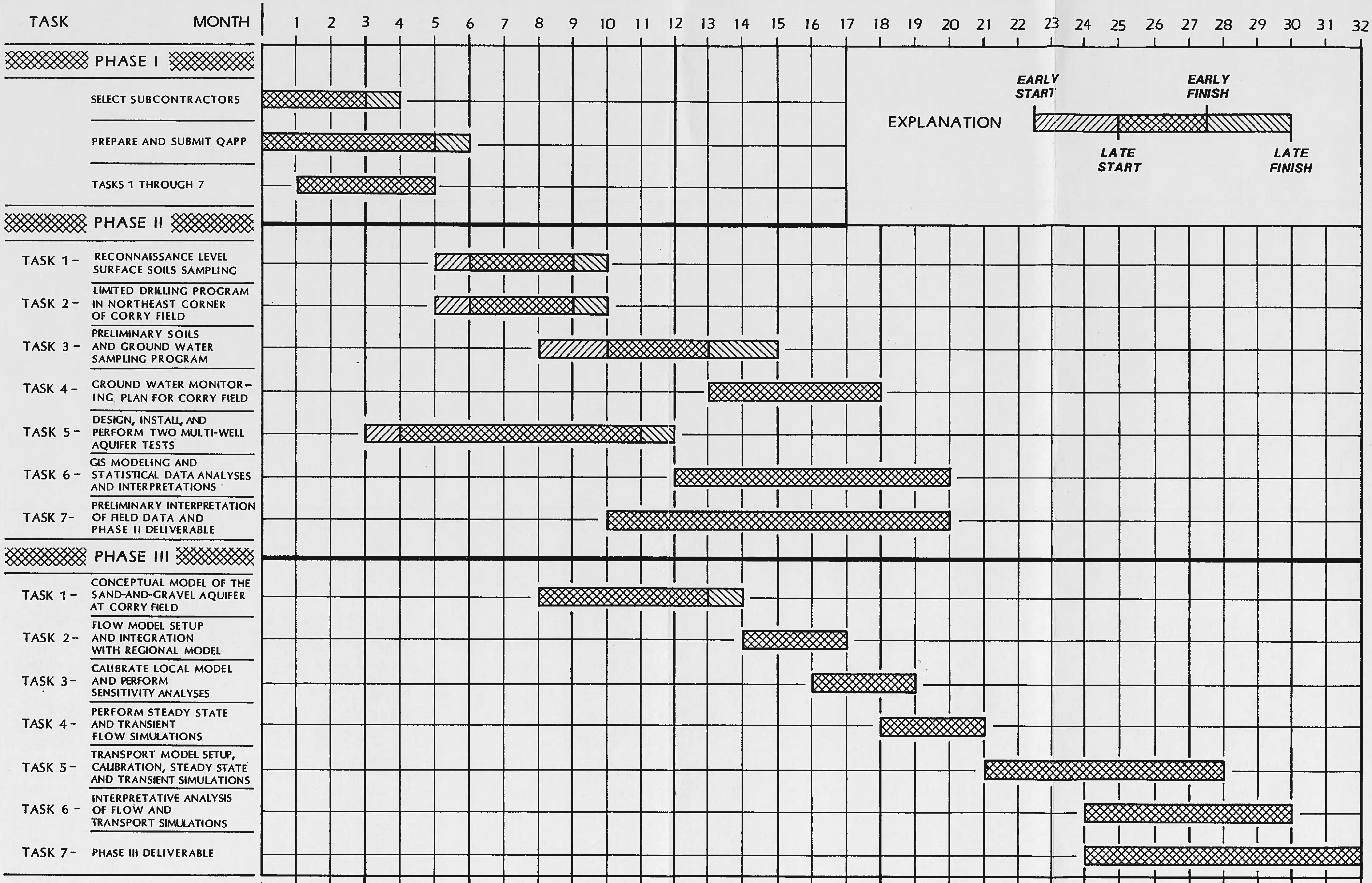

Figure 3.20-1. Project Schedule.

- The earliest start and completion date for the principal data collection tasks.

- The latest allowable completion date for each task that will still provide for completion of the entire project on schedule.

By approaching the project schedule in this manner, the Project Manager has the flexibility to actually control the schedule, rather than simply monitor the activities. By carefully identifying and controlling the schedule of all activities, the Project Manager can ensure the project runs smoothly and is completed on schedule. In the event that problems develop, the Project Manager will immediately notify the Project Director who has the authority to allocate the additional District resources that are required to alleviate the problem.

Based on further discussions with U. S. Navy staff following acceptance of this proposal, the final project schedule will be prepared and submitted for approval. Once the final schedule is approved and the project initiated, the Project Manager will meet with the Principal Investigators and other project staff no less than weekly to review progress. On a monthly basis, project expenditures will be reviewed by the Project Director and Project Manager and compared with the project schedule to determine if the level of activity and expenditures are consistent with the work completed to date and the overall project schedule. To facilitate this, the District has developed a project reporting system that provides budgetary information at the individual staff level. This system provides detailed information on project expenditures and is used for tracking projects on a temporal basis. The project reporting system provides the following information:

- Hours worked by each project team member during the previous month and a cumulative total for the life of the project.

- Monthly and cumulative total project personnel expenditures.

- Separate listings of expenditures for consultants, services, commodities and capital outlay for the previous month and for the project life.

- Project summaries providing a tabulation of all project expenditures for the previous month and for the project life.

Time, equipment and travel expenses are reported bi-weekly by each employee. These records provide the basis for recording and monitoring all project activities and serve as the basis for the monthly Projects Reports. The following charge records are submitted by employees on a bi-weekly or monthly basis:

- Personnel time record, used to record actual work hours on a project at intervals of one-quarter hour.

- Reimbursable expense records, used for documenting and recovering authorized travel expenses and other employee expenses such as meals, parking, etc.

- Computer usage records, used to document microcomputer usage and charges for the Geographic Information System.

- Equipment record, completed whenever District equipment, such as the borehole geophysical logger, is used for the project.

All invoices from subcontractors are verified and approved by the Project Manager and entered into the computer records of the District as they are received. These are then reflected on the next monthly Projects Report provided to the Project Director and Project Manager.

The District's proposed project scheduling and reporting, and existing financial control procedures, provide a mechanism for careful coordination and management of the project. The reporting, scheduling and financial management controls are specifically intended to ensure:

- There is continuous communication between the U. S. Navy's technical and management staff and the District's project team.

- There is internal management of the principal investigators, project staff, support personnel and subcontractors to provide for timely completion of all project phases and tasks.

- There is cost control, resource scheduling, and financial accounting for all phases and components of the project.

- Competent, professional subcontractors are retained and services are provided in the most cost-effective manner possible.

3.30 Quality Control Procedures

Analysis of the ground water samples will entail detection of extremely small concentrations of organic compounds. In order for these compounds to be accurately detected, the methods used to obtain and analyze samples must follow a strict set of procedures. The District has extensive experience in dealing with near-detection organic compounds based on its current and previous ground water monitoring programs. Consequently, it is recognized that well-documented Quality Assurance Quality Control Procedures (QA/QC) are critical in this type of project.

A Quality Assurance Project Plan (QAPP) will be prepared by the Northwest Florida Water Management District for the proposed work at Corry Field. The QAPP will be delivered to the Southern Division QA Project Officer for approval. Requested revisions will be incorporated into the document and implemented within the project. This QAPP will present the policies, organization, objectives, and specific quality assurance/quality control (QA/QC) procedures used by the District to ensure the accuracy, precision, and representativeness of all field data collection activities conducted under the District's direction.

All QA/QC procedures will follow established U.S. Environmental Protection Agency (USEPA) procedures and will be supplemented, where appropriate, by Florida Department of Environmental Regulation (FDER) guidelines. The QAPP document will be prepared in accordance with FDER specifications and U.S. Navy guidance documents, specifically the Contract Laboratory Program (CLP).

All subcontractors involved in data collection will be required to submit a QAPP to the District. The District QA Officer will review these plans to ensure that they conform to the appropriate QA/QC guidelines and incorporate them into the District QAPP.

No data collection will proceed until the District QAPP has been approved by the Southern Division QA Project Officer. Specific elements incorporated in the District QAPP will include:

Statement of Policy
Organization and Responsibility
QA Targets for Precision and Accuracy
QA Targets for Method Detection Limits
Sampling Procedures
Field and Laboratory Documentation
Chain-of-Custody and Sample Shipment
Sampling Equipment Decontamination
Analytical Procedures
Calibration Procedures and Frequency
Preventative Maintenance
Quality Control Checks and Routines to Assess Precision and Accuracy
Data Reduction, Validation, Reporting
Corrective Action
Performance and System Audits
Quality Assurance Reports
Resumes of Key Personnel

3.40 Resumes

Attached are the resumes for the District's key project management personnel and staff from GeoTrans, Inc. that will provide assistance and quality control for the development and application of the ground water flow and contaminant transport model. The District personnel selected for the project have a wide range of experience and expertise in addressing ground water resources related issues and problems, and cumulatively have over 60 years of experience specific to northwest Florida.

As noted in Section 3.12, GeoTrans, Inc. is an internationally recognized firm with highly specialized expertise in the area of ground water model development and application. GeoTrans, Inc. is especially well-suited to assist with the ground water model and provide independent quality control regarding the Corry Field model.

RESUME

DOUGLAS E. BARR

AREAS OF INTEREST

Water Resources Management
Project Development and Management
Ground Water Hydrology
Well Hydraulics

POSITIONS HELD

06/89 - Present	--	Deputy Executive Director and Director - Resource Management Division, Northwest Florida Water Management District
03/89 - 09/89	--	Acting Executive Director, Northwest Florida Water Management District
05/83 - 06/89	--	Director, Water Resources Division, Northwest Florida Water Management District
11/80 - 05/83	--	Senior Hydrogeologist, Northwest Florida Water Management District
03/80 - 10/80	--	Ground Water Hydrologist, Dames and Moore, Inc.-Chicago, Illinois
10/78 - 12/80	--	Associate Hydrogeologist, Northwest Florida Water Management District
05/77 - 10/78	--	Assistant Hydrogeologist, Northwest Florida Water Management District

STATEMENT OF QUALIFICATIONS

The past eight years have been spent in supervisory positions at the Northwest Florida Water Management District, including Director of the Water Resources Division and more recently as Deputy Executive Director and Director of the Resource Management Division. Duties as Division Director include supervision of a highly technical, multidisciplinary staff of 44 hydrologists, hydrogeologists, engineers, water resources planners, field data collection staff and support staff, and technical administration of all special projects. Other duties include development, planning and administration of water resources projects and technical programs, ranging from ground water resource assessments to development of stormwater management plans, and preparation of project proposals and budgets.

More recently, as Deputy Executive Director, responsibilities have been expanded to include oversight of all District operations and Divisions. These include regulatory programs for protection of the District's ground water and surface water resources, all technical programs, personnel matters, preparation of the District operating budget and other administrative duties.

Prior to assuming a supervisory position, the previous six years were spent primarily on various technical projects for the Northwest Florida Water Management District. Most projects entailed the application of two- and three- dimensional finite-difference models to problems in ground water flow and contaminant transport. These included model analysis of various ground water development schemes for meeting present and future water demands of the Fort Walton Beach metropolitan area, areal and profile modeling of projected ground water flow patterns following installation of environmental security measures at site contaminated with polybrominated biphenyl and other contaminants, simulations of nutrient migration from wastewater percolation ponds, and prediction of water-level declines and saltwater intrusion resulting from development of the Sand-and-Gravel Aquifer in Santa Rosa County, northwest Florida. Completion of these and other projects required extensive field data collection programs including test well drilling, aquifer tests, water-level mapping, and mapping of hydrogeologic units.

EXPERIENCE - Project Director (A complete listing is available upon request)

Development of a Comprehensive Stormwater Management Plan for Leon County and the City of Tallahassee -- Analyze and recommend cost-effective solutions to current and anticipated problems related to stormwater flooding and pollutant loading of area lakes. The completed master plan will provide stormwater management strategies and projects (structural and nonstructural) including priorities, cost estimates and implementation schedules.

Surface Water Improvement and Management (SWIM) Program -- This program is specifically intended to preserve and restore the surface water bodies of state or regional significance in northwest Florida. The current program emphasis is the Pensacola Bay System and associated bayous, Deer Point Lake, Apalachicola Bay and River, and the Lake Jackson watershed in Leon County. At present, over 30 discrete projects are being conducted under this program.

Management and Treatment of Stormwater for the Restoration of Bayou Texar, Escambia County -- Bayou Texar in Escambia County has a history of persistent water quality problems, depressed productivity, and periodic fish kills. Recognizing that the primary problem is discharge of large volumes of untreated stormwater, this project is intended to provide specific structural and nonstructural stormwater treatment projects that will lead to restoration of the bayou, including the location, sizing, and design criteria for the treatment facilities.

Ethylene Dibromide Contamination Study of Jackson County -- Project entails describing the occurrence and movement of Ethylene Dibromide (EDB) within the

Florida Aquifer of Jackson County, correlating the EDB levels with well depths to map the vertical distribution of the contaminant, and to undertake computer modeling of the aquifer to determine how long the contamination may persist in the area.

Ambient Ground Water Monitoring Network -- For the past six years, work has been conducted on the installation of a regional ground water monitoring network for purposes of establishing the background quality of ground water in northwest Florida, detecting any changes in quality. This project has also provided an extensive data base on the ground water conditions on northwest Florida, including basic hydrogeology, water quality, aquifer characteristics and ground water flow. Special emphasis has been placed on the Sand-and-Gravel Aquifer in southern Escambia County because of the sensitivity of this aquifer to surface sources of contamination.

Preliminary Evaluation of Circulation and Flushing Characteristics of St. Andrews Bay -- Application of a three-dimensional estuarine model to examine the overall circulation and tidal flushing of a large bay system in the Panama City area of northwest Florida. The model is also designed to simulate the transport of contaminants discharged from a large wastewater treatment plant.

Water Quality Evaluation of Lake Munson, Leon County -- Identify major sources of pollution impacting the lake and develop restoration alternatives based on detailed evaluations of the hydrology, hydraulics, and water quality characteristics of the lake and drainage basin.

Regional Solid Waste and Wastewater Disposal Plan -- Technical project director to the Walton/Okaloosa/Santa Rosa Regional Utility Authority for purposes of preparing a comprehensive plan for meeting the present and future waste disposal needs in a rapidly growing coastal area of northwest Florida.

Water Resources Restoration of Old Pass Lagoon, Destin, Florida -- Evaluation of engineering alternatives for restoring water quality in Old Pass Lagoon. Two and three-dimensional hydrodynamic models were applied to evaluate alternatives and to serve as management tools. Subsequently, a 50,000 gal/min circulation facility selected as the preferred alternative and the engineering design and construction specifications completed.

Nutrient Loading Assessment of Wastewater Percolation Ponds -- Design and installation of a ground water monitoring network to determine the distribution and concentration of nutrients in ground water adjacent to a large wastewater disposal facility.

Regional Water Supply Plan for the Coastal Areas of Santa Rosa, Okaloosa and Walton Counties, Northwest Florida -- Preparation of a detailed water supply plan for select coastal areas of northwest Florida, including assessment of future needs and evaluation of alternative sources of supply. The plan also included information on when additional supplies would be required, and preliminary design of sub-regional water supply systems.

Construction of Old Pass Lagoon Circulation Facility, Phase I -- Project entailed the construction of a 50,000 gal/min pump station, associated discharge canal and seven-foot diameter intake line for restoring the water quality of Old Pass Lagoon. The second phase of construction will include installation of approximately 1,000 feet of intake pipe into the Gulf of Mexico and construction of an intake structure.

Ground Water Monitoring Needs in the Coastal Areas of northwest Florida -- Project included an assessment of the ground water conditions, adequacy of monitoring in the coastal areas of northwest Florida, and design of a coastal ground water monitoring network. To accomplish this goal, the project included mapping the lateral and vertical position of the freshwater/saltwater interface and delineation of major permeability zones in the Floridan Aquifer.

Hydrostratigraphic Investigation of Southern Escambia County -- Detailed hydrostratigraphic evaluation of southern Escambia County to provide basic data needed to assess the potential for contamination of major water-bearing zones utilized for public supply, and to establish a network of background monitor wells.

Resource Assessment of an Inland Well Field to Provide Public Water Supply for the Coastal Areas of Santa Rosa And Okaloosa Counties -- This project, scheduled to begin in June, 1991, will provide a resource assessment of an inland well field proposed for southern Santa Rosa County. The well field is intended to provide public water supply for the coastal areas of southern Santa Rosa County and Okaloosa County. The project will include preparing plans for the number, location, and distribution of wells that will comprise the well field and the resource impacts that can be expected. The project is being performed in conjunction with the Walton/Okaloosa/Santa Rosa Regional Utility Authority.

Northwest Florida Abandoned Well Plugging Program -- Abandoned wells represent a serious threat to the ground water resources in many areas of northwest Florida. As a result, a plan was prepared for proper disposal of abandoned wells throughout the District. Subsequently, funds were obtained from both state and local sources to initiate the program and begin to effectively deal with abandoned wells in northwest Florida.

Regional Water Supply Facility Master Plan for Walton, Okaloosa and Santa Rosa Counties -- Served as Project Director and principal technical advisor to the Walton/Okaloosa/Santa Rosa Regional Utility Authority in the preparation of the facility master plan for water supply, sludge disposal and wastewater disposal in the area. This included preparation of the Request for Proposals, consultant selection, and technical oversight of the project. Was also retained by the Authority to develop all information needed to initiate negotiations with Eglin Air Force Base for installation of needed water supply facilities. This will include information on availability of water, demand projections, existing regulatory framework, requirements of state water policy, and development of tasks required to assess the impacts of the proposed ground water withdrawals.

Hydrogeologic Assessment of Solid Waste Landfills in Northwest Florida -- Assessment of ground water conditions, adequacy of monitoring and leachate generation rate for 36 solid waste landfills in northwest Florida. Later phases of the project included computer model simulations of contaminant migration and an assessment of environmental security measures for closure of selected landfills.

Environmental Security Measures for Containment of Contaminated Ground Water -- Computer model analysis of environmental security measures, including slurry cut-off walls, interceptor drains, and impervious cover for containing ground water at an industrial site contaminated with polybrominated biphenyl and other industrial pollutants.

Subsurface Migration of Wastewater Nutrients to Coastal Surface Water Bodies -- Application of ground water solute transport model to simulate the subsurface migration of wastewater nutrients through high permeability coastal beach and dune sands and discharge to saline surface waters. The results were used to establish appropriate setbacks lines for package sewage treatment plants in coastal areas of west Florida.

EXPERIENCE - Project Manager (A complete listing is available upon request)

Water Resources of Southern Okaloosa and Walton Counties, Northwest Florida -- Hydrogeologic and computer model evaluation of alternatives for developing ground water supplies from the Floridan and Sand-and-Gravel Aquifer to meet present and projected water supply needs. Project included complete descriptions of the water quality and hydraulic characteristics of the aquifers and identification of areas for future ground water development.

Site Investigation of an Abandoned Industrial Disposal Area Containing Polybrominated Biphenyl -- Designed and implemented a program to determine the nature and extent of ground water contamination at a hazardous waste burial site and the potential for contaminant migration to a nearby river.

Hydrogeologic Evaluations of Hazardous Waste Disposal Sites -- Prepared descriptions of the hydrogeologic framework and ground water flow conditions at seven hazardous waste disposal sites and spill areas at various industrial sites covering a wide range of hydrogeologic conditions.

Availability of Ground Water from the Sand-And-Gravel Aquifer in Southern Santa Rosa County -- Computer model analysis of water-level declines and inland migration of saltwater resulting from development of a shallow ground water supply on a coastal peninsula. Model analysis included simulations of numerous pumping and development schemes under both normal and drought conditions.

EDUCATION

Bradley University, B.S., Geology
Texas Christian University, M.S., Specialty in Ground Water Hydrology
Thesis Topic: Hydrogeology of the Lower Rio Grande Valley Alluvial Aquifer

PUBLICATIONS (A complete listing is available upon request)

Barr, D.E., 1990. Western Sub-Regional Water Supply System for the Walton/Okaloosa/Santa Rosa Regional Utility Authority. Summary Report to the Regional Utility Authority.

Maristany, A.E., Esry, D.H., and Barr, D.E., 1988. Harbor Restoration Through Improved Circulation. Proceedings, National Conference of the Hydraulic Division of American Society of Civil Engineers.

Barr, D.E., 1988. Regional Water Supply Plan for the Coastal Areas of Walton, Okaloosa, and Santa Rosa Counties- Addendum. Northwest Florida Water Management District Technical File Report 88-1.

Maristany, A.E., Esry, D.E., and Barr, D.E., 1987. Water Resources Restoration of Old Pass Lagoon, Destin, Florida. Northwest Florida Water Management District Water Resources Assessment 87-1.

Barr, D.E., and Bowman, E., 1985. Results of Ground Water Nutrient Monitoring at Wastewater Percolation Ponds in Destin, Florida. Northwest Florida Water Management District Technical File Report 85-1.

Barr, D.E., Hayes, L.R., and Kwader, T., 1984. Hydrology of the Southern Parts of Okaloosa and Walton Counties, Northwest Florida with Special Emphasis on the Upper Limestone of the Floridan Aquifer. U.S. Geological Survey Water Resources Investigation Report 84-4305.

Barr, D.E., Wilkins, K.T., and Barton, D.L., 1983. Evaluation of Minimum Package Sewage Treatment Plant Set-Back Lines on Selected Coastal Soils in West Florida. Northwest Florida Water Management District Special Report 83-9.

Barr, D.E., 1983. Ground Water Conditions in the Vicinity of Choctawhatchee Bay, Northwest Florida. Northwest Florida Water Management District Special Report 83-10.

Pratt, T.R., and Barr, D.E., 1982. Availability and Quality of Water from the Sand-And-Gravel Aquifer in Southern Santa Rosa County, Florida. Northwest Florida Water Management District Water Resources Special Report 82-1.

Hayes, L.R., and Barr, D.E., 1982. Hydrology of the Sand-And-Gravel Aquifer, Southern Okaloosa and Walton Counties, Northwest Florida. U.S. Geological Survey Water Resources Investigations Report 82-4110.

Barr, D.E., and Pratt, T.R., 1981. Aquifer Characteristics and Water Supply Potential of the Sand-And-Gravel Aquifer, Gulf Breeze, Santa Rosa County. Northwest Florida Water Management District Technical File Report 81-5.

Barr, D.E., and Wagner, J.R., 1981. Reconnaissance of the Ground Water Resources of Southwestern Bay County. Northwest Florida Water Management District Technical File Report 81-1.

Stidham, J.A., and Barr, D.E., 1981. Florida's Ground Water: An Endangered Resource Worth Saving! The Situation in Northwest Florida. Journal, Florida Engineering Society, p. 15-16 and 25.

Barr, D.E., and Pratt, T.R., 1981. Results of Aquifer Test and Estimated Drawdowns in the Floridan Aquifer, Northern Gulf County, Northwest Florida. Northwest Florida Water Management District Water Resources Special Report 85-1.

Barr, D.E., Maristany, A., and Kwader, T., 1981. Water Resources of Southern Okaloosa and Walton Counties, Northwest Florida. Northwest Florida Water Management District Water Resources Assessment 81-1.

Wagner, J.R., Lewis, C., Hayes, L.R., and Barr, D.E., 1980. Hydrologic Data for Okaloosa, Walton and Southeastern Santa Rosa Counties, Florida. U.S. Geological Survey Open-File Report 80-741.

Barr, D.E. and Hayes, L.R., 1979. Hydraulic Characteristics and Digital Numerical Model of the Floridan Aquifer in Southern Okaloosa County, Northwest Florida. Fourteenth American Water Resources Conference, Lake Buena Vista, Florida.

PROFESSIONAL AFFILIATIONS

American Water Resources Association, Florida Section
Sigma Xi National Honorary Research Society
Florida Water Well Association
Registered Professional Geologist, State of Florida Registration No. 171
Technical Advisor and Coordinator, Walton/Okaloosa/Santa Rosa Regional Utility Authority
Member, Lake Jackson Action Team appointed by Leon County Commission to develop a management plan for restoring and preserving Lake Jackson
Member, St. Andrews Bay Resource Protection Committee
Former Board Member, Florida Section, American Water Resources Association

RESUME

THOMAS R. PRATT

AREAS OF INTEREST

Ground Water Hydrology
Numerical Modeling of Ground Water Flow
and Solute Transport
Solute Transport in Heterogeneous Media

POSITIONS HELD

10/89 - Present -- Senior Hydrologist. Northwest Florida Water Management District

08/86 - 10/89 -- Associate Hydrologist. Northwest Florida Water Management District

06/84 - 08/86 -- Graduate Research Assistant. Department of Civil Engineering, Auburn University, Alabama

07/79 - 05/84 -- Assistant Hydrogeologist. Northwest Florida Water Management District

05/78 - 02/79 -- Drilling Assistant. Layne-Central Co., Pensacola, Florida

STATEMENT OF QUALIFICATIONS

During the past twelve years, professional responsibilities have involved participation in a number of ground and surface water related projects. These activities have included planning and implementation of field data collection programs, as well as synthesizing the results of data collection into water resources assessments. Data collection programs have included installation of test wells, aquifer testing, description of study area hydrogeology, water level mapping, operation of automated data collection systems, surface water quality sampling, and quality assurance issues. Associated supervisory responsibilities have included oversight of drilling contractors, analytical laboratories, and field technical staff. Two of the past twelve years were spent in a university research environment as a research assistant, where responsibilities included application of two- and three-dimensional flow and solute transport codes in various numerical experiments.

More recent activities involve various elements of project management, including supervision of junior-level hydrogeologists and hydrologists, project scheduling and cost-tracking, and oversight of invoice and deliverable preparation. Recent project management experience includes the implementation of a three-dimensional flow and solute transport model of the principal fresh water aquifer in Escambia County, northwest Florida. Project objectives include preparation of an appropriate conceptual model of the aquifer, model implementation, and use of model results to identify aquifer management policies that avoid undesirable resource utilization conditions.

Other current responsibilities include overseeing the implementation of a major surface water resource assessment in northwest Florida. This assessment includes the development of restoration alternatives for a highly degraded estuary which is impacted by urban stormwater runoff and poor bottom sediment quality. Responsibilities also include the characterization of stormwater quality and volumes originating from urban watersheds, as well as the identification of stormwater restoration alternatives. This position requires extensive interaction with the principal regulatory agency in the State of Florida and the ability to conduct public meetings.

EXPERIENCE - Project Manager

Escambia County Sand-and-Gravel Aquifer Ground Water Model Study -- Directing the application of a three-dimensional, finite-element flow and transport code to the Sand-And-Gravel Aquifer in Escambia County, northwest Florida. Study objectives include conceptualization of the aquifer flow regime, assessment of existing water availability and contaminant problems, and development of remedial measures.

Bayou Chico Restoration Project -- Currently supervising an assessment of the hydraulics, hydrology, and water and sediment quality of a small, highly degraded urban estuary. Assessment activities include application of a hydrodynamic model, application of the USEPA Stormwater Management Model (SWMM) to the estuary watershed, and characterization of existing stormwater, water, and sediment quality. Program goals include identification and implementation of preferred restoration alternatives.

Palafox and Coyle Watershed Project -- Currently supervising a stormwater assessment of two urban watersheds in northwest Florida. Utilizing the Stormwater Management Model, impacts of stormwater discharge and restoration alternatives will be evaluated.

Ethylene Dibromide Contamination Study of Jackson County, Florida -- Conducted a study of the spatial distribution and movement of agriculture related, nonpoint contamination in a hydrogeologically vulnerable portion of a northwest Florida county. Study objectives included a description of the hydrogeology of a Karst recharge area and calibration of a two-dimensional flow model of the study area.

EXPERIENCE - Principal Investigator

Choctawhatchee River Basin Surface Water Resource Assessment, Phase II -- Directed an investigation of the hydraulics, hydrology and biology of a large northwest Florida river basin. Project objectives included a backwater model analysis of the river flood plain and application of a hydrologic watershed model to the basin. Work products were used in the management of state-owned lands and to assess the flooding potential of the river corridor.

Choctawhatchee River Basin Surface Water Resource Assessment, Phase I -- Implemented a surface water data collection program to quantify basin flows and water quality, with emphasis on nutrients, metals, sediments and agricultural chemicals. Information generated by project was used to prepare a basin water budget and annual load estimates for selected constituents.

Availability of Ground Water from the Sand-and-Gravel Aquifer in Southern Santa Rosa County -- Prepared a detailed assessment of the availability and quality of water in the Sand-and-Gravel Aquifer in the coastal portion of a northwest Florida county. Assessment included a description of aquifer hydrogeology, hydraulic properties and water quality, and was designed to facilitate resource utilization.

EXPERIENCE

Quality Assurance Officer -- Supervised the preparation of generic and project-specific quality assurance plans for approval by the Florida Department of Environmental Regulation. Responsible for District-wide quality assurance of ground and surface water sampling programs.

Design of Dewatering System -- Utilizing a three-dimensional flow code, designed a deep well dewatering system for a barrier inland construction site. System was installed at a cost of approximately $100,000 and successfully dewatered a $1.3 million construction site for nine months. Evaluation included the performance and analysis of a water table aquifer test.

Solute Transport Modeling in Heterogeneous Porous Media -- Authored a three-dimensional solute transport code. Applied this code to hypothetical, heterogeneous, isotropic hydraulic conductivity distributions to evaluate the effects of heterogeneous hydraulic conductivity distributions on advective transport of contaminants.

Water Resources Assessment of Southern Okaloosa and Walton Counties -- Supervised an intensive ground water data collection program. Prepared a detailed description of the hydrogeologic framework for the study area with the data collected. Responsibilities included supervision of drilling contractors, performance of aquifer tests and field data collection.

Technical Review of Consumptive Use Permit Applications -- Designed and implemented a technical review procedure for pending ground water consumptive use permit applications. Supervised the review of ground water and surface water permit applications.

Operation and Maintenance of Geophysical Logger -- Operated and maintained a truck-mounted geophysical logging unit. Logged over 300 water wells during tenure as operator. Geophysical logs accumulated during this period form an integral part of the District's hydrogeologic data base.

EDUCATION

Master of Science in Civil Engineering, Auburn University. Specialty in Hydraulics and Hydrology.

Bachelor of Science in Geology, University of Alabama.

PUBLICATIONS

NWFWMD, 1989. Generic Quality Assurance Project Plan for the Northwest Florida Water Management District. Approved by the Florida Department of Environmental Regulation, November 29, 1989.

Roaza, H.P., Pratt, T.R., and Moore, W.B., 1989. Hydrogeology and Nonpoint Source Contamination of Ground Water by Ethylene Dibromide in Northeast Jackson County, Florida. Northwest Florida Water Management District, Water Resources Special Report 89-5, 96 p.

Pratt, T.R., Clewell, A.F. and Cleckley, W.O., 1989. Principal Vegetation Communities of the Choctawhatchee River Flood Plain, Northwest Florida. Proceedings of the Symposium on Wetlands: Concerns and Successes. AWRA Technical Publication Series TPS-89-3, p. 91-99.

Pratt, T.R., 1986. Numerical Experiments Involving Solute Transport in Heterogeneous Media. Unpublished Masters Thesis, Auburn University, 191 p.

Pratt, T.R. and Barr, D.E., 1982. Availability and Quality of Water from the Sand-and-Gravel Aquifer in southern Santa Rosa County, Florida. Northwest Florida Water Management District, Water Resources Special Report 82-1, 99 p.

Barr, D.E. and Pratt, T.R., 1981. Results of Aquifer Test and Estimated Drawdowns in the Floridan Aquifer, Northern Gulf County, Northwest Florida. Northwest Florida Water Management District, Water Resources Special Report 81-1, 38 p.

MEMBERSHIP

American Geophysical Union

PROFESSIONAL REGISTRATION

Licensed Professional Geologist, Florida, No. 159

RESUME

HONESTO P. ROAZA

AREAS OF INTEREST

Aqueous Geochemistry
Ground Water and Contaminant Hydrology
Numerical Modeling
Geographic Information System Applications
Environmental Management System Development

POSITIONS HELD

9/88 - present	--	Assistant Hydrogeologist. Bureau of Ground Water. Northwest Florida Water Management District
9/87 - 9/88	--	Environmental Specialist. Bureau of Ground Water Protection. Florida Department of Environmental Regulation
1/87 - 9/87	--	Hydrologic Field Technician. Water Resources Division. U. S. Geological Survey
3/85 - 6/86	--	Instructor. Department of Geological Sciences. The Ohio University. Athens and Lancaster Campuses, Ohio

STATEMENT OF QUALIFICATIONS

Professional experience has been in the technical fields of ground water hydrology, water quality and numerical modeling studies. Project participation included field data collection, interpretation of data, analyses of data, methods and computer applications.

EXPERIENCE

Escambia County Sand and Gravel Aquifer Computer Model -- (Principal Investigator) Development of a flow and contaminant computer model of the Sand and Gravel Aquifer in Escambia County, Florida. Development of an integrated ground water management system using the computer model and a geographic information system.

Hydrogeology and Nonpoint Source Contamination of Ground Water in Northeast Jackson County, Florida -- (Principal Investigator) Assessment of the hydrogeology and the extent of ground water contamination by the pesticide Ethylene Dibromide. Included numerical flow modeling of the Floridan Aquifer.

Water Quality Study of the Apalachicola River Basin: SWIM -- (Principal Investigator) Assessment of historical water quality conditions of the Apalachicola River Basin.

Water Quality Study of the Pensacola Bay System: SWIM -- (Principal Investigator) Preliminary assessment of the historical water quality of the Escambia River Basin, Blackwater River Basin, Yellow River Basin and the East Bay River Basin for constituent loading estimations to the Pensacola Bay system.

Pesticide Monitoring and Data Review -- Agrichemical data analyses, technical support of agrichemical field studies and testing of nonpoint source numerical models.

Pensacola Superfund Creosote Contamination Study -- Field data collection and preliminary set up of contaminant transport model for the creosote contamination study at the American Creosote Works Superfund site.

Instructor -- Instructor/Lecturer for Oceanography/Marine Geology, Historical and Physical Geology classes at the Ohio University.

EDUCATION

Master of Science in the Geological Sciences
The Ohio University, Athens, Ohio

Bachelor of Science in Geology
Muskingum College, New Concord, Ohio

General Motors Institute
Mechanical Engineering Program, Fisher Body Division
Flint, Michigan

PUBLICATIONS

Hydrogeology and Nonpoint Source Contamination of Ground Water by Ethylene Dibromide in Northeast Jackson County, Florida (with T.R. Pratt and W.B. Moore). Northwest Florida Water Management District Water Resources Special Report 89-5; 1990.

Ground Water Contamination of the Floridan Aquifer in Northeast Jackson County, Florida by Agriculture Chemicals (with W.B. Moore). Geological Society of America Abstracts, Southeast Section Annual Meeting; April, 1990.

The Significance of Maximum Contaminant Levels in Natural Aquifer Systems: Implications for Remediation of Nonpoint Source Pollution Via Dilution. (with W.B. Moore). Geological Society of America Abstracts, Southeast Section Annual Meeting; April, 1990.

PreQuaternary Age Dating Using Electron Spin Resonance: Peroxy Radical Defects in Natural Quartz. Geological Society of America Abstracts, Southeast Section Annual Meeting; April, 1990.

Effectiveness of Aquifers in the Dilution of Nonpoint Source Low MCL Contaminants (with W.B. Moore). Abstracts of the Technical Sessions, U. S. Geological Survey Second National Symposium on Water Quality; November, 1989.

M.S. Thesis on Basic Research in the Magnetic Resonance Theory and Methods towards Geological applications with Primary Emphasis on Radiation Damages. The Ohio University, 1989.

MEMBER

Sigma Xi, The Research Society of America

RESUME

JEFFRY R. WAGNER

AREAS OF INTEREST

Project Management
Ground Water Hydrology
Hydrostratigraphy
Data Collection - Ground Water
and Surface Water

POSITIONS HELD

10/89 - Present	--	Chief, Bureau of Ground Water, Northwest Florida Water Management District
10/87 - 10/89	--	Chief, Hydrologic Services/Senior Hydrogeologist, Northwest Florida Water Management District
10/85 - 10/87	--	Chief, Hydrologic Services/Associate Hydrogeologist, Northwest Florida Water Management District
10/80 - 10/85	--	Associate Hydrogeologist, Northwest Florida Water Management District
05/79 - 10/80	--	Assistant Hydrogeologist, Northwest Florida Water Management District
12/72 - 05/79	--	Hydrologic Technician, U. S. Geological Survey

STATEMENT OF QUALIFICATIONS

During a nineteen-year career in an interdisciplinary hydrology position, the primary focus of professional activity has been hydrogeology. For the past five years, there has been an emphasis on administration and project management. Most of my career has been as a principal researcher in regional ground water investigations with the Northwest Florida Water Management District and the U. S. Geological Survey. These studies entail defining the hydrogeologic framework and defining geochemical characteristics including the correlation to stratigraphy and geologic structures, assessing recharge-discharge processes, describing and quantifying flow properties and determining the mechanisms for surface and ground water interaction. All of these projects involved extensive data collection. Data analyses include correlation of rainfall, pumpage, water-quality trends and water-level fluctuations. Additionally, geophysical log interpretation, monitor well design and construction, aquifer testing and areal mapping (including water levels and hydrostratigraphy) are an integral part of the evaluations.

The first three years of professional work dealt with project support involving data collection. Field data collection pertained to stream gaging procedures, ground water measurements, and field collection of representative water-quality samples. Responsibilities included installation, servicing and maintenance of data collection equipment.

Subsequent and current work is primarily as a principal investigator for technical investigations. The present position supervises and coordinates technical and field personnel within the Bureau of Ground Water of the Resource Management Division. The current position requires effective communication with the public as well as with engineers, planners, biologists, resource managers and other professionals. Other responsibilities involve the organization and management of computerized data base files.

EXPERIENCE - Principal Investigator

Water Resources of the Ochlockonee River Area, Northwest Florida -- Regional investigation to evaluate the hydrology within the basin. Ground water, surface water and water-quality characteristics were assessed to delineate areas favorable or unfavorable for water-supply development.

Evaluation of Industrial Water Availability for Selected Areas: Northwest Florida -- Identification of potential industrial development areas and evaluation of water resources to determine areas hydrologically compatible with intensive water use. Work included design and construction of monitor wells for aquifer testing.

Ground Water Resources of the Little River Basin and Vicinity, Northwest Florida -- Detailed ground water investigation to evaluate and define hydrostratigraphy, assess aquifer hydraulic properties, and determine the potential impact of highly mineralized water on future ground water development within the primary aquifer system.

Ground Water Resources of the Dougherty Plain, Southwest Georgia -- Investigation to determine the impact of ground water pumpage to the primary aquifer. Involved trend analysis of data for past 40 years.

Water Resources of Leon, Wakulla and Jefferson Counties -- Regional water-resources investigation to define and evaluate the hydrology of a three-county area. Emphasis is placed on evaluating karst hydrogeology with an assessment of ground, surface water relationships.

Hydrologic Assessment of Lake Iamonia and Iamonia Sink, Leon County, Florida -- An investigation of surface and ground water relationships of a lake basin. Acceptance rate of sinkhole was quantified and lake level fluctuations and evapotranspiration were assessed. Results provide basis for lake management practices.

Hydrogeologic Assessment of the October 1982 Draining of Lake Jackson, Leon County -- Investigation of processes surrounding sinkhole development in a lake basin and their relationship to the ground water setting. Also included historical accounting of sinkhole activity within basin.

Interim Ground Water Assessment of the Apalachicola-Chattahoochee-Flint River Basin -- Involved correlation of stratigraphy and hydrogeologic units for a three-state area. Also included evaluation of occurrence, characteristics and changes to the ground water throughout the basin. Results were intended to present the current level of understanding for a coordinated effort by the states of Florida, Georgia, and Alabama and the U. S. Corps of Engineers.

An Ordinary High Water Line Survey of Lake Jackson, Leon County -- Participant with multi-disciplinary team to develop guidelines and methodology for establishing ordinary high water line. Served as hydrologist and assessed the ground, surface water characteristics for the lake basin.

Hydrogeologic Data for Sand-and-Gravel Aquifer in Southern Escambia County -- Sixty-six monitor wells were designed and installed within the three primary zones composing the Sand-and-Gravel Aquifer. The construction of the monitor wells was coordinated with existing ground water observation wells in the highly industrialized area. The hydrostratigraphic evaluation provided data to assess the potential for contamination of the primary aquifer.

Ambient Ground Water Monitoring Program - Phase 1 -- This investigation involved the evaluation of all existing ground water information for northwest Florida. Thickness and structural surface maps were completed for each hydrogeologic unit. Additionally, maps were completed which define the occurrence and extent of aquifer systems and confining units; potential recharge areas; saltwater-freshwater interface for the Floridan Aquifer; areas where free-flowing wells will occur. Aquifer outcrop areas; and areas where karst features are present.

Ambient Ground Water Monitoring Program - Phase 2 -- This study entailed establishing a long-term monitoring network for northwest Florida. Initial emphasis for the network is to determine baseline ground water quality information. Involved construction of nearly 50 monitor wells which are constructed within all water-bearing zones at each monitor site.

Potential Power Plant Site - Ground Water Assessment -- Evaluation of ground water availability at several selected sites. Includes production and monitor well design and construction and aquifer testing to determine aquifer properties.

Ambient Ground Water Monitoring Program - Phase 4 -- Involved determination of high risk areas for ground water contamination. Potential point sources and non-point sources are assessed based on existing hydrogeologic settings. Future monitoring will be determined based on the potential contamination risk factors.

Ambient Ground Water Monitoring Program - Phase 5 -- This phase begins the initial establishment of a monitoring network for the Surficial Aquifer. Site selection criteria was based on results of Phase 4. Wells are constructed in areas identified as sensitive to ground water contamination. Detailed assessments of areas will be included.

Ambient Ground Water Monitoring Program - Phase 6 -- Involved characterization of monitoring sites for both the Background and VISA Networks in addition to interpretation of water quality data per aquifer segment per hydrogeologic setting. Sampling of selected sites within Background Network will commence during this phase. Concentration maps were prepared for the various parameters for each aquifer segment. These maps are intended to define background water quality characteristics.

Ambient Ground Water Monitoring Program - Phase 7 -- Sampling of VISA, Background and Temporal networks continued for this phase. Analysis results were compared with past sampling events, variability, and areal distribution were assessed.

EDUCATION

Florida State University, B. S., Geology

PUBLICATIONS

Dysart, J. E., Kipple, F. P., Pascale, C. A., Trapp, H., Jr., Wagner, J. R., and others, 1977, Water Resources Inventory of Northwest Florida: U. S. Geological Survey, Water Resources Investigation 77-84, 114 p.

Pascale, Charles A., Wagner, Jeffry R., and Sohm, James E., 1978, Hydrologic, Geologic, and Water-Quality Data, Ochlockonee River Basin Area: USGS, WRI 78-97, 515 p.

Wagner, Jeffry R., Lewis Charles, Hayes, Larry R., and Barr, Douglas E., 1980, Hydrologic Data for Okaloosa, Walton, and Southeastern Santa Rosa counties, Florida: USGS, Open File Report 80-741, 228 p.

Wagner, Jeffry R., Hodecker, Elizabeth A., and Murphy, Robert, 1980, Evaluation of Industrial Water Availability for Selected Areas, Northwest Florida; Northwest Florida Water Management District, Water Resources Assessment 80-1, 391 p.

Kwader, Thomas and Wagner, Jeffry R., 1980, Ground Water Resources of the Dougherty Plain, Southwest Georgia: Prepared for Decatur County, Georgia, 110 p.

Barr, Douglas E., and Wagner, Jeffry R., 1981, Reconnaissance of the Ground Water Resources of Southwestern Bay County: NWFWMD, Technical File Report 81-8, 47 p.

Wagner, Jeffry R., 1981, Ground Water Availability Evaluation, City of Quincy and Vicinity, Northwest Florida: NWFWMD, Technical File Report 81-10, 25 p.

Pascale, Charles A., and Wagner, Jeffry R., 1982, Water Resources of the Ochlockonee River Area, Northwest Florida: USGS, WRI Open File Report 81-1121, 114 p.

Wagner, Jeffry R., 1982, Ground Water Resources of the Little River Basin and Vicinity, Northwest Florida: NWFWMD, Water Resources Special Report 82-2, 62 p.

Wagner, Jeffry R., 1982, Hydrogeology of the Northwest Florida Water Management District--Ground Water in Florida, Proceedings of the 1st Annual Symposium on Florida Hydrogeology: NWFWMD, Public Information Bulletin 82-2, 14 p.

Wagner, Jeffry R., and Musgrove, Richard J., 1983, Hydrologic Assessment of Lake Iamonia and Iamonia Sink, Leon County, Florida: NWFWMD, Water Resources Special Report 83-1, 50 p.

Wagner, Jeffry R., 1983, Summary of Hydrogeologic Characteristics along the Apalachicola River between Estiffanulgua and Chattahoochee, Proceedings of the 1983 Southeastern Geological Society Annual Field Trip, Southeastern Geological Society, 10 p.

Wagner, Jeffry R., 1984, Hydrologic Assessment of the October 1982 Draining of Lake Jackson, Leon County, Florida: NWFWMD, Water Resources Special Report 84-1, 37 p.

Maristany, Agustin E., Wagner, Jeffry R., and Moustakas, Michelle, 1984, Statistical Summary and Inventory of Streams and Lakes in Northwest Florida: NWFWMD, Water Resources Special Report 84-4, 197 p.

Wagner, Jeffry R., and Allen, Thomas W., 1984, Ground Water Assessment for the Apalachicola-Chattahoochee-Flint River Basin - in 1984 Water Assessment for the A-C-F River Basins: U. S. Army Corps of Engineers, Vol. 3, Appendix III, Water Resources, Section 3, Ground Water, 127 p.

Wagner, Jeffry R., 1984, The Ground Water Resources of Jackson County, Florida: NWFWMD, Public Information Bulletin 84-2, 7 p.

Wagner, Jeffry R., Allen, Thomas W., Clemens, Linda Ann and Dalton, James B., 1984, Ambient Ground Water Monitoring Program - Phase I: NWFWMD, DER Contract No. WM65, 154 p., 38 plates.

Thompson, Douglas A., Schmidt, Walter, Wagner, Jeffry R., Gilbert, Katherine M., and Neuman, Louis A., 1985, An Ordinary High Water Line Survey of Lake Jackson, Leon County, Florida: Florida Department of Natural Resources, Tallahassee, Florida, 126 p., 15 plates.

Wilkins, Keithley T., Wagner, Jeffry R., and Allen, Thomas W., 1985, Hydrogeologic Data for the Sand-and-Gravel Aquifer in Southern Escambia County, Florida: NWFWMD, Technical File Report 85-2, 153 p.

Wagner, Jeffry R., 1986, Ground Water Bibliography with Selected Geological References for the Northwest Florida Water Management District: NWFWMD, Technical File Report, 86-1, 25 p.

Wagner, Jeffry R., 1987, Ground Water in Escambia County, Florida: NWFWMD, Public Information Bulletin 87-2, 8 p.

Wagner, Jeffry R., 1988, Fundamental Ground Water Conditions within the Northwest Florida Water Management District: NWFWMD Public Information Bulletin 88-1, 24p.

MEMBER

Southeastern Geological Society

PROFESSIONAL REGISTRATION

Professional Geologist, State of Florida, PG-156

RESUME

RONALD L. BARTEL

AREAS OF INTEREST

Hydrology
Ground Water and Contaminant Transport Modeling
Water Quality

POSITIONS HELD

08/89 - present	--	Bureau Chief. Bureau of Surface Water, Northwest Florida Water Management District
05/89 - 08/89	--	Senior Hydrologist. Northwest Florida Water Management District
09/88 - 05/89	--	Senior Hydrogeologist. Northwest Florida Water Management District
01/84 - 09/88	--	Associate Hydrogeologist. Northwest Florida Water Management District
08/81 - 01/84	--	Hydrologist II. St. Johns River Water Management District, Palatka, Florida
12/78 - 06/81	--	Research Assistant. Institute for Land and Water Resources, University Park, Pennsylvania

STATEMENT OF QUALIFICATIONS

Professional experience has been in the field of hydrology and hydrogeology with advanced level work on water quality, ground water, and surface water projects. Project experience includes the application of mathematical finite difference, finite element, analytical and multi-correlative statistical models for a wide range of water resources problems. These include problems of two- and three-dimensional contaminant transport and ground water flow, unsaturated zone modeling, and regional consumptive use studies. Additional experience includes work while completing graduate studies on projects of stormwater management, low flow frequency analysis, evapotranspiration, irrigation, and the assessment of a leaking industrial waste stabilization pond.

Hydrologic work at the Northwest Florida Water Management District has included the investigation of the movement of contaminants to ground water from 36 landfills in Northwest Florida, a program leading to the restoration of Lake Munson, Florida, the study of stormwater drainage problems in Leon County, Florida, the study of stormwater quality for the restoration of Bayou Texar, Escambia County, Florida and technical assistance provided to state and local government agencies concerning the PCE contamination in the Sand-and-

Gravel Aquifer, Escambia County, Florida. In most instances, the above projects have included water quality and hydrologic field data collection programs. The data collection programs included the installation of monitor wells, the deployment of automated data acquisition instruments, and the development and oversight of quality assurance.

Recent responsibilities in addition to technical work have been as a supervisor of professional staff and support personnel in the Bureau of Surface Water, under the Water Management District's Division of Resource Management. The Bureau includes 15 professionals including engineers, hydrologists, technicians, and graduate assistants. The Bureau's primary function is to conduct analyses of surface water-related problems in the District and to develop programs, which are in the fields of stormwater hydrology and hydraulics, estuarine hydrodynamics, hydro-engineering, drought management, water quality analysis, limnology, and field data collection, in order to solve these problems. In addition, two months were served as Acting Division Director of the District's Resource Management Division, which is a multi-disciplinary team of 44 personnel that includes the District's Bureau of Surface Water, Bureau of Ground Water, Bureau of Environmental and Resource Planning, Geographical Information Section, and Field Services Section.

EXPERIENCE - Project Management

Movement of Contaminants from Landfills to Ground Water in Northwest Florida -- The flow of water and contaminant movement from landfills in unsaturated soils was identified through the use of soil-water sampling techniques and computer model simulations.

Stormwater Management Plan for Bayou Texar -- Hydrologic and water quality data acquisition and development of a stormwater simulation and management model for recommending restoration alternatives in the watershed.

Water Quality Evaluation of Lake Munson -- Water quality data quality assurance officer. Analysis of lake water quality, stormwater pollutant loads, and hydrogeologic conditions.

Stormwater Drainage Evaluation of Leon County -- Hydrologic and water quality analysis, statistical analysis of stormwater data, and statistical modeling of stormwater pollutant loads.

Hydrogeology and Contaminant Movement at Five Solid Waste Landfills in Northwest Florida -- Identification of the subsurface migration of leachate in ground water for determining the effectiveness of remedial measures used to restore water quality. Analytical and two-dimensional solute transport models were used to predict contaminant transport and proposed remedial measure results.

Hydrogeologic Assessment of Solid Waste Landfills in Northwest Florida -- Assessment of ground water conditions, adequacy of monitoring and leachate generation rates for 36 solid waste landfills in northwest Florida.

Saltwater Intrusion in Volusia County, Florida -- Three dimensional model analysis of saltwater intrusion as a result of pumping from a semi-confined, limestone aquifer in a rapidly growing coastal area.

Brevard County Depression Focused Recharge -- Implementation of a hydrologic monitoring system in small surface water basins to understand recharge rates in relation to topography and surface water drainage. Data collected indicates areas suitable for development in a coastal community dependent on shallow aquifer ground water supplies.

Brevard, Indian River, Osceola, and Orange Counties Regional Ground Water Model Study -- Application of a three-dimensional finite difference ground water flow model to analyze water-level declines and projected water demands.

Ground Water Level Time Series In Northeast Florida -- Stochastic analysis of ground water levels in long-term monitoring wells for forecasting drought and ground water storage conditions.

Adaptation of Predictive Ground Water Models -- Implement and maintain a ground water model computer codes and documentation library for regulatory and planning function of the St. Johns River Water Management District.

Private Consultant -- Assessment of contamination potential at an industrial waste stabilization lagoon site and technical support for Cornell University research team on the implementation of a soil moisture accounting program.

Irrigation Water Demands and Availability in Pennsylvania -- Development of water production functions to computer simulate irrigation water demands. Used water demands in conjunction with low-flow equations to provide projections of water availability.

Teacher Assistant - Teach methods in aquatic ecology lab for sampling streams and lakes in the New Jersey Pine Barrens.

EDUCATION

B.S., Environmental Science
Stockton State College, Dept. Natural and Mathematical Science, 1978

M.S., Environmental Pollution Control, Water Resources Program
The Pennsylvania State University, Dept. Civil Engineering, 1982

PUBLICATIONS

M.S. Thesis: Water Stress Functions for Pennsylvania; 1981.

Hydro-Economic Analysis and Projection of Irrigation Water Demands in Pennsylvania (with D. F. Kibler, et al.) Pennsylvania State University Research Report; 1981.

Computer Modeling as an Aid to Ground-Water Management in Volusia County, Florida (with J. W. Mercer and S. D. Thomas) ASCE National Specialty Conference; March, 1983.

Hydrogeologic Simulation for Saltwater Intrusion in the Floridan Aquifer in Brevard and Indian River Counties, Florida. GSA Abstracts, Southeast Section Meeting; March, 1983.

Ground-Water Level Index for Evaluating the Potentiometric Surface of the Floridan Aquifer in the St. Johns River Water Management District (with D. Munch). GSA abstracts, Southeast section meeting; March, 1983.

Hydrogeologic Assessment of Solid Waste Landfills in Northwest Florida. Northwest Florida Water Management District Water Resources Special Report 85-1; January, 1985.

Simulation of Saltwater Intrusion in Volusia County, Florida (with J. W. Mercer, et al.) American Water Resources Association, Water Resources Bulletin, Vol. 22, No. 6; December, 1986.

Models of the Floridan Aquifer Applied by North Florida's Water Management Districts; Association of Ground-Water Scientist and Engineers Annual Meeting: The Impact of Regional Variations on Hydrogeologic Investigations, NWWA National Convention, Baltimore; (Invited Paper) Sept., 1985.

Quality Assurance Project Plan, Submitted to FDER in reference to USEPA. 205J Project Phase II Landfill Studies; Approved July, 1985.

Hydrogeology and Contaminant Movement at Selected Solid Waste Landfills in Northwest Florida. Northwest Florida Water Management District Water Resources Special Report 86-2; February, 1986.

Quality Assurance Project Plan, Submitted to FDER in Reference to USEPA. 205J Project Phase III Landfill Studies; Approved March, 1986.

Quality Assurance Project Plan, Submitted to FDER in Reference to the Water Quality Evaluation of Lake Munson Project; Approved Sept., 1986.

Landfill Leachate Migration in Florida's Surficial Aquifer System: Proceedings of the FOCUS Conference on Southeastern Ground Water Issues, National Water Well Association; Oct., 1986.

Modeling Remedial Actions for Landfill Contamination of Ground Water: Southeastern Groundwater Symposium, Proceedings, FWWA Tech Div: Oct., 1986.

Three-Dimensional Assessments of Ground-Water Withdrawals From The Sand-and-Gravel Aquifer In Escambia County (with D. E. Barr and J. R. Wagner). Scope of Work, Northwest Florida Water Management District, May, 1986.

Optimal Sample Periods for the Assessment of Contaminants Moving Through the Unsaturated Zone to Ground Water (with A. T. Benoit): Southeastern Ground Water Symposium, Proceedings, FWWA Tech Div: Oct., 1988.

Water Quality Evaluation of Lake Munson, Leon County Florida (with A. E. Maristany). Northwest Florida Water Management District Water Resources Assessment 88-1, August, 1988.

The Movement of Contaminants from Landfills to Ground Water in Northwest Florida (with A. T. Benoit). Northwest Florida Water Management District Water Resources Special Report 88-2, November, 1988.

Wetlands and Stormwater Management: A Case Study of Lake Munson, Part I: Long-Term Treatment Efficiencies (with A. E. Maristany). AWRA 25th Annual Conference and Symposium, Sept., 1989.

Wetlands and Stormwater Management: A Case Study of Lake Munson, Part II: Impacts on Sediments and Water Quality (with A. E. Maristany) AWRA 25th Annual Conference and Symposium, Sept., 1989.

Surface Water Resources of the Choctawhatchee River Basin in Northwest Florida (with T. Pratt and R. Artega). Northwest Florida Water Management District Water Resources Assessment 90-1, December, 1989.

MEMBER

American Geophysical Union
American Water Resources Association
Association of Ground-Water Scientists and Engineers
Florida Water Well Association (Technical Board of Directors)

RESUME

LUANN RAINS

AREAS OF INTEREST

GIS Analyst Mapping
Environmental Resources Planning

POSITIONS HELD

03/90 - Present	--	Associate Geographic Information Systems (GIS) Analyst, Northwest Florida Water Management District
08/88 - 03/90	--	Assistant Water Resources Planner, Northwest Florida Water Management District
05/88 - 07/88	--	Grant Manager, Tallahassee-Leon County Planning Department
06/86 - 05/88	--	Planner II, Tallahassee-Leon County Planning Department
01/86 - 06/86	--	Planner II, Department of Community Affairs
09/84 - 01/86	--	Planner II, Development of Regional Impact Section, Department of Community Affairs
08/83 - 01/84	--	Grants Specialist, Planning and Grants Department Gadsden County
08/82 - 05/83	--	Graduate Research Assistant, Department of Urban and Regional Planning, Florida State University

STATEMENT OF QUALIFICATIONS

My professional experience has involved environmental resource planning and mapping. During the past seven years, I have worked for city, county and regional agencies involved in environmental resource impact assessment and regulation and comprehensive plan development and implementation. My project experience includes land use/cover, environmentally sensitive areas and impervious areas mapping. These projects involved classification of satellite imagery utilizing ERDAS, raster-to-vestor conversion of the ERDAS files to ARC/INFO coverages, quantification/spatial analysis of coverages within the delineated areas of ground water contamination and mapping changes in aquatic vegetation within Escambia Bay during the past 40 years.

EXPERIENCE - PROJECT MANAGEMENT

Assessment of Land Use and Vegetative Cover in Deer Point Lake Watershed -- The location, type, and amount of land use and vegetative cover was mapped through the classification of SPOT satellite imagery and interpretation of aerial photography in order to develop watershed management strategies.

Identification of Environmentally Sensitive Areas in Deer Point Lake Watershed -- Utilizing ARC/INFO, areas highly susceptible to rapid degradation from development or alteration were identified and mapped in order to develop preservation strategies for these areas.

Land Use and Nonpoint Assessment of the Apalachicola River and Bay Watershed -- The location, type, and amount of land use and vegetative cover was mapped through the classification of Landsat TM and SPOT satellite imagery and interpretation of aerial photography in order to identify potential water quality impacts of various land uses and develop watershed management strategies.

Land Use and Land Cover Mapping of Tallahassee-Leon County -- Land use and land cover maps of Tallahassee-Leon County were classified and digitized in Intergraph from low altitude aerial photography to provide data for the Tallahassee-Leon County Comprehensive Plan.

Environmentally Sensitive Areas Mapping of Tallahassee-Leon County -- A series of maps delineating environmentally sensitive areas, such as floodplains, wetlands, excessive slopes and areas unsuitable for septic tanks, were developed utilizing extensive field verification and numerous source maps. These maps were used in conjunction with land development regulations to preserve environmentally sensitive areas and mitigate the impacts of urban development.

PUBLICATIONS

Deer Point Lake: Preliminary Land Use and Nonpoint Source Assessment, with D. Wiley, Northwest Florida Water Management District, June 1990.

EDUCATION

M.S., Urban & Regional Planning
Florida State University, 1984

B.S., Geography
University of Southern Mississippi, 1982

ADDITIONAL TRAINING

PC ARC/INFO Training Course 1989
ERDAS Training Course 1989
ARC/INFO Training Course 1990

PROFESSIONAL CERTIFICATION

American Institute of Certified Planners

PROFESSIONAL ORGANIZATIONS

American Planning Association, Florida Chapter

RESUME

TIEN-SHUENN WU, Ph.D., P.E.

AREAS OF INTEREST

Hydrodynamic and Water Quality Modeling of Lake, Reservoir, River, and Estuarine Systems
Watershed Hydraulic-hydrological Simulation
Management, Design and Planning of Water Resources Systems

POSITIONS HELD

11/90 - present	--	Associate Hydrologist - Northwest Florida Water Management District
02/89 - 10/90	--	Assistant Hydrologist - Northwest Florida Water Management District
02/87 - 01/89	--	Post Doctoral Associate - Coastal & Oceanographic Engineering Dept., University of Florida
08/81 - 12/86	--	Research/Teaching Assistant - North Carolina State University
08/79 - 12/80	--	Research Assistant - Department of Agricultural Engineering and Hydraulic Research Laboratory National Taiwan University

STATEMENT OF QUALIFICATIONS

After my service as an officer in the Army Corps of Engineers of the Republic of China (October, 1977-August, 1979), I was a research assistant at the Hydraulic Research Laboratory of the National University of Taiwan (September, 1979-December, 1980). While working toward my doctorate at North Carolina State University (January, 1981-December 1986), I had a wide range of teaching experience. I tutored students in such courses as Electrical Circuits (Electrical Engineering), Partial Differential Equations (Department of Mathematics), Pascal, Data Structure (computer science), Hydraulics, Statics and Dynamics (Civil Engineering). As a post-doctoral associate at the University of Florida (January, 1987-January, 1988), I advised and supervised Ph.D. and M.S. thesis work.

Since being employed by the Northwest Florida Water Management District (NWFWMD) in February, 1989, I have been the project manager or principal investigator for six funded projects. One current project, an assessment of "Apalachicola Bay Freshwater Needs," was conceived and designed by me while I was in charge of the more comprehensive "Hydrologic Assessment of the Apalachicola and Bay." "Freshwater Needs" is likely to become the seed of a four-year project that will integrate hydrologic, three-dimensional hydrodynamic, water quality, and ecologic models and hopefully yield a deeper understanding of the Bay's functioning.

I have previously worked on seven complex estuarine systems including: Pamlico Sound, North Carolina; The Bay of Fundy, Canada; James River/Hampton Roads Estuarine System, Virginia; St. Andrew and adjoining bays, Florida; Pensacola Bay, Florida; Bayou Chico, Florida; and Apalachicola Bay, Florida. As part of my experience and employment, I have modified and applied four three-dimensional estuarine models: SIM3DLIU, Rand Corporation; HYDRO3D, U. S. Environmental Protection Agency, CH3D, U. S. Army Engineering Corps and University of Florida; and ECOM-3D, HydroQual Inc. Company and University of South Florida.

Qualifications include the ability to solicit, supervise and conduct the research/technical projects related to estuarine hydrodynamics/contaminant transport, stormwater hydrology/hydraulics, ground water, and water quality.

EXPERIENCE - Project Manager

Hydrologic Assessment of the Apalachicola River and Bay Scope of Work -- Evaluate the existing freshwater need for a healthy Apalachicola Bay and organize a team to select an estuarine model for the Apalachicola Bay.

EXPERIENCE - Principal Investigator

Apalachicola Bay Fresh Water Needs -- Applying a selected curvilinear model and calibrating it by using the prototype data provided by the Mobile District of U. S. Army Corps of Engineers.

Initial Analysis of Circulation and Flushing Characteristics of St. Andrew Bay System -- Applied a three-dimensional (3-D) hydrodynamic model to St. Andrew and adjoining bays and studied the flushing and pollution problems.

Quality Assurance Project Plan, Pensacola Bay Area Swim Program, Bayou Chico Restoration Project -- Applying a three-dimensional (3-D) hydrodynamic model to Bayou Chico to evaluate the flushing effects in the flood, drought, and average seasons.

Stormwater Drainage Evaluation of the Lake Lafayette, Lake Munson, Lake Jackson, and Fred George Basin -- Applying the HEC-2 Model to all these basins to calculate the water elevation at 1-, 2-, 5-, 10, 20-, 50-, 100-, 200-, and 500- year storms.

Pensacola Bay - Hydrodynamic Modeling -- applied a three-dimensional hydrodynamic model to Pensacola Bay to analyze the circulation characteristics.

EXPERIENCE - Post Doctoral Associate

Three-Dimensional Numerical Modeling of James River/Hampton Roads Estuarine System -- Developed a three-dimensional (3-D) curvilinear model and calibrated it using the prototype data provided by Virginia Institute of Marine Science (VIMS).

EXPERIENCE - Post Graduate

Operation of Hydraulic Model of Feitsui Dam, Spillway, Sluiceway, and Plunge Pool -- constructed and operated the 1:80 scale hydraulic model.

EDUCATION

United States Environmental Protection Agency, Athens, GA. - Training Course on Advanced Water Quality and Exposure Modeling with Water Analysis Simulation Program (WASP4) -- July 1990

Ph. D. Civil Engineering
North Carolina State University, Raleigh, NC - January 1987

M. S. Civil Engineering
North Carolina State University, Raleigh, NC - December 1982

B. S. Agricultural Engineering (hydraulic section)
National Taiwan University, Taiwan, ROC

Doctoral Thesis: "The Direct Computation of Tidal Circulation in Harbors"

PUBLICATIONS

Amein, M., J. C. Li and T. S. Wu, "Direct Computation of Dam-Break Waves," Frontiers of Hydraulic Engineering, p. 331-336, August, 1983.

Wu, T. S., "The Direct Computation of Tidal Circulation in Harbors," University Microfilm International, 300, N. Zeeb Road, Ann Arbor, MI 48106, Ph. D., 1987.

Sheng, Y. P., T. S. Wu, M. Abdelrhman, K. Liu, and H. Lee, "Coastal and Estuarine Hydrodynamic Modeling," International Coastal Engineering Conference, in Spain, June, 1988.

Sheng, Y. P., T. S. Wu and P. F. Wang, "Coastal and Estuarine Hydrodynamic Modeling in Curvilinear Grids," Proceeding of 21st International Conference on Coastal.

Wu, T. S. and G. S. Janowitz, "An Analytical Solution to Verify a Nonlinear Tidal Circulation Model," Proceeding of the ASCE 1989 National Conference on Hydraulic Engineering.

Wu, T. S., W. K, Jones, and A. Rodriguez., "Three-dimensional Model of a Stratified Estuary, St. Andrew Bay System," Proceeding of the ASCE 1990 National Conference on Hydraulic Engineering.

Wu, T. S., W. K. Jones, D. Wilber, R. Bartel, K. H. Wang, "A Team Approach to Estuarine Modeling for Apalachicola Bay," Proceeding of ASCE 1990 Florida Section Annual Meeting on Hydrology Technical Program.

Wu, T. S., K. H. Wang, W. K. Jones, "An Analytical Solution to Explain the Transient in an Estuarine Tidal Circulation," International Conference on Computer Applications in Water Resources, Taipei, Taiwan, July 3-6, 1991.

Wu, T. S., W. K. Jones, T. Pratt, K. H. Wang, "Three-Dimensional Model for a Degraded Water Body -- Bayou Chico, Florida, USA," International Conference on Computer Applications in Water Resources, Taipei, Taiwan, July 3-6, 1991.

PROFESSIONAL REGISTRATION

Licensed Civil/Sanitary Professional Engineer, Florida, No. 44199

RESUME

JAY L. JOHNSON

AREAS OF INTEREST

Ground Water Geochemistry
Geostatistics
Ground Water Sampling Techniques
Ground Water Flow Modelling

POSITIONS HELD

07/90 - Present	--	District Quality Assurance Officer, Northwest Florida Water Management District
03/90 - Present	--	Assistant Hydrogeologist, Northwest Florida Water Management District
02/88 - 03/90	--	Hydrogeology Specialist, Northwest Florida Water Management District
03/87 - 02/88	--	Environmental Health Specialist, Department of Health and Rehabilitative Services, Sumter County Public Health Unit

STATEMENT OF QUALIFICATIONS

Responsibilities as Assistant Hydrogeologist at the Northwest Florida Water Management District include analyzing, interpreting, and distributing hydrochemical and hydrologic data from the District's active monitoring programs. Quality Assurance Officer responsibilities include overseeing the quality control of all sampling programs within the District, both surface water and ground water.

Possess wide experience with microcomputer applications, including data bases, statistical and graphing packages, and mapping/CAD systems.

EXPERIENCE

Statistical Analysis of Hydrochemical Results -- Perform statistical tests to determine presence of trends, cycles, and seasonal components in water quality data. Produce summary statistics, contour maps, and dominant water type maps to determine baseline ambient hydrochemical conditions in ground water in the Florida panhandle. Check both accuracy and precision of data as reported from laboratories.

Escambia County Sand and Gravel Aquifer Model Team Member -- Part of team effort to create conceptual and numerical flow model for Escambia county. Primarily responsible for contamination inventory, ground water quality summary, and coordination of sampling saline intrusion evaluation network. Contributed to development of semi-automated mesh generator for finite element flow model.

Coordination of DOT Altha Drainage Well Study -- Manage routine aspects of study to define quality of runoff entering selected drainage wells. Responsible for site preparation, coordination with Florida Department of Environmental Regulation (FDER) lab, design of sampling techniques, training of field personnel, compilation of monthly progress reports to Florida Department of Transportation (FDOT), and major contributions to final report.

Quality Assurance Audits -- Conduct regular field audits of sampling teams to assess procedures and team performance from a quality assurance perspective. Assist field personnel with suggested methods and equipment designed to eliminate cross-contamination of equipment and samples.

Quality Assurance Plans -- Write quality assurance project plans to satisfy FDER requirements. Maintain and update Comprehensive Plan which acts as reference for all project plans. These plans document all aspects of their projects, from field collection and handling of samples to laboratory methods of analysis.

Physical and Chemical Safety Plan -- Responsible for writing and updating guidance document for field personnel covering proper procedures for dealing with physical and chemical hazards of field operations.

Collected Samples for AMBIENT V Seasonal Variability Study -- Was responsible for field collection of ground water samples over the period of one year from selected background wells across the District. Resolved QA/QC issues. Interpreted data.

Design and Installation of VISA Monitoring Well Network -- Planned monitor well network to be installed in Gulf Breeze Peninsula, obtained easements, and coordinated drilling of these wells. Supervised finishing and development of wells.

Maintain Multiple Data Bases -- Respond to information requests and prepare data for publication from water quality, well inventory, rainfall, water level, and point source contamination data bases.

EDUCATION

University of Florida, Graduate course work, Geoscience
University of Florida, Bachelor of Science, Geology, 1984

CONTINUING EDUCATION COURSES

Use of Statistics in Sample Planning and Design, FDER by Dr. Sam Upchurch, 2-day short course, 1991

The Use of Statistics in the Evaluation of Ground Water Quality, FDER by Dr. Sam Upchurch, 2-day short course, 1990

Clay Mineralogy and Ground Water, FDER by Dr. Sam Upchurch, 2-day short course, 1989

Statistical Analysis of Geological Data, FDER by Dr. Sam Upchurch, 2-day short course, 1989

Ground Water Chemistry, FDER by Dr. Sam Upchurch, 2-day short course, 1989

Water-Quality Field Techniques for Ground-Water Monitoring, USGS, 2-day short course, 1988

Well Construction Techniques, HRS, 1- day seminar, 1987

Environmental Health Training, HRS and USF, 3 week course, 1987

PUBLICATIONS

Johnson, J. L., 1990, Seasonal Water Quality Variations in Background Wells in Northwest Florida, July 1988 to May 1989; Preliminary Analysis. Northwest Florida Water Management District Technical File Notes.

Clemens, L. A., Dalton, J. B., and Fendick, R. D., edited by Johnson, J. L., 1989, Ambient Ground Water Quality in Northwest Florida Part I: Ground Water Sampling and Analysis. Northwest Florida Water Management District Water Resources Special Report 87-1, Revised Edition.

RESUME

CHRISTOPHER J. RICHARDS

AREAS OF INTEREST

Hydrostratigraphy
Ground Water Hydrology
Geophysics
Log Analysis

POSITIONS HELD

10/90 - present	--	Associate Hydrogeologist. Northwest Florida Water Management District
12/85 - 10/90	--	Assistant Hydrogeologist. Northwest Florida Water Management District
08/80 - 08/84	--	Field Engineer. Dresser Atlas, Inc., San Angelo, Texas
10/76 - 04/77	--	Geologist I. State of Louisiana, Louisiana State Mineral Board, Baton Rouge, Louisiana

STATEMENT OF QUALIFICATIONS

For the past nine years I have been involved in all aspects of borehole geophysics in both petroleum exploration and ground water investigations. Planning, data acquisition, log analysis and formation evaluation in a wide variety of geologic settings required the use of a variety of geophysical logs and many different analytical techniques. For the past four years, I have been involved in a variety of ground water projects. Responsibilities included delineation and mapping of hydrostratigraphic units, aquifer testing and analysis, review of ground water monitoring networks associated with landfills and underground injection facilities, design and installation of ground water monitoring networks, log analysis and ground water availability studies. Petroleum exploration work involved determination of the oil and gas potential of mineral leases.

EXPERIENCE

Availability of Ground Water at Selected Sites in Gadsden and Leon Counties, Northwest Florida -- (Principle Investigator) Conducted an investigation of the hydrogeology and availability of ground water at four sites being considered for a coal-fired electric generating plant. Project included construction of wells for multi-well aquifer tests, aquifer testing at three sites, analysis of existing data, water quality considerations and predicting aquifer drawdown for various withdrawal rates.

Northwest Florida Water Management District Well Plugging Program -- (Project Manager) Responsibilities include identification of abandoned wells and prioritization for plugging based on the potential for aquifer contamination and possible impact to local populations. Other responsibilities include oversight of field plugging operations and sub-contractors.

Design and Installation of the VISA Monitoring Well Network -- Designed a monitoring well network for an industrialized portion of Pensacola, Florida. Managed the installation of monitor wells in the Pensacola and four other Very Intensely Studied Areas of Northwest Florida. The VISA areas were selected based on susceptibility to ground water contamination and land use analysis. The network consists of 75 newly constructed wells and approximately 50 existing wells.

Geophysical Logging -- Operated all types of geophysical logging equipment. Experience includes logging over one thousand wells in both petroleum exploration and ground water investigations, quantitative analysis of these logs, and managing logging crews.

Investigation of Ground Water Availability and Water Quality -- Planned a multi-well aquifer test in northern Calhoun County utilizing existing wells. Verified the heterogeneous nature of the carbonate aquifer by flow log analysis. Using porosity and resistivity logs, determined the water quality and degree of increasing mineralization within the lower, untested portion of the aquifer.

Ambient Ground Water Monitoring Project -- Mapped hydrogeologic units present in Northwest Florida. Participated in the design and installation of a regional background water quality monitoring network. Supervised field activities and conducted well logging operations. Other responsibilities included updating the data base and data base management.

EDUCATION

Bachelor of Science in Geology, Louisiana State University

PUBLICATIONS

Richards, C. J. and Dalton, J. B., 1987. Availability of Ground Water at Selected Sites in Gadsden and Leon Counties, Northwest Florida. Northwest Florida Water Management District, Water Resources Special Report 87-2.

PROFESSIONAL REGISTRATION

Licensed Professional Geologist, Florida, No. 487

JAMES W. MERCER, Ph.D.

President, GeoTrans, Inc.
Principal Hydrogeologist

Professional Expertise:

Numerical simulation
Groundwater hydrology
Groundwater pollution and aquifer water quality
Solute & heat transport
Multiphase flow in porous media
Hazardous waste disposal
Radioactive waste disposal
Remedial actions
Seawater intrusion
Geothermal reservoir analysis

Education:

Ph.D., Geology, University of Illinois, 1973
M.S., Geology, University of Illinois, 1971
B.S., Geology, Florida State University, 1969
A.S., Gulf Coast Jr. College, Panama City, Florida, 1967

Professional Experience:

October 1979 - Present

President and Principal Hydrogeologist, GeoTrans, Inc., Herndon, Virginia.
Specializes in all phases of geohydrologic transport analysis including groundwater flow, heat and solute transport in porous media for a wide range of applications such as aquifer resource analysis, aquifer thermal storage, geothermal energy development, radioactive waste storage, seawater intrusion, and hazardous waste problems. Experience in the following U.S. Environmental Protection Agency programs: RCRA, CERCLA/SARA, UST, and UIC. Management responsibilities include supervision of approximately 50 professionals and serving as principal investigator on several contracts.

Daily project work involves overseeing data collection, data management, and analysis. Various tasks include modeling, training, and expert witness testimony.

June 1971 - October 1979

Hydrologist, U.S. Geological Survey, Water Resources Division, Reston, Virginia.
Planning and conducting research in groundwater hydrology to predict the effects of specified stresses on groundwater systems using finite difference and finite element techniques to develop and test numerical models for describing and predicting mass and energy transport in multiphase, multi-dimensional groundwater systems. Problems examined include transport related to high- and low-level radioactive waste storage, geothermal reservoir analysis, seawater intrusion in coastal aquifers, and multifluid flow in reservoirs.

Teaching and Lecturing Experience:

Taught "Modeling of Ground-Water Flow" as part of the 1990 Spring meeting of the American Institute of Hydrology on March 14, 1990 in Las Vegas, Nevada.

Participated in U.S. Environmental Protection Agency Seminar on Site Characterization for Subsurface Remediations, taught at all ten EPA regional offices, Fall 1989 - Spring 1990.

Participated in RSKERL-Ada Technical Assistance Program: Oily Waste-Fate, Transport, Site Characterization, Remediation, Denver, CO, May 17-18, 1989.

Taught short course (3 1/2 days) on Hydrogeology and Groundwater Pollution at the U.S. Department of Energy, Grand Junction, Colorado compound, November 28 - December 2, 1988.

Participated in short course on Risk Assessment and Management for Hazardous Materials: From Cradle to Grave at The Center for Risk Management of Engineering Systems of the University of Virginia, Oct. 25-26, 1988.

Taught seminar in advanced hydrology (including well testing and modeling) at the George Washington University, Spring Semester 1979; Spring Semester 1983; Spring Semester 1985; Spring Semester 1987; as an Associate Professorial Lecturer in Geology.

Participated in the U.S. Geological Survey training courses in groundwater modeling, advanced groundwater hydrology, and salt water-fresh water relationships.

Participated in a short course held at the University of Southern California on recent advances in reservoir simulation, July 5 - 9, 1977.

Taught groundwater modeling short courses at the Holcomb Research Institute, Butler University, Indianapolis, Indiana, April and June 1980; May and June 1981; August 1982 (with Dr. Jacob Bear); March 1983; March 1984; March 1985; March 1986; March 1987; March 1988; March 1989, April 1989.

Included in the U.S. Geological Survey Centennial (1979) lecture series made available to Sigma Xi chapters.

Taught introduction to groundwater modeling short course at EPA Headquarters, Washington, D.C., March 1980, and EPA Region IV, Atlanta, Georgia, November 1981; taught groundwater modeling short course using personal computers at EPA Region IV, Atlanta, Georgia, February 1985.Taught groundwater modeling short course at Georgia Southwestern College, Americus, Georgia, July 1982.

Taught groundwater modeling short courses to St. Johns River Water Management District, Palatka, Florida, October 1982 and October 1983; and to South Florida Water Management District, October 1983 and February 1986; and to Southwest Florida Water Management District, October 1984 and July 1986.

Included in the University of South Florida's seminar on pesticides in groundwater, May 1984.

Professional Certification:

Certified Professional Geologist,
State of Delaware, No. 309, State of Indiana, No. 341, State of Virginia, No. 273,
State of South Carolina, No. 562, State of Florida, No. 275
American Institute of Professional Geologists, Number 6020
American Institute of Hydrology - Professional Hydrogeologist, No. 886

Professional Affiliations:

Society of Petroleum Engineers, Member
American Geophysical Union, Member
Geological Society of America, Fellow

National Water Well Association, Member
American Water Resources Association, Member
American Society of Civil Engineers, Member
International Association of Hydrogeologists, Member

Honor Societies and Awards:

Phi Beta Kappa
Pi Mu Epsilon
Sigma Xi
Summa Cum Laude
Chevron Senior Scholarship
NDEA Title IV Fellowship
Who's Who in Frontier Science and Technology
ASCE 1985 Wesley W. Horner Award
NWWA 1987 Distinguished Seminar Series
26th Henry W. Shaw Lecture in Civil Engineering (North Carolina State University)

Committees:

Member of the U.S. Environmental Protection Agency Solid Waste Management Units (SWMUs) Stabilization Workgroup, September, 1990.

Member of the U.S. Department of Energy Peer Review Team for Unsaturated Zone Hydrology (at Yucca Mountain, Nevada), April - September, 1990.

Member of a mission to the Donana National Park, Spain, Sponsored by the International Union for Conservation of Nature and Natural Resources (IUCN) and ADENA, the Spanish affiliate of the Worldwide Fund for Nature (WWF), November, 1988.

Member of the site visit committee of the Natural Sciences and Engineering Council of Canada. Site visit was to the University of Waterloo to review proposal on "Field behavior of dense solvents in groundwater," July 27, 1988.

Member of Water Science and Technology Board Committee on Ground Water Modeling Assessment, 1987-1989.

Member of the Water Pollution Control Federation's Groundwater Committee, 1987-1989.

Member of the Laboratory Director's Annual Review Committee, Earth Sciences Division, Lawrence Berkeley Laboratory, University of California, 1987.

National Research Council's Water Science and Technology Board, 1986 - 1989.

Secretary of the Hydrology Section of the American Geophysical Union, 1986 - 1988.

Co-convener of the American Geophysical Union Chapman Conference on Microbial Process in the Transport, Fate and In-situ Treatment of Subsurface Contaminants, Snowbird, Utah, October 1986.

Member of the U.S. Department of Energy Radionuclide Migration (RNM) Project Peer Review Committee, 1986.

Member of the U.S. Environmental Protection Agency Ground-Water Modeling Study Group, February 1986 - May 1986.

Co-convener of the American Geophysical Union Symposium on Saturated/Unsaturated Ground-Water Flow Systems: Measurement and Estimation of Parameters. Baltimore, Maryland, May 1985.

Member of the Ground-Water Research Subcommittee of the Science Advisory Board of the U.S. Environmental Protection Agency, December 1984 - June 1985.

Co-convener of the American Geophysical Union Symposium on Miscible and Immiscible Transport in Ground Water, Cincinnati, Ohio, May 1984.

National Research Council Panel on Groundwater Contamination (1983).

Advisory panel for the Office of Technology Assessment (Congress of the United States) on national groundwater contamination (1983).

International technical advisory committee of the International Ground Water Modeling Center (1983 - 1985).

Co-convener of the American Geophysical Union Symposium on the Role of the Unsaturated Zone in Radioactive and Hazardous Waste Disposal, Philadelphia, Pennsylvania, May 1982.

Co-convener of the Gordon Conference on Fluids in Permeable Media: Mathematics of Modeling and Simulating, Andover, New Hampshire, July 1980.

Co-convener of the American Geophysical Union Symposium on the Unsaturated Zone as a Barrier in Waste Disposal, Washington, D.C., May 1979.

Co-convener of the Geological Society of America Penrose Conference on Heat Transport Processes in the Earth, Vail, Colorado, November 1978.

Member of the Editorial Board for Journal of Contaminant Hydrology (1985 - present).

Member of the Editorial Board for Ground Water (1980 - 1984).

Member of the Editorial Board for Geology (1979 - 1982).

Member of the 1982 - 1985 American Geophysical Union Ground Water Committee.

Member of the 1978 - 1983 American Geophysical Union Committee on Water in the Unsaturated Zone.

Member of the 1977 - 1978 ERDA Geothermal Exploration, Modeling and Reservoir Assessment Committee.

Publications:

Publications in Water Supply:

1. Andersen, P.F., R.M. Cohen, and J.W. Mercer, 1984. Numerical Modeling as a Conceptual Tool to Assess Drawdown in a Multiaquifer System, Symposium on Practical Applications of Ground Water Models, sponsored by National Water Well Association, Columbus, Ohio.

Publications in Vadose Zone Evaluation:

1. Huyakorn, P.S., J.W. Mercer, and D.S. Ward, 1985. Finite-element matrix and mass balance computational schemes for transport in variably-saturated porous media, *Water Resources Research,* 21(3):346-358.
2. Mercer, J.W., P.S.C. Rao, and I.W. Marine, (Eds.), 1983. Role of the unsaturated zone in radioactive and hazardous waste disposal: Ann Arbor Science Publishers, Inc., Ann Arbor, Michigan, 339 pp.
3. Mercer, J.W., and C.R. Faust, 1976. The application of finite-element techniques to immiscible flow in porous media, presented at the International Conference on Finite Elements in Water Resources, Princeton University.

Publications in Wetland Hydrology

1. Hollis, T., P. Heurteaux, and J.W. Mercer, 1989. The implication of groundwater extractions for the long term future of the Donana National Park, report of the WWF/IUCN/ADENA Mission to the Donana National Park, May, 60 pp.

Publications in General Groundwater:

1. Faust, C.R., and J.W. Mercer, 1984. Evaluation of the skin effect in slug tests, *Water Resources Research*, 20(2): 504-506.

Publications in General Modeling:

1. Mercer, J.W., 1988. Standards of performance for investigative methods used in assessing groundwater pollution problems with emphases on the use and abuse on numerical models, *Proceedings of the Workshop on Groundwater Quality Protection*, Water Pollution Control Federation Annual Conference Workshop, Dallas, TX.
2. Konikow, L.F., and J.W. Mercer, 1988. Groundwater flow and transport modeling, *Journal of Hydrology*, Vol. 100, 379-409.
3. van der Heijde, P.K.M., P.S. Huyakorn, and J.W. Mercer, 1985. Testing and validation of groundwater models, Symposium on Practical Applications of Ground Water Models, pp. 14-31.
4. Mercer, J.W., and C.R. Faust, (in press). Application of computers, *Groundwater Handbook*, McGraw-Hill, New York.
5. Mercer, J.W., and C.R. Faust, 1981. *Ground-Water Modeling*, National Water Well Association, Columbus, Ohio, 60 pp.
6. Faust, C.R., and J.W. Mercer, 1980. Ground-water modeling: Recent developments: *Ground Water*, 18(6).
7. Mercer, J.W., and C.R. Faust, 1980. Ground-water modeling: Applications: *Ground Water*, 18(5).
8. Faust, C.R., and J.W. Mercer, 1980. Ground-water modeling: Numerical models: *Ground Water*, 18(4).
9. Mercer, J.W., and C.R. Faust, 1980. Ground-water modeling: Mathematical models, *Ground Water*, 18(3): 212-227.
10. Mercer, J.W., and C.R. Faust, 1980. Ground-water modeling: An overview, *Ground Water*, 18(2): 108-115.
11. Wells, R.B., C.R. Faust, and J.W. Mercer, 1976. A Cross-Section Plotting Program (CSPP) for Gridded (MAP) Data, U.S. Geological Survey, *Open-File Report 76-689*.
12. Faust, C.R., and J.W. Mercer, 1976. An analysis of finite-difference and finite-element techniques for geothermal reservoir simulation, *Proceedings of Fourth Society of Petroleum Engineers Symposium on Numerical Simulation of Reservoir Performance*, Los Angeles, California, February 19-20.

Publications in Geochemistry:

1. Li, T.M.C., J.W. Mercer, C.R. Faust, and R.J. Greenfield, 1978. Simulation of geothermal reservoirs including changes in porosity and permeability due to silica-water reactions, presented at the Fourth Workshop on Geothermal Reservoir Engineering, Stanford University, Stanford, California.

Publications in Optimization Techniques:

1. Maddock, T., III, J.W. Mercer, and C.R. Faust, 1982. Management model for power production from a geothermal field: 1. Hot water reservoir and power plant model, *Water Resources Research*, 18(3): 499-512.
2. Maddock, T. III, J.W. Mercer, C.R. Faust, and E.D. Attanasi, 1979. Management model for electrical power production from a hot-water geothermal reservoir, Reports on Natural Resources Systems, No. 34, University of Arizona, Tucson, Arizona, 114 pp.

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1. Andersen, P.F., H.O. White, Jr., and J.W. Mercer, 1988. Numerical modeling of saltwater intrusion at Hallandale, Florida, *Ground Water*, 26(5):619-630.
2. Huyakorn, P.S., P.F. Andersen, J.W. Mercer, and H.O. White, Jr., 1987. Saltwater intrusion in aquifers: Development and testing of a three-dimensional, finite-element model, *Water Resources Research*, 23(2): 293-312.
3. Andersen, P.F., H.O. White, J.W. Mercer, A.D. Truschel and P.S. Huyakorn, 1986. Numerical modeling of ground water flow and saltwater transport in Northern Pinellas County, Florida, *Proceedings of FOCUS Conference on Southeastern Ground Water Issues*, National Water Well Association, Dublin, Ohio, pp. 419-449.
4. Mercer, J.W., B.H. Lester, S.D. Thomas, and R.L. Bartel, 1986. Simulation of saltwater intrusion in Volusia County, Florida, *Water Resources Bulletin*, 22(6): 951-965.
5. Huyakorn, P.S., J.W. Mercer, and P.F. Andersen, 1986. Seawater intrusion in coastal aquifers: Theory, finite-element solution, and verification tests, VI International Conference on Finite-Elements in Water Resources, Lisbon, Portugal.
6. Faust, C.R., and J.W. Mercer, 1982. Preliminary analysis of ground-water development and brackish water upconing at Virginia Beach, Virginia, Special Publications: Number 1, Georgia Southwestern College - *Studies of the Hydrogeology of the Southeastern United States:* 1981, B.F. Beck (ed.), pp. 30-37, pp. 797-818.
7. Mercer, J.W., S.P. Larson, and C.R. Faust, 1980. Simulation of salt-water interface motion, *Ground Water*, 18(4):374-385.
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2. Mercer, J.W., D.C. Skipp, and D. Giffin, 1990. Basics of pump-and-treat groundwater remediation, U.S. Environmental Protection Agency EPA/600/8-90/003, Ada, Oklahoma, 31 p.
3. Mercer, J.W., 1990. Don't gamble on a real estate purchase: An environmental assessment can separate winners from losers, American Society of Appraisers, *Valuation*, 35(1): 116-121.
4. Faust, C.R., J.H. Guswa, and J.W. Mercer, 1989. Simulation of three-dimensional flow of immiscible fluids within and below the unsaturated zone, *Water Resources Research*, 25(12): 2449-2464.
5. Mercer, J.W., D.A. Giffin, Jr., J.C. Herweijer, and P. Srinivasan, 1989. Groundwater contamination: Processes, characterization, analysis, and remediation, International Workshop on Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries, Hyderabad, India, Feb 28 - Mar 4, 1989.
6. Bouwer, E., J. Mercer, M. Kavanaugh, and F. DiGiano, 1988. Coping with groundwater contamination, *Journal Water Pollution Control Federation*, 6(8): 1414-1428.
7. Srinivasan, P., and J.W. Mercer, 1988. Simulation of biodegradation and sorption processes in groundwater, *Ground Water*, 26(4):475-487.
8. Faust, C.R., R.R. Rabold, and J.W. Mercer, 1988. Modeling remedial actions at S-Area, Niagara Falls, NY, *Proceedings of the Seminar on Impact of Hazardous Waste Facilities on Water Utilities*, American Water Works Association Annual Conference, Orlando, FL.

9. Mercer, J.W., C.R. Faust, A.D. Truschel, and R.M. Cohen, 1987. Control of Groundwater Contamination: Case Studies, *Proceedings of Detection, Control, and Renovation of Contaminated Ground Water,* American Society of Civil Engineers, Environmental Engineering Division, pp. 121-133.

10. Duffield, G.M., D.R. Buss, D.E. Stephenson, and J.W. Mercer, 1987. A grid refinement approach to flow and transport modeling of a proposed ground-water corrective action at the Savannah River Plant, Aiken, South Carolina, *Proceedings of the Conference on Solving Ground Water Problems with Models,* National Water Well Association, Dublin, Ohio, pp. 1087-1120.

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13. Buss, D.R., B.H. Lester, and J.W. Mercer, 1986. A numerical simulation study of deep-well injection, *Current Practices in Environmental Science and Engineering,* Vol. 2, pp. 93-117.

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15. Mercer, J.W., C.R. Faust, R.M. Cohen, P.F. Andersen, and P.S. Huyakorn, 1984. Remedial Action Assessment for Hazardous Waste Sites Via Numerical Simulation, Seventh Annual Madison Waste Conference on Municipal & Industrial Waste, University of Wisconsin, Madison, Wisconsin.

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17. Cohen, R.M. and J.W. Mercer, 1984. Evaluation of a proposed synthetic cap and concrete cut-off wall at Love Canal using a cross-sectional model, Fourth National Symposium and Exposition on Aquifer Restoration and Ground-Water Monitoring, Columbus, Ohio.

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1. Faust, C.R., J.W. Mercer, S.D. Thomas, and W.P. Balleau, 1984. Quantitative analysis of existing conditions and production strategies for the Baca geothermal system, New Mexico: *Water Resources Research,* 20(5): 601-618.

2. Faust, C.R., J.W. Mercer, and W.J. Miller, 1980. The DOE code comparison study: Summary of results for problem 1, presented at the Sixth Workshop on Geothermal Reservoir Engineering, Stanford, California, December 17, 1980.

3. Mercer, J.W., and C.R. Faust, 1980. The physics of fluid flow and heat transport in geothermal systems, *Sourcebook on the Production of Electricity from Geothermal Energy*, Joseph Kestin (ed), U.S. Department of Energy DOE/RA/4051-1, pp. 121-135.

4. Mercer, J.W., and C.R. Faust, 1979. A review of numerical simulation of hydrothermal systems, *Hydrological Sciences Bulletin*, 24(3): 335-343.

5. Mercer, J.W., and C.R. Faust, 1979. Geothermal reservoir simulation 3: Application of liquid- and vapor-dominated hydrothermal modeling techniques to Wairakei, New Zealand, *Water Resources Research*, 15(3): 653-671.

6. Mercer, J.W., and C.R. Faust, 1979. Reservoir engineering and evaluation, presented at the Geothermal Resources Council Symposium on Geothermal Energy and Its Direct Uses in the Eastern United States, Roanoke, Virginia.

7. Faust, C.R., and J.W. Mercer, 1979. Geothermal reservoir simulation 2. Numerical solution techniques for liquid- and vapor-dominated hydrothermal systems, *Water Resources Research*, 15(1): 31-46.

8. Faust, C.R., and J.W. Mercer, 1979. Geothermal reservoir simulation 1. Mathematical models for liquid- and vapor-dominated hydrothermal systems, *Water Resources Research*, 15(1): 23-30.

9. Huyakorn, P.S., G.F. Pinder, C.R. Faust, and J.W. Mercer, 1978. Finite element simulation on two-phase flows in porous media, *Computational Techniques for Interface Problems*, ASME, AMD, Vol. 30, pp. 19-43.

10. Faust, C.R., and J.W. Mercer, 1977. Version I, A finite-difference model of two-dimensional, single- and two-phase heat transport in a porous medium, U.S. Geological Survey, *Open-File Report 77-234.*

11. Faust, C.R., and J.W. Mercer, 1977. A theoretical analysis of fluid flow and energy transport in hydrothermal systems, U.S. Geological Survey, *Open-File Report 77-60.*

12. Mercer, J.W., and G.F. Pinder, 1975. A finite-element model of a two-dimensional, single-phase heat transport in a porous medium, U.S. Geological Survey, *Open-File Report 75-574*, 115 pp.

13. Mercer, J.W., and C.R. Faust, 1975. Simulation of water- and vapor-dominated hydrothermal reservoirs, presented at 50th Annual Fall Meeting of Society of Petroleum Engineers of AIME, Dallas, Texas.

14. Faust, C.R., and J.W. Mercer, 1975. Mathematical modeling of geothermal systems, presented at the Second United Nations Symposium on the Development and Use of Geothermal Resources, San Francisco, California.

15. Mercer, J.W., G.F. Pinder, and I.G. Donaldson, 1975. A Galerkin finite-element analysis of the hydrothermal system at Wairakei, New Zealand, *Journal of Geophysical Research*, 80(17): 2608-2621.

16. Mercer, J.W., C.R. Faust, and G.F. Pinder, 1974. Geothermal reservoir simulation, *Proceedings of National Science Foundation Conference on Research for the Development of Geothermal Energy Resources*, Pasadena, California, pp. 256-257.

17. Mercer, J.W., and G.F. Pinder, 1974. Finite-element analysis of hydrothermal systems, Oden, J.T., et al. (ed), *Proceedings of International Symposium on Finite Element Methods in Flow Problems*, Swansea, Wales, UAH Press, pp. 410-414.

18. Mercer, J.W., and G.F. Pinder, 1973. Galerkin finite-element simulation of a geothermal reservoir, *Geothermics*, 2(3 and 4): 81-89.

19. Mercer, J.W., 1973. *Finite-element Approach to the Modeling of Hydrothermal Systems*, Ph.D. Thesis, University of Illinois, 106 pp.

Publications in Aquifer Thermal Energy Storage:

1. Mercer, J.W., C.R. Faust, W.J. Miller, and F.J. Pearson, Jr., 1982. Review of simulation techniques for aquifer thermal energy storage (ATES), *Advances in Hydroscience*, Academic Press, New York, Vol. 13, pp. 1-129.

2. Mercer, J.W., C.R. Faust, W.J. Miller III, and F.J. Pearson, Jr., 1981. Summary of simulation techniques for aquifer thermal energy storage (ATES), presented at Mechanical, Magnetic, and Underground Energy Storage 1981 Annual Contractor's Review, Washington, D.C.

Publications in Radioactive Waste Disposal:

1. Huyakorn, P.S., B. Lester, and J.W. Mercer, 1983. Finite-element simulation of fluid flow and solute transport in fractured media, presented at ASCE Engineering Mechanics Specialty Conference, Purdue University, May 23-25.
2. Huyakorn, P.S., B. Lester, and J.W. Mercer, 1983. An efficient finite-element technique for modeling transport in fractured porous media: 2. Nuclide decay chain transport: *Water Resources Research,* 19(5):1286-1296.
3. Huyakorn, P.S., B. Lester, and J.W. Mercer, 1983. An efficient finite-element technique for modeling transport in fractured porous media: 1. Single species transport, *Water Resources Research,* 19(3):841-854.
4. Mercer, J.W., S.D. Thomas, and B. Ross, 1982. Parameters and variables appearing in repository siting models, U.S. Nuclear Regulatory Commission, *NUREG/CR-3066,* 244 pp.
5. Ross, B., J.W. Mercer, S.D. Thomas, and B.H. Lester, 1982. Benchmark problems for repository siting models, *NUREG/CR-3097,* 138 pp.
6. Thomas, S.D., B. Ross, and J.W. Mercer, 1982. A summary of repository siting models, U.S. Nuclear Regulatory Commission *NUREG/CR-2782,* 237 pp.
7. Intera/GeoTrans, 1980. Groundwater pathways analysis for the Indian Point Site: Prepared for Pickard, Lowe, & Garrick, Inc., 67 pp.

Books Reviewed:

1. *Processing and Synthesis of Hydrogeological Data* by A. Gheorghe: Geology (Geological Society of America), 1979.
2. *Geothermal Reservoir Engineering* by M.A. Grant, I.G. Donaldson, and P.F. Bixley: 1983, EOS Transactions, American Geophysical Union, 64(31): 486.

Litigation Support/Expert Witness:

1. **Case:** Robert Prohosky, et al. v. The Prudential Insurance Company of America
   Representing: Plaintiff, Nesbitt Law Firm
   Jack Nesbitt
   116 N. Front Street
   Rensselaer, Indiana 47978-2692
   (219) 866-5168
   Role: Expert Witness, Water Rights Litigation
   Trial: October 24 - November 3, 1983
   United States District Court
   Lafayette, Indiana

2. **Case:** United States of America, et al. v. Ottati & Goss, Inc., et al.
   Representing: Plaintiffs, U.S. Environmental Protection Agency/Department of Justice
   Philip Boxell
   JFK Building, 22nd floor
   Boston, Massachusetts 02203
   (617) 223-3372
   Role: Potential Rebuttal Witness, Hazardous Waste Liability
   Trial: January 1984 - February 1985

United States District Court
Bedford, New Hampshire

3. **Case:** United States of America v. Chem-Dyne Corporation, et al.State of Ohio ex rel. Celebrezze v. Rohm and Haas Company, et al.
Representing: Plaintiff, Ohio Attorney General
Michael C. Donovan
State Office Tower
30 East Broad Street, 17th floor
Columbus, Ohio 43215
(614) 466-2766
Role: Expert Witness, Hazardous Waste Liability and Natural Resources Damage
Trial: Settled December 6, 1984
United States District Court
Cincinnati, Ohio

4. **Case:** United States of America v. Reilly Tar & Chemical Corporation
Representing: Plaintiff, Minnesota Attorney General
Stephen Shakman
Pollution Control Division
1935 West County Road B-2
Roseville, Minnesota 55113
(612) 296-7342
Role: Expert Witness, Hazardous Waste Liability
Trial: In negotiation

5. **Case:** United States of America v. Occidental Chemical Corporation (102nd Street)
Representing: Plaintiffs, U.S. Environmental Protection/Department of Justice
Roger Marzulla, DOJ
Lands and Natural Resources Division
Environment Enforcement Section, Room 2350
Washington, D.C. 20530
(202) 633-2716
Role: Litigation/Technical Support Hazardous Waste Liability
Trial: In negotiation
United States District Court
Buffalo, New York

6. **Case:** United States of America v. Occidental Chemical Corporation (Love Canal)
Representing: Plaintiffs, U.S. Environmental Protection Agency/Department of Justice
Albert Cohen, DOJ
Lands and Natural Resources Division
Environment Enforcement Section, Room 1714
Washington, D.C. 20530
(202) 633-4293
Role: Litigation/Technical Support, Hazardous Waste Liability
Trial: In negotiation
United States District Court
Buffalo, New York

7. **Case:** State of Colorado v. Gulf & Western Industries, Inc., et al.
Representing: Plaintiffs, Colorado Department of Law
Michael R. Hope, Deputy Attorney General
CERCLA Litigation Section

Department of Law
One Civic Center Plaza
1560 Broadway, Suite 250
Denver, Colorado 80202
(303) 894-2299

Role: Expert Witness/Technical Support, Hazardous Waste Liability

Trial: In negotiation
United State District Court
Denver, Colorado

8. **Case:** State of Colorado v. United States Department of the Army

Representing: Plaintiffs, Colorado Department of Law
Michael R. Hope, Deputy Attorney General
CERCLA Litigation Section
Department of Law
One Civic Center Plaza
1560 Broadway, Suite 250
Denver, Colorado 80202
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Role: Expert Witness/Technical Support, Hazardous Waste Liability

Trial: December 11, 1987
United States District Court
Denver, Colorado

PETER F. ANDERSEN, P.E.

Vice President, Sterling Office
Principal Engineer
GeoTrans, Inc.

Professional Expertise:

Numerical methods in hydrology
Groundwater hydrology
Surface water hydrology
Computer programming
Saltwater intrusion and aquifer water quality
Wellfield analysis
Aquifer thermal energy storage

Education:

M.S., Civil Engineering, Department of Civil Engineering, Auburn University, 1980
B.C.E., Civil Engineering, Department of Civil Engineering, Auburn University, 1977

Professional Experience:

April 1986 - Present
Principal Engineer, Vice President, GeoTrans, Inc., Sterling, Virginia.

October 1984 - April 1986
Senior Engineer, GeoTrans, Inc., Herndon, Virginia.

January 1982 - October 1984
Engineer, GeoTrans, Inc., Herndon, Virginia.

July 1981 - December 1981
Water Resource Engineer, South Florida Water Management District, Water Use Division, Resource Control Department.

January 1981 - June 1981
Instructor, Department of Civil Engineering, Auburn University.

June 1979 - December 1980
Graduate Research - Teaching Assistant, Department of Civil Engineering, Auburn University.

January 1978 - June 1979
Field Engineer, Water Resources Research Institute, Auburn, Alabama.

Relevant Project Experience:

Performed numerical modeling in preparation of an Environmental Impact Statement (EIS) for a new production reactor (NPR) at the Savannah River Site, South Carolina.

Evaluated and modified existing numerical models of drawdown impact resulting from a large agricultural concern in southwestern Florida. Provided expert witness testimony on the results of the analysis.

Performed three-dimensional numerical modeling in support of a permit application to the New Jersey DEP for a new landfill.

Developed and calibrated a regional three-dimensional groundwater flow model of the hydrogeologic system underlying the Savannah River Plant, South Carolina.

Conducted an investigation on the current status of groundwater availability in Nassau County, Long Island. The results were presented at a NYDEC regulatory hearing.

Performed numerical modeling of RCRA closure options for two seepage basins at the Savannah River Plant, South Carolina.

Managed projects for two Florida water management districts which involved performing three-dimensional modeling of saltwater intrusion to aid in development of a comprehensive water management plan.

Performed numerical modeling of alternative remedial measures at the Prices Pit Landfill in New Jersey.

Developed methodology and performed numerical simulation of solute transport in a two-well tracer test in a stratified aquifer.

Developed preprocessors to facilitate data preparation for the USGS two-dimensional model, USGS modular model, and a proprietary saltwater intrusion model.

Instructor for groundwater modeling short courses at the International Groundwater Modeling Center, Georgia Southwestern College, St. Johns River Water Management District, and South Florida Water Management District, Roy F. Weston, Inc., Southwest Florida Water Management District, and several regions of the U.S. Environmental Protection Agency.

Conducted numerical modeling to conceptualize flow in a multilayer aquifer system in northwestern Indiana. Assessed the possibility that lowered water-levels in the surficial aquifer were the result of pumpage in an underlying aquifer.

Participated in investigation of available groundwater resources from the San Juan Basin of New Mexico for litigation purposes. Compiled existing data, conducted numerical modeling, and served as project manager.

Performed computer modeling of alternative remedial measures at the Lipari Landfill in New Jersey.

Provided expert witness testimony for the U.S. Attorney's office in a hearing concerning water appropriation for an electrical generation facility near Gallup, New Mexico.

Extensively modified the USGS two-dimensional groundwater flow model to include effects of varying principle directions of anisotropy, layered systems and barriers to flow in the Edwards Aquifer, Texas.

Evaluated water use permit applications in South Florida for withdrawals greater than 100,000 gal/day for municipal, industrial, and agricultural use and wrote reports citing staff recommendations.

Coordinated water quality monitoring with water utilities in South Florida and assisted in establishing programs to manage saltwater intrusion.

Aided in the design, construction, operation, and data analysis of the Auburn University Aquifer Thermal Energy Storage (ATES) projects. Fifty percent of the work was in the field, operating pumps and a hot water boiler as well as collecting temperature, water level, and flow rate data.

Teaching Experience:

Short Courses, GeoTrans, Inc., 1982-1989

Basics of Groundwater Flow and Pollution (USGS2D, MODFLOW):
- Georgia Southwestern College, July 1982
- International Groundwater Modeling Center, Indianapolis, Indiana, March 1983,

1984, 1985, 1986, 1987, (March and October), 1988, 1989 (March and April)
Region IV EPA, February 1985
Roy F. Weston, Inc., May 1985
Southwest Florida Water Management District, July 1986
Tipton and Kalmbach, Inc., May 1987
BP America, May 1988

Introduction to the U.S.G.S. Three-dimensional Groundwater Flow Model:
St. Johns River Water Management District, October 1983

Introduction to DAFI2D, a preprocessor for the U.S.G.S. Two-dimensional Groundwater Flow Model:
South Florida Water Management District, October 1983

Saturated Zone Modeling (U.S.G.S. Method of Characteristics):
USEPA Region VI, November, 1988
USEPA Region VIII, November, 1988
USEPA Region IX, December, 1988
USEPA Region X, December, 1988

Introduction to modeling saltwater intrusion (SWICHA):
Southwest Florida Water Management District, October 1984
South Florida Water Management District, February 1986
St. Johns River Water Management District, November 1986

Instructor, Auburn University, 1981
Computer Methods in Civil Engineering (CE202)
Theory of Structures I (CE304)
Hydraulics (CE308)
Hydrology (CE312)

Graduate Teaching Assistant, Auburn University, 1979-80
Computer Methods in Civil Engineering (CE202)

Litigation Experience:

Expert Witness in an administration hearing, City of Sarasota, Florida vs. Roger Harloff and Southwest Florida Water Management District, regarding an agricultural water use permit (August 1989).

Technical support and preparation of testimony for a regulatory hearing by the NYDEC in the matter of the proposed modification of water supply permits of the Long Island Water Corporation (September, 1987).

Deposition concerning groundwater modeling performed to assess drawdowns in an upper aquifer created by irrigation pumping in northwestern Indiana by Prudential Company of America (September 1983).

Expert Witness for U.S. Attorney's Office, Albuquerque New Mexico. Hearing before the New Mexico State Engineer concerning groundwater appropriations near Gallup, New Mexico for Plains Electric (September 1982 and January 1983).

Professional Certification:

Professional Engineer, Commonwealth of Virginia, Registration No. 014511

Professional Affiliations:

Chi Epsilon Civil Engineering Honorary
American Society of Civil Engineers (ASCE)
National Water Well Association (NWWA)

Publications:

1. Guswa, J.H., P.F. Andersen, and T.V. Whiteside, 1989. Analysis of recent data regarding groundwater conditions of Nassau County, New York. *Proceedings of the Focus Conference on Eastern Regional Groundwater Issues,* Natural Water Well Association.

2. Sims, P.N., P.F. Andersen, D.E. Stephenson, and C.R. Faust, 1989. Testing and Benchmarking of a Three-Dimensional Groundwater Flow and Solute Transport Model, Proceedings of the Solving Groundwater Problems with Models Conference, National Water Well Association.

3. Andersen, P.F., J.W. Mercer, and H.O. White, Jr., 1988. Numerical modeling of saltwater intrusion at Hallandale, Florida, *Ground Water* 26(5): 619-630.

4. Andersen, P.F., J.H. Guswa, and E.J. Quinn, 1987. Analysis of potential contaminant migration at a coal tar site, presented at the ASCE Water Resources Planning and Management Division Conference (March 16-18) Kansas City, Missouri.

5. Huyakorn, P.S., J.W. Mercer, P.F. Andersen, and H.O. White, Jr., 1986. Saltwater intrusion in aquifers: Development and testing of a three-dimensional finite-element model, *Water Resources Research,* 23(2): 293-312.

6. Gleason, P.J., C.W. Profilet, and P.F. Andersen, 1986. The Status of Salt Water Intrusion in South Florida, *Proceedings of the Focus Conference on Southeastern Groundwater Issues,* National Water Well Association, Columbus, Ohio, pp 462-491.

7. Andersen, P.F., H.O. White, Jr., J.W. Mercer, P.S. Huyakorn, and A.D. Truschel, 1986. Numerical Modeling of Groundwater Flow and Saltwater Transport in Northern Pinellas County, Florida, *Proceedings of the Focus Conference on Southeastern Ground Water Issues,* National Water Well Association, Columbus, Ohio, pp 419-449.

8. Huyakorn, P.S., P.F. Andersen, F.J. Molz, O. Guven, and J.G. Melville, 1986. Simulations of two-well tracer tests in stratified aquifers at the Chalk River and Mobile Sites, *Water Resources Research*, 22(7): 1016-1030.

9. Huyakorn, P.S., J.W. Mercer, and P.F. Andersen, 1986. Seawater intrusion in coastal aquifers: Theory, finite-element solution, and verification tests, presented at the VI International Conference on Finite Elements in Water Resources Conference (June 1-5), Lisbon, Portugal.

10. Huyakorn, P.S., P.F. Andersen, O. Guven, and F.J. Molz, 1986. A curvilinear finite-element model for simulating two-well tracer tests and transport in stratified aquifers, *Water Resources Research,* 22 (5): 663-678.

11. Huyakorn, P.S., B.G. Jones, and P.F. Andersen, 1986. Finite-element alogorithms for simulating three-dimensional groundwater flow and solute transport in multilayer systems, *Water Resources Research,* 22 (3): 361-374.

12. Huyakorn, P.S., P.F. Andersen, and F.J. Molz, 1985. Finite-element simulation of two-well tracer tests in homogeneous and stratified aquifers, presented at the American Geophysical Union Fall Meeting (Dec. 19-23), San Francisco, California.

13. Huyakorn, P.S., P.F. Andersen, H.O. White, Jr., P.K.M. van der Heijde, 1985. Testing and application of a finite-element groundwater flow and transport model, presented at the International Symposium on Management of Hazardous Chemical Waste Sites (October 9-10), Winston-Salem, North Carolina.

14. Andersen, P.F., 1985. Groundwater models: Converting research developments into practical applications, *Proceedings of the A.S.C.E. Computer Applications in Water Resources Conference* (June 10-12), Buffalo, New York.

15. Andersen, P.F., R.M. Cohen, and J.W. Mercer, 1984. Numerical modeling as a conceptual tool to assess drawdown in a multiaquifer system, *Proceedings of the Symposium on Practical Applications of Ground Water Models,* National Water Well Association, Columbus, Ohio.

16. Andersen, P.F., C.R. Faust, and J.W. Mercer, 1984. Analysis of conceptual designs for remedial measures at Lipari Landfill, New Jersey, *Ground Water* 22(2):176-190.

17. Mercer, J.W., C.R. Faust, R.M. Cohen, and P.F. Andersen, 1984. Remedial action assessment for hazardous waste sites via numerical simulation, presented at Seventh Annual Madison Waste Conference on Municipal & Industrial Waste (Sept. 10-12), University of Wisconsin.

18. Cohen, R.M., and P.F. Andersen, 1983. Numerical simulation of proposed well field in the San Andres-Glorieta aquifer in west central New Mexico, presented at the 12th Annual Rocky Mountain Groundwater Conference (April 11-13), Boise, Idaho.

19. Molz, F.J., A.D. Parr, and P.F. Andersen, 1981. Thermal energy storage in a confined aquifer--second cycle, *Water Resources Research* 17(3):641-645.

20. Andersen, P.F., 1980. *A field experiment involving the storage of thermal energy in aquifers,* M.S. Thesis, Auburn University.

21. Molz, F.J., A.D. Parr, P.F. Andersen, V.D. Lucido, and J.C. Warman, 1979. Thermal energy storage in a confined aquifer--experimental results, *Water Resources Research* 15(6):1509-1514.

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Senior Hydrogeologist
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Professional Expertise:

Computer code development and applications in hydrogeology and rock mechanics
Field and laboratory analysis in rock and soil mechanics

Education:

Ph.D. (Candidate), Department of Earth and Planetary Sciences, Johns Hopkins University, Expected Date of Graduation, 1992
M.S., Geology, Department of Geosciences, The Pennsylvania State University, 1981
Minor: Engineering Mechanics, B.S., Earth Sciences, Department of Geosciences, The Pennsylvania State University, 1973

Professional Experience:

February 1980-Present
Senior Hydrogeologist, GeoTrans, Inc., Sterling, Virginia.
Responsible for the development, modification, benchmark testing and application of various computer codes applicable to mining, radioactive waste management and groundwater pollution control. Principal investigator of problems pertaining to site specific fate and transport of dissolved aqueous and non-aqueous phase liquid contaminants.

March 1978 - February 1980
The Pennsylvania State University.
Organized geology laboratory classes and supervised teaching assistants. Developed analytic solution to valley unloading problem.

September 1975 - March 1978
The Pennsylvania State University.
Teaching Assistant for engineering geology and basic geology courses. Studies valley unloading phenomena in Northwest Wyoming. Baselined creep and elastic finite element programs. Investigated rheologic behavior of geologic modeling materials.

Relevant Project Experience:

Extension of U.S. EPA's multimedia code EPAMMM (formerly EPAMCL) to handle Freundlich and general non-linear adsorption.

Extension of the pesticide application code RUSTIC to handle Freundlich isotherms and advective-dispersive transport in an aquitard. Evaluation of organic solute and NAPL transport at a hazardous waste site in California.

Application of three-dimensional variably saturated flow model to Love Canal site in Upstate New York.

Application of analytic solution for solute transport to evaluate attenuation potential of organic and inorganic contaminants at hazardous waste site.

Support of USEPA applications of composite models developed for evaluating leachate migration from landfills and surface impoundments.

Project Experience includes: development and documentation of composite finite element and analytical solution codes for evaluating leachate migration through the vadose and saturated zones from landfills and surface impoundments; coding and documentation of a package of analytical solutions for evaluating transport of dissolved contaminants through porous and fractured porous media; development, documentation and application of finite element codes for simulating fluid flow and radionuclide transport in fractured porous media (FTRANS, TRAFRAP, MPFTRANS) and in saturated or unsaturated porous media (SATURN); development and documentation of finite element code for simulating coupled deformation and fluid flow in fractured porous media (STAFAN); development and documentation of package on coded analytical solutions to be used for benchmarking heat flow, fluid flow, radionuclide transport, and coupled deformation/fluid flow numerical codes; development of boundary element code for analyzing transient fluid flow problems; and development and documentation of streamline analysis and travel-time contour program.

Experience in nuclear waste isolation tasks includes reviewing groundwater flow and radionuclide modeling studies from BWIP site; benchmarking of flow and transport codes to be used by NRC high-level waste group; performance of numerical simulations of potential radionuclide release scenarios; modification, benchmark testing and application of various mechanical and thermomechanical codes including DAMSWEL, VISCOT, UTAH2, SALT4, SAPIV, and NONSAP.

Experience in evaluating contaminant migration includes computer modeling of tracer tests; computer modeling of contaminant transport at RCRA sites; sensitivity analysis of parameters pertinent to modeling deep-well injection problems; and sensitivity analysis of parameters governing transport at landfill sites.
Experience in evaluating saltwater intrusion problems includes three-dimensional simulations to evaluate effects of different well production schemes on saltwater intrusion along Florida's eastern coast.

Certification:

Professional Geologist, Commonwealth of Virginia
Certification, Oceanography Field School, Marine Science Consortium, Wallops Island, Virginia, 1973.

Publications and Presentations:

1. Huyakorn, P.S., B.H. Lester, H.O. White, Jr., T.D. Wadsworth, and J.E. Buckley, 1987. Analytical and numerical simulations of leachate migration in unconfined aquifers, to be presented at *Solving Ground Water Problems with Models*, (NWWA sponsored), Denver, Colorado (February 10-12).
2. Buss, D.R., B.H. Lester, and J.W. Mercer, 1986. A numerical simulation study of deep-well injection, accepted for publication in 1986 volume of *Current Practices in Environmental Science and Engineering.*
3. Mercer, J.W., B.H. Lester, S.D. Thomas, and R. Bartel, 1985. Simulation of saltwater intrusion in Volusia County, Florida, accepted for publication in *Water Resources Bulletin.*
4. Huyakorn, P.S., B.H. Lester, and C.R. Faust, 1983. Finite-element techniques for modeling groundwater flow in fractured aquifers, *Water Resources Research*, 19(4):1019-1035.
5. Huyakorn, P.S., B.H. Lester, and J.W. Mercer, 1983. An efficient finite-element technique for modeling transport in fractured porous media: 1. Single species transport, *Water Resources Research,* 19(3):841-854.
6. Huyakorn, P.S., B.H. Lester, J.W. Mercer, and M. Reeves, 1983. An efficient finite-element technique for modeling transport in fractured porous media: 2. Multiple species transport, *Water Resources Research,* 19(5).

7. Huyakorn, P.S., J.W. Mercer, and B.H. Lester, 1983. Finite-element simulation of fluid flow and solute transport in fractured media, ASCE Engineering Mechanics Specialty Conference, Purdue University, May 23-25, 1983.

8. Huyakorn, P.S., and B.H. Lester, 1983. Mathematical modeling of fluid flow and contaminant transport in fractured aquifers, presented at AGU Spring Meeting, Baltimore, Maryland, June 1983.

Technical Reports:

1. Lester, B.H., 1990. Enhancements to the multimedia exposure assessment model for Evaluating the land disposal of hazardous waste, prepared for Aqua Terra Consultants, Inc., Mountain View, California.

2. Lester, B.H., P.S. Huyakorn, H.O. White, Jr., T.D. Wadsworth, and J.E. Buckley, 1986. EPAMCL: Composite analytical-numerical model for simulating leachate migration in unconfined aquifers, prepared for Woodward Clyde Consultants, Walnut Creek, California.

3. Lester, B.H., P.S. Huyakorn, H.O. White, Jr., T.D. Wadsworth, and J.E. Buckley, 1986. Analytical models for evaluating leachate migration in groundwater systems, Technical Report submitted to the U.S. Environmental Protection Agency.

4. Huyakorn, P.S., B.H. Lester, V.M. Guvanasen, T.D. Wadsworth, and J.O. White, Jr., 1986. SATURN: A finite-element model for simulating saturated-unsaturated flow and radionuclide transport, Documentation and Users Guide - Version 1.3, GeoTrans Technical Report, GeoTrans, Inc., Herndon, Virginia.

5. Huyakorn, P.S., T.D. Wadsworth, H.O. White, Jr., J.E. Buckley, and B.H. Lester, 1986. VADOFT: Finite-element code for simulating one-dimensional flow and solute transport in the vadose zone, prepared for U.S. Environmental Protection Agency, Washington, DC.

6. Huyakorn, P.S., V.M. Guvanasen, T.D. Wadsworth, and B.H. Lester, 1986. EFLOW: EPRI Groundwater Flow Code, Technical Report prepared for the Electric Power Research Institute, Palo Alto, California.

7. Huyakorn, P.S., H.O. White, Jr., V.M. Guvanasen, and B.H. Lester, 1986. TRAFRAP: A two-dimensional finite-element code for simulating fluid flow and transport of radionuclides in fractured porous media, GeoTrans Technical Report, GeoTrans, Inc., Herndon, Virginia.

8. Lester, B.H., and J.W. Mercer, 1984. Sensitivity analysis on Phase II tracer injection test, GeoTrans Technical Report, GeoTrans, Inc., Herndon, Virginia.

9. Mercer, J.W., S.D. Thomas, B.H. Lester, and R.W. Broome, 1984. Saltwater intrusion in Volusia County, Florida due to groundwater withdrawals, GeoTrans Technical Report, GeoTrans, Inc., Herndon, Virginia.

10. Buss, D.R., B.H. Lester, G.C. Zalaskus, and J.W. Mercer, 1984. A numerical simulation study of deep-well injection in two hydrogeologic settings: Texas Gulf Coast, Great Lakes Basin, GeoTrans Technical Report, GeoTrans, Inc., Herndon, Virginia.

11. Huyakorn, P.S., and B.H. Lester, 1983. STAFAN: A two-dimensional code for fluid flow and the interaction of fluid pressure and stress in fractured rock for repository performance assessment, Office of Nuclear Waste Isolation, Technical Report No. ONWI 427.

12. Lester, B.H., P.S. Huyakorn, and S.D. Thomas, 1983. VERTPAK-1: Package of analytical solutions for use in model verifications, Office of Nuclear Waste Isolation, Technical Report No. ONWI 451.

13. Huyakorn, P.S., and B.H. Lester, 1983. VISCOT viscoplastic thermomechanical analysis by Galerkin finite-element method: SCEPTER documentation and user's manual, Office of Nuclear Waste Isolation, Technical Report No. ONWI 437.

14. Lester, B.H., 1983. UTAH2: Finite-element model for simulating thermoelastic-plastic behavior in anisotropic rock masses: SCEPTER documentation and user's manual, Office of Nuclear Waste Isolation, Technical Report No. ONWI 430.

15. Lester, B.H., and T.Chan, 1983. A two-dimensional displacement discontinuity code for thermomechanical analysis in bedded salt deposits: SCEPTER documentation and user's manual, Office of Nuclear Waste Isolation, Technical Report No. ONWI 429.

16. Mercer, J.W., B. Ross, B.H. Lester, B.G. Jones, and P.S. Huyakorn, 1983. Review of BWIP site modeling, Technical Report submitted to the U.S. Nuclear Regulatory Commission.

17. Ross, B.I., J.W. Mercer, S.D. Thomas, and B.H. Lester, 1982. Benchmark problems for repository siting models, U.S. Nuclear Regulatory Commission, NUREG/CR3097.

18. Lester, B.H., S.D. Thomas, and C.R. Faust, 1982. Analysis of BWIP site modeling, Technical Report submitted to U.S. Nuclear Regulatory Commission.

19. Lester, B.H., 1981. The evaluation of elastic rebound in a three layered geologic system using potential theory, Masters Thesis, The Pennsylvania State University.

PAST PROJECT EXPERIENCE

4.00 PAST PROJECT EXPERIENCE

The Division of Resource Management of the Northwest Florida Water Management District, has performed numerous surface water and ground water studies throughout northwest Florida. Following is a listing of selected water resources projects completed since 1983. All the projects listed below were performed by the District under contract with various local, state and federal agencies. In addition to these, the District has also completed a number of other special projects that were performed as part of the District's overall mission to preserve and protect the water resources of northwest Florida.

Water Quality Evaluation of Stormwater Discharge to Drainage Wells in the Vicinity of Altha, Liberty County, Florida. Funded by the Florida Department of Transportation.

Abandoned Well Plugging Program for the Protection of Ground Water, Northwest Florida. Funded by the Florida Department of Environmental Regulation.

Water Quality Evaluation of Lake Munson, Leon County. Funded by the U.S. Environmental Protection Agency.

Evaluation of Circulation and Flushing Characteristics of St. Andrews Bay with a Three-dimensional Hydrodynamic Model. Funded by the National Oceanic and Atmospheric Administration.

Ethylene Dibromide Ground Water Contamination Study of Jackson County, Northwest Florida. Funded by the Florida Department of Environmental Regulation.

Hydrostratigraphic Investigation of Southern Escambia County, Northwest Florida. Funded by the Florida Department of Environmental Regulation.

Hydrogeologic Assessment of Solid Waste Landfills in Northwest Florida. Funded by the U.S. Environmental Protection Agency.

Hydrogeology and Contaminant Movement at Selected Solid Waste Landfills in Northwest Florida. Funded by the U.S. Environmental Protection Agency.

Solute Transport Model Analysis of Contaminant Movement from Landfills to Ground Water in Northwest Florida. Funded by the U.S. Environmental Protection Agency.

Ambient Ground Water Monitoring Program, Phase I, II - Design and Installation of Background Monitoring Network. Funded by the Florida Department of Environmental Regulation.

Ambient Ground Water Monitoring Program, Phase III - Sample Collection and Analysis for the Background Network. Funded by the Florida Department of Environmental Regulation.

Ambient Ground Water Monitoring Program, Phase IV - Continuation and Refinement of the Background Monitoring Network. Funded by the Florida Department of Environmental Regulation.

Ambient Ground Water Monitoring Program, Phase V - Design and Installation of Very Intensely Studied Areas (VISA) Monitoring Network (Intended to Monitor Ground Water Quality as a Function of Land Use). Funded by the Florida Department of Environmental Regulation.

Ambient Ground Water Monitoring Network, Phase VI - Sample Collection and Analysis for the VISA Network. Funded by the Florida Department of Environmental Regulation.

Ambient Ground Water Monitoring Program, Phase VII - Seasonal Sampling and Analysis of the Background Network and Resampling of the VISA Network. Funded by the Florida Department of Environmental Regulation.

Availability of Ground Water at Selected Sites in Gadsden and Leon Counties, Florida. Funded by the City of Tallahassee.

Development of a Three-dimensional Hydrodynamic Model of Choctawhatchee Bay, Northwest Florida. Funded by the Florida Department of Environmental Regulation.

Research Program to Enhance the Productivity of the Choctawhatchee Bay System. Funded by the Florida Department of Community Affairs.

Chemical Characterization of Bottom Sediments in Choctawhatchee Bay. Funded by Florida Department of Environmental Regulation and the U.S. Environmental Protection Agency.

Development of a Management Plan for Choctawhatchee Bay and Adjoining Bayous and Wetland Areas. Funded by National Oceanic and Atmospheric Administration and Florida Department of Environmental Regulation.

Evaluation of Minimum Package Sewage Treatment Plant Set-back Line for Selected Coastal Soils in West Florida. West Florida Regional Planning Council.

Assessment of Ground Water Monitoring Requirements Along the Coastal Area of Northwest Florida. Funded by National Oceanic and Atmospheric Administration and the Florida Department of Environmental Regulation.

Development of Comprehensive Stormwater Management Plan for the Lake Jackson, Lake Munson and Lake Lafayette Drainage Basins, Leon County. Funded by the City of Tallahassee and Leon County.

Stormwater Monitoring Program for the Lake Jackson, Lake Munson and Lake Lafayette Drainage Basins, Leon County. Funded by the City of Tallahassee and Leon County.

Design and Construction of a Stormwater Treatment Facility and Artificial Marsh for the Lake Jackson/Megginnis Arm Drainage Basin. Funded by the U.S. Environmental Protection Agency and the Florida Department of Environmental Regulation.

Step Backwater Analysis of the Lake Jackson, Lake Munson and Lake Lafayette Drainage Basins, Leon County. Funded by the City of Tallahassee and Leon County.

Choctawhatchee River Basin Surface Water Resource Assessment, Phase I - Basin Flows and Water Quality. Funded by the Florida Department of Environmental Regulation and Florida Legislature.

Choctawhatchee River Basin Surface Water Resource Assessment, Phase II - Basin Hydrology, Hydraulics and Biology. Funded by the Florida Department of Environmental Regulation and Florida Legislature.

Development of an Interim Drought Management Plan for the Apalachicola-Chattahoochee-Flint River System. Funded by the Florida Department of Environmental Regulation.

Evaluation of Water Quality Degradation of Old Pass Lagoon, Destin, Florida. Funded by the Florida Legislature and Holiday Isle Improvement Association.

Hydrodynamic Analysis and Design of a Circulation Facility for the Restoration of Old Pass Lagoon, Destin, Florida. Funded by the Florida Legislature.

Final Design and Construction of a Circulation Facility for the Restoration of Old Pass Lagoon, Destin, Florida. Funded by the Florida Legislature.

Development of a Stormwater Management Plan for the Bayou Texar Drainage Basin, Escambia County, Florida. Funded by the Florida Department of Environmental Regulation.