MARCO ISLAND UTILITIES / SSU SERVICES COMBINED WASTE STREAM INJECTION WELL CONSTRUCTION AND TESTING PROGRAM

M&A MISSIMER & ASSOCIATES, INC.
Environmental and Groundwater Consultants

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COMBINED WASTE STREAM INJECTION WELL
CONSTRUCTION AND TESTING PROGRAM

Prepared For

SSU Services, Inc.
1787 South Orange Blossom Trail
Apopka, Florida 32703

March, 1990

Certified:

James E. McGrath 4/20/90

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H89-314

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Mr. Vincent Meeley
Florida Department of
Environmental Regulation - U.I.C.
2269 Bay Street
Fort Myers, Florida 33901

Re: Marco Island Utilities Injection Well System

Dear Mr. Meeley:

Enclosed, please find the application and supporting documentation for a permit to construct one Class I injection well and one dual-completion deep monitor well on the Marco Island Utilities plant site. In addition, a check (# 1549) in the amount of $3000.00 has been included in your package on behalf of SSU Services, Inc. A copy of these documents have been sent to each member of the TAC.

Sincerely,

James E. McGrath, P.G.
Manager, Environmental Services

lw/JEM

cc: Richard Deuerling
Steve Burton
Craig Hutchinson
Greg Raul
Ralph Terrero

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INTRODUCTION

Marco Island Utilities and SSU Services plan to construct a Class I injection well system at the water and waste-water treatment plant located on Marco Island, Florida. Figure 1 shows the general location of the proposed well site. The injection well disposal system has been designed to handle reverse osmosis reject concentrate and secondarily treated domestic effluent. The system has been designed to dispose of this combined waste stream at a maximum rate of 10.2 million gallons per day (mgd). The system will include one 20-inch diameter Class I injection well, fitted with injection tubing and a packer, and one dual-completion deep monitor well.

In accordance with Section 17-28.33, Florida Administrative Code (FAC), background geologic and hydrogeologic information, well construction details, and a description of the hydrogeologic testing program are presented in this document. The information contained in this report is submitted in support of an application for a Class I Test / Injection Well Construction Permit.

The well design and testing program are based on existing data from the construction of the Marco Island Utilities Test Well, the Humble Oil Company Collier Corp. #2 Test well, the South Florida Water Management (SFWMD) Alligator Alley Well, various other wells in the region, and regional geologic information. The final well design will depend on the actual conditions found during the drilling and testing portion of the program, as required by Chapter 17-28, (FAC).

Area of Review and Geologic Setting

An area of review encompassing a radius of one mile was established in accordance with Chapter 17-28 FAC as sufficient for the purposes of this program. In accordance with the requirement of Section 17-28.33(2) (a), information of public record was used for the area of review study. Additionally, available literature was researched and geologic data in Missimer & Associates, Inc. files were used. This information revealed no known faults and no wells known to be penetrating the potential confining beds or the injection zone within the area of review. The entire area of review is located within the Marco Island Utilities water system service area. A site location map showing the area of review is presented as Figure 2; the site plan is shown in figure 3.

Wells within the Area of Review

Twenty-six wells are known to exist on Marco Island, of which, thirteen are known to exist within the area of review. Four wells (MW #s 1-4) are shallow monitoring wells at a service station. Two wells, the test well and the monitor well, are owned by Marco Island Utilities and were installed on the utility plant site. The remaining wells are water supply wells for heat pump / air conditioning units and their associated Class V injection wells. It is assumed that the well completion form for the supply well owned by Sunbrella, at 1465 Firewood Court, has been misplaced

since their is no other known use for a Class V injection well at that location. Well-construction data for these wells, where known, are presented in Appendix A and locations are shown in Figure 2. There are no wells known that penetrate the confining layer or the injection zone within the area of review.

HYDROGEOLOGIC SETTING

The geologic formations expected to be encountered beneath the site consist of a thick sequence of carbonate rocks of Eocene age overlain by sediments consisting of sand, shell, clay, and limestone ranging from Miocene to Recent age. Available information indicates that an injection zone exists approximately 2650 feet below land surface in fractured, cavernous dolomitic zones of the lower Eocene. overlying these permeable dolomitic zones are middle Eocene zones of chalky limestone. These will serve as a confining sequence between the injection zone and the base of waters containing less than 10,000 mg/L (milligrams per liter) of total dissolved solids. Figure 4 defines the line of the geologic cross section A-A' shown in Figure 5. A generalized geologic column delineating the various formations underlying the area also is presented. The Tamiami, Tampa, and Suwanee Formations have been included in the description of the Hawthorn Formation since they are very similar lithologically.

Surficial Sediments

The surficial in the area of the proposal well locations consist of unconsolidated to semi-consolidated beds of quartz sand, shell, sandy limestone, and marly clay. The sediments extend to a depth of approximately 230 feet below land surface, and range in age from Recent to possibly late Miocene.

The Surficial Aquifer lies within these sediments and is used as a source of fresh water for public supply. The Surficial Aquifer extends to a depth of about 230 feet below land surface in the area. Below about 230 feet, the surficial sediments are underlain by lower permeability Miocene sediments of the Hawthorn Formation. The first string of casing in the injection well will be set at approximately 230 feet in order to case off the Surficial Aquifer. The general direction of ground-water flow in the Surficial Aquifer in this area is depicted on Figure 6.

Hawthorn Formation

The Hawthorn Formation is of Miocene age and underlines the Surficial Aquifer. The Hawthorn Formation is composed of greenish-grey calcareous clay with varying amounts of quartz sand, phosphate, and limestone and occurs in the interval between approximately 230 feet and 910 feet below land surface in this area. The clay zones within the formation are relatively impermeable however, the interbedded limestones are important fresh water aquifers. In general, the clays of the Hawthorn Formation have significantly lower permeability than the underlying permeable

limestones and provide good confinement for the Floridan Aquifer below. Based on available data from construction and testing of the Marco Island WWTP Test Well, the base of the fresh water (total dissolved solids less than 10,000 mg/L) will be encountered within this sequence between 720 and 760 feet.

Ocala Group

The Ocala Group, of upper Eocene age, underlies the Miocene-age Hawthorn Formation and occurs near the top of the Floridan Aquifer. The Ocala Group consists of very permeable, fossiliferous limestone. The water present in this portion of the Floridan Aquifer is poor and is not considered to be potable, except with advanced treatment. The direction of ground-water flow in the Floridan Aquifer in this area is depicted on Figure 7.

Avon Park Limestone and Lake City Limestone

The Avon park and Lake City Limestones are a middle Eocene age and underline the Ocala Group. These formations are composed of fossiliferous limestones and dolomites distinguishable only by microfossils. However, the acceptance of these index fossils is not universal within the geologic community and the validity of their use has recently been questioned by J.A. Miller (1986). Therefore, for purposes of this investigation, the boundaries between these formations will not be delineated. Generally, the limestone in this section is light brown to buff colored, chalky, dense, and occasionally highly fossiliferous. The dolomite is

generally brown to dark brown, crystalline, with fossil remains and mold common. The chalky limestone sections of these formations will comprise part of the confining sequence overlying the injection zone.

Oldsmar Limestone

The Oldsmar Limestone is of lower Eocene age and, based on data from the Humble Oil Company Collier Corp. #2 Test Well, the top is expected to occur at approximately 2600 feet below land surface. Generally, the upper Oldsmar Limestone consists of light brown to chalky white or grey, fossiliferous limestone. In the lower Oldsmar, interbedded with the limestone is usually a dark brown , porous, crystalline dolomite with minor amounts of gypsum and anhydride. throughout much of south Florida, the lower part of the Oldsmar limestone is extensively fractured and large cavities occur in the dolomite layers. This section is referred to as the "Boulder Zone". Many successful injection wells have been completed in this zone in south Florida and it is the anticipated injection zone for this program.

INJECTION-WELL DESIGN

The Marco Island Utilities Combined Waste Stream injection Well is designed to dispose of effluent at an average rate 10.2 mgd or about 8000 gpm (gallons per minute). The injection casing will be 24-inch diameter new, seamless steel casing having a wall thickness of 0.500 inches and contain 20-inch diameter new,

seamless steel tubing having a wall thickness of 0.635-inch. Well construction details are shown in Figure 8. Construction details of the reinforced wellhead are shown in Figure 9. Based on a Hazen and Williams friction coefficient of 100, the injection pressure at the well head will be approximately 50 psi (pounds per square inch). Based on available information, the 20-inch diameter injection tubing in the well will extend from land surface to approximately 2750 feet below land surface; its base will be set with a packer near the bottom of the injection casing which will be set near the bottom of the confining sequence. The injection casing will be cemented in place with sulfate-resistant cement (ASTM Type II), with gel and lost-circulation materials as needed. Gel blends will be used (as much as 12 percent), except for the "tail-in" cement, which will contain only lost-circulation materials. It is expected that the open hole portion of the well will penetrate the Boulder Zone over a vertical thickness of about 600 feet. The diameter of the open hole will be a nominal 24 inches.

The 24-inch diameter injection casing will extend from land surface to approximately 2800 feet below land surface. The injection casing will be new steel, and will have a 0.500-inch wall thickness. The casing will be cemented in place with ASTM Type II sulfate resistent cement, with gel and lost circulation material as needed.

The 34-inch-diameter surface casing will extend from land surface to approximately 900 feet below land surface and extend

below the base of the Underground Source of Drinking Water (USDW). The surface casing will be new steel and will have a 0.375-inch wall thickness. The casing will be cemented in place with ASTM Type II sulfate-resistant cement, with gel and lost-circulation material as needed.

Conductor casing will extend from land surface to about 230 feet below land surface. The conductor casing will be new steel, will have a 0.375-inch wall thickness, and will be 42 inches in diameter. The casing will be cemented in place with ASTM Type II cement, using gel and lost-circulation material as needed. This casing will be used to aid in construction of the well by preventing the collapse of unconsolidated material.

All casing of the injection well shall be fitted with steel centralizers. Each centralizer shall at a minimum, centralize the casing within the borehole or casing at four positions described by the azimuths 0, 90, 180, and 270 degrees around the casing. The casing centralizers shall be located as follows:

Conductor Casing:

1. One at 20 feet above the bottom end of the casing.

2. Two at 40-foot intervals above the bottom centralizer.

3. One at 20-feet below land surface.

All other casings:

1. One at 20 feet above the bottom end of the casing.

2. Three at 40-foot intervals above the bottom centralizer and at 200-foot intervals thereafter.

3. The topmost centralizer to be at a depth of 20 feet below land surface.

All centralizers shall be in precise vertical alignment, one above the other, to allow for the placement of tremie pipe in the annuli.

Based on experience and the strict straight hole requirements at forth in FAC Chapter 17-28, the casing centralizer spacing as outlined, is sufficient to ensure a reasonable uniform distribution of cement around the pipe and will allow a competent seal between the casing and formation. The addition of more centralizers will significantly increase the risks associated with lowering tremie pipe in the annulus for use in cementing.

DUAL COMPLETION DEEP MONITOR WELL DESIGN

The Dual Completion Deep Monitor Well has been designed to monitor water quality in two discreet zones in the Floridan aquifer. The shallow zone will be below the base of the USDW (Underground Source of Drinking water) at approximately 1000 feet below land surface. The deep monitor zone will monitor the first substantial transmissive zone above the top of the injection zone's confining sequence at approximately 2200 feet below land surface.

The shallow monitor zone will be sampled by developing water from outside the uncemented portion of the 6-5/8-inch diameter deep monitor casing above approximately 1100 feet below land surface. By not cementing the deep monitor casing to surface, the annular space between the two casings (16-inch and 6-5/8-inch) can be utilized to transmit water samples to the surface. The deep monitor zone will have a typical open hole completion with approximately 100 feet of open hole. The prospective total depth of the well is 2300 feet below land surface.

To minimise the adverse effects of corrosion on the well's usefull life, the 6-5/8-inch diameter casing will be externally coated with a corrosion inhibiting epoxy-amide coating. The coating will be applied to the exposed portion of the casing as well as the top 50 feet of cemented casing.

Construction details of the Dual Complertion Deep Monitor Well are provided in Figure 8. Actual construction details will be determined during the construction and testing of the injection well.

DRILLING PROGRAM

Site Preparation

Before drilling begins, a construction schedule shall be prepared and submitted to the TAC (Technical Advisory Committee) and site preparation will be completed by the Contractor. Items such as water supply and electrical power will be necessary before actual construction can begin. Included as part of the site preparation will be the installation of pit casings, if required. The intent of the pit casing is to provide a stable base for the initial drilling operations. The injection well pit casing will be a section of pipe with an inside diameter sufficient to accommodate a nominal 50-inch-diameter drilling bit. Installation procedures for pit casing will be at the Contractor's option.

It may be necessary to grub and fill areas the well sites prior to the construction of the concrete drilling pad. The pad shall be a work floor for the drilling rig, sufficient to bear the load of all necessary equipment and materials. The pad will be formed with 2-foot high curbing (minimum requirement) to contain spills of water and drilling fluids. The Contractor will be required to maintain the pad and curbing in satisfactory condition throughout the construction and testing program. An approved disposal site for excess fluids generated during construction testing that cannot be pumped back into the well must be obtained prior to the commencement of drilling. A generalized schematic of the drilling pad is shown on Figure 10.

Water-Table Monitoring Wells

As shown on Figure 9, four monitoring wells will be installed around each drilling pad for the purpose of monitoring the water quality of the Surficial Aquifer for increases in chlorides due to any spills from salty or brackish water produced during spill operations. These wells will be two inches in diameter, approximately 15 feet deep, with five feet of well screen on the bottom. The construction details for these wells are shown in Figure 11.

Water samples will be collected from each monitoring well on a weekly basis and analyzed for temperature, specific conductance and chloride concentrations. Samples will be collected prior to drilling to establish background values. These analyses will be performed by a Missimer & Associates, Inc. staff geologist in the field. The results of these tests shall be submitted to the TAC before drilling. If, during the construction and testing program, an increase in chlorides is observed in a shallow monitoring well that can be attributed to a spill of drilling fluids or saline water, the Contractor will be required to restore the water quality to natural background conditions. This cleanup may be accomplished by pumping out the monitoring wells properly disposing of the water. Additional shallow wells may be necessary to facilitate an adequate cleanup and will be installed if needed.

Drilling Methods

The conventional mud-rotary drilling method will be employed for the first stage of drilling through Surficial Aquifer and Hawthorn Formation to a depth of approximately 1000 feet below land surface (until installation of the surface casing has been completed). For the remaining drilling, the reverse-circulation rotary drilling method will be employed with drilling mud and/or salt being used as weight material. In all of the drilling phases, inclination surveys will be performed at approximately 60-foot intervals. During drilling, all fluids and cuttings will be contained in a closed-circulation system in which the cuttings are removed and the fluid returned to the borehole. The closed-circulation system will consist of leak-proof steel tanks with a minimum capacity of storing 2000 cubic feet (15,000 gallons) of fluid and/or cuttings. The circulation system also will contain suitable devices such as screens, shale shakers, and settling tanks for the removal of cuttings from the drilling fluids.

During the reverse-circulation drilling, the boreholes will be open to the Floridan Aquifer and may flow. The drilling contractor will be required to prevent the wells from flowing at all times. Blow-out preventers will be kept on the wells from flowing at all times ready for use. Blow-out will be placed on the wells when no work is being performed and shall be tested once per week by each crew.

Drill cuttings consisting of clay, excess mud, and drilling fluid will be removed from the drilling site and disposed of at an approved location to be established before drilling commences. The fluid will be considered as excess drilling fluid and will be properly disposed.

During all drilling, formation samples will be collected at ten-foot intervals and at formation changes or drilling breaks. Two complete sets of formation samples will be collected, preserved in well-marked containers, and stored on-site. Upon completion of the program, one complete set of samples will be furnished to the Florida Bureau of Geology. If requested, additional sample sets can be collected for interested agencies or members of the Technical Advisory Committee.

In order to comply with the monitoring requirements specified in Chapter 17-28 FAC, a separate monitor well will be constructed. The monitor well will be completed in two discrete zones; the shallow zone will be approximately 900 to 1000 feet below land surface. The deep monitor zone will be accessed by a string of 6 5/8-inch-diameter, 0.562-inch wall thickness steel casing set at a depth of approximately 2000 feet below land surface. The shallow monitor zone will be accessed through the annulus between the 6 5/8-inch diameter casing and the 16-inch diameter casing. The construction details of the dual-completion monitor well are shown in Figure 8. No drilling of the dual completion deep monitor well will be allowed until the base of the USDW (Underground Source of Drinking Water) has been determined.

HYDROGEOLOGIC TESTING PROGRAM

Water-Quality Testing

Water samples will be collected by an analyzed by a State-certified laboratory from the shallow monitor tube, deep monitor tube, and the injection zone. Monitor-well sampling will not be conducted until after disinfection.

(a) Monitor-Zone Tests

The shallow and deep monitor tubes shall be disinfected prior to development for sample collection. A volume equal to 10 times the volume of each casing will then be produced before the sample is collected by personnel from a state certified laboratory. The water produced from each tube will be contained in the closed-circulation system, and ultimately returned to the injection well.

The samples collected from the monitor zones shall be analyzed for all constituents listed in Section 17-22.104 FAC for primary and secondary drinking water standards, including microbiological analysis, for radionuclides, BOD and constituents listed under EPA (Environmental Protection Agency) Test Methods 608, 624, and 625.

Additionally, the following constituents will be included:

Hydrogen Sulfide	Alkalinity
Soluble Orthophosphate	COD (Chemical Oxygen Demand)
Ammonium	pH
Organic Nitrogen	TOC (Total Organic Carbon)
Antimony	Acidity
Magnesium	Specific Gravity
Calcium	Total Suspended Solids
Potassium	Total Kjeldahl Nitrogen, as N
Bicarbonate	Dissolved Oxygen
Bromide	Total Phosphorus, as P
Strontium	Borate
Fluoride	

(b) Injection-Zone Tests

Prior to conducting the TV Survey and injection test, the Contractor shall have a water sample collected from the injection well. Before collecting the water sample, the blow-out preventer shall be installed and the return line from the closed circulation system will be shut, forcing the injection zone to development pumping begins. A volume equal to at least 3 times the volume of the drill pipe must be removed. The Contractor shall then have a water sample collected from the well and have it analyzed for the primary and secondary drinking water standards and constituents listed under EPA Test Methods

608, 624, and 625. Additionally, the following constituents will be included:

Hydrogen Sulfide	Alkalinity
Soluble Orthophosphate	COD (Chemical Oxygen Demand)
Ammonium	pH
Organic Nitrogen	TOC (Total Organic Carbon)
Antimony	Acidity
Magnesium	Specific Gravity
Calcium	Total Suspended Solids
Potassium Total	Kjeldahl Nitrogen, as N
Bicarbonate	Dissolved Oxygen
Bromide	Total Phosphorus, as P
Fluoride	

Borehole Testing

Following completion of each stage of pilot-hole drilling in the injection well, geophysical logs will be conducted. An injection test, radioactive tracer survey, temperature log, and television survey will be conducted upon completion of the well. The data from the drill cuttings, cores, drill stem tests, and geophysical logs will be used to evaluate the thickness and the effectiveness of the confining sequence.

Drill Stem Tests

The Drill Stem Tests will be performed on isolated sections of the borehole in order to determine the hydrogeologic properties of the tested intervals, collect water samples, and to select the two monitor zones. An inflatable packer will be run into the hole on drill pipe and casing of sufficient diameter to house a submersible pump. After testing equipment is in place, the packer seated and the isolated zone is developed, a pump-out test will be conducted and drawdown and recovery data collected for determination of the hydrogeologic properties. The discharge water will be sampled periodically throughout the tests and chloride, conductivity, and temperatures will be recorded. These data will ensure that representative (background) water-quality data are collected. Just prior to the completion of the pumping portion of each test, water samples will be collected for analysis by a state-certified laboratory. The exact depths for the tests and the packer intervals will be determined from previously collected data (drill cutting, cores, drilling conditions). Provision will be made in the drilling contract for five Drill Stem tests, with an allowance for additional tests in the event that field conditions warrant.

Geophysical Logs

Geophysical well logging includes all techniques which sensing devices are lowered into a borehole to record some physical parameter that indicates characteristics of the subsurface material

or the fluids contained in the subsurface material. The purpose in running geophysical logs on the test-injection well is to obtain data on the presence, thickness, and areal extent of potential injection zones and confining beds. The logs will be correlated with log from other wells in the area. All geophysical logging will be conducted with the use of a "lubricator", or a stripper head that can prevent uncontrolled flowing conditions if the well "comes alive" while logging. The following series of geophysical logs will be conducted during each stage of pilot-hole drilling in the test-injection well:

1) Gamma ray
2) Temperature
3) X - Y caliper
4) Dual Induction
5) Borehole-compensated sonic

All geophysical logging will be performed by a qualified service company as part of the drilling contract.

Pressure Test

After the 24-inch-diameter final casing string is cemented in place and a cement bond log is run, a pressure test will be conducted. The anticipated wellhead operating pressure is approximately 50 psi. However, the 24-inch-diameter casing will be filled with water and placed under a minimum wellhead pressure of 150 psi for a period of 1 hour. The 20-inch diameter casing

liner will be open to the injection zone when installed so no pressure test will be possible. However, the annulus between the 24-inch diameter casing and the 20-inch diameter tubing will be pressure tested. The annulus will be filled with water and corrosion inhibiting fluid, place under a minimum of 150 psi for a period of one hour. No pressure change is allowed in sixty minutes. If a pressure change occurs, the tests will be repeated to the satisfaction of the consultant and regulatory agency.

Injection Test

Following the completion of the injection well, an injection test will be conducted. It is anticipated that the test will be conducted for approximately 24 hours. The length will be dependent on test results and will be sufficient to satisfy the requirements of Chapter 17-28 FAC. The test will be conducted at a flow rate of approximately 3,066 gpm (4.5 feet per second). The data that will be collected during the test will consist of injection pressure (wellhead), annular pressure, injection rate, injection well bottom hole temperature and bottom hole pressure.

The hydrostatic pressures in each monitor zone also will be measured and recorded. The test will be conducted using potable water from the Marco Island Utilities Water System Plant as the water supply.

Television Survey

Following completion of drilling through the injection zone and collection of water samples, a television survey will be performed on the well from the top of the 24-inch diameter injection casing to the bottom of the borehole. A tape of the television survey will be made and copies will be furnished to members of the TAC (Technical Advisory Committee).

Following completion of the injection test, a television survey will be performed on the well from the top of the 20-inch diameter tubing to the bottom of the packer. A tape of the television survey will be made and copies will be furnished to members of the TAC.

Radioactive Tracer Survey

A radioactive tracer survey will be conducted following the injection test. The survey results will be used to determine the absence of fluid movement behind the injection tubing and casing, from the injection zone into underground sources of drinking water (containing less than 10,000 mg/L TDS)> A background gamma-ray log will be run in the injection casing; then a radioactive tracer material (Iodine 131) will be ejected while the tracer tool is at the bottom of the injection casing. A series of gamma-ray logs then will be run in the casing in order to track any upward movement of the tracer. The test will be performed at the expected operating injection velocity to ensure that data obtained will

represent normal operating conditions. The test will also be performed at a slower rate (approximately 0.1 ft/sec. velocity), and at static conditions with no pumping. A detailed procedure for this test is included in the Technical Specifications.

ABANDONMENT

In the event that no suitable confining sequence or injection zone is found to exist in the injection well, the well will be abandoned. Missimer & Associates, Inc. would make a recommendation as to the number and depths of cement plugs to be used based on analysis of data collected during the drilling and testing. This information would be forwarded to members of the TAC for their comment and approval before proceeding.

It is not anticipated that cement plugs would be set in permeable zones in the Floridan Aquifer. These zones would be filled with crushed limestone gravel to reduce cement losses to the formation. The cement to be used in the plugs would consist of ASTM Type II or API Grade B, sulfate-resistant cement grout with gel and lost-circulation material as needed.

The documents required to demonstrate that Marco Island Utilities and SSU Services possess the financial resources to plug and abandon the well will be sent to the FDER'S (Department of Environmental Regulation) Tallahassee Office.

CLOSING COMMENTS

The techniques described in this program have been used successfully on other injection-well projects. The Consultant will provide qualified personnel for continuous on-site supervision during all testing and geophysical logging operations. During the program, a variety of records will be prepared and kept on site. A construction log will maintained as a permanent record for use in evaluating Contractor payment requests and in preparing as-built drawings. A daily log of activities and events will be prepared; copies of this will be furnished to the TAC on a weekly basis as part of a weekly construction-progress report will contain the following information:

1. A cover letter summary of the daily engineer/geologist report and driller's log and projection for activities in next reporting period.

2. Driller's log with descriptions of all testing, logging, casing, cementing, and drilling activities pursuant to Section 17-28.34 FAC.

3. Lithologic log with cuttings descriptions, drilling rate curve, and formation tops.

4. Weekly water-quality analyses and water levels for the four (4) surficial aquifer wells.

5. Detailed description of any unusual construction-related events that occur during the reporting period.

The geologic samples and cores will be stored on location until the well is completed. Copies of the field prints of the geophysical logs will be kept on the site and will be furnished to each member of the TAC as soon as they are available. Final copies of the logs also will be included in the final report; this, too, will be furnished to the TAC. At least 24 hours notice prior to any mechanical integrity testing will be provided to the TAC through the TAC chairman. Finally, periodic meetings will be held on site with the TAC so that a presentation of findings can be made and recommendations discussed. These meetings will be held at key times with ample notification provided so that individual TAC members may adjust their schedule accordingly.

These practices have evolved as a result of participation by key staff members in previous programs and have been found to be satisfactory method of communicating with the TAC and have led to the prevention and resolution of many problems that may have otherwise occurred. Additionally, these techniques are an effective means of monitoring a costly around-the-clock operation without delaying the program.

The final report to be prepared by Missimer & Associates, Inc. will serve as the supporting document for the operating permit for the well. It will be a descriptive report detailing testing procedures interpreting the results of the various geophysical

logs, core, and test data, demonstrating the adequacy of confinement, and of the injection and monitor zones. Copies of all logs, laboratory reports, and test data will be included, along with certification of mechanical integrity, an operation and maintenance manual and a plugging and abandonment program. Finally, recommendations will be presented regarding injection and monitor-well operating programs.

Respectfully submitted,

Missimer & Associates, Inc.

James E. McGrath, P.G.

Patrick G. Smith, P.G.

JMcG/law

FIGURES

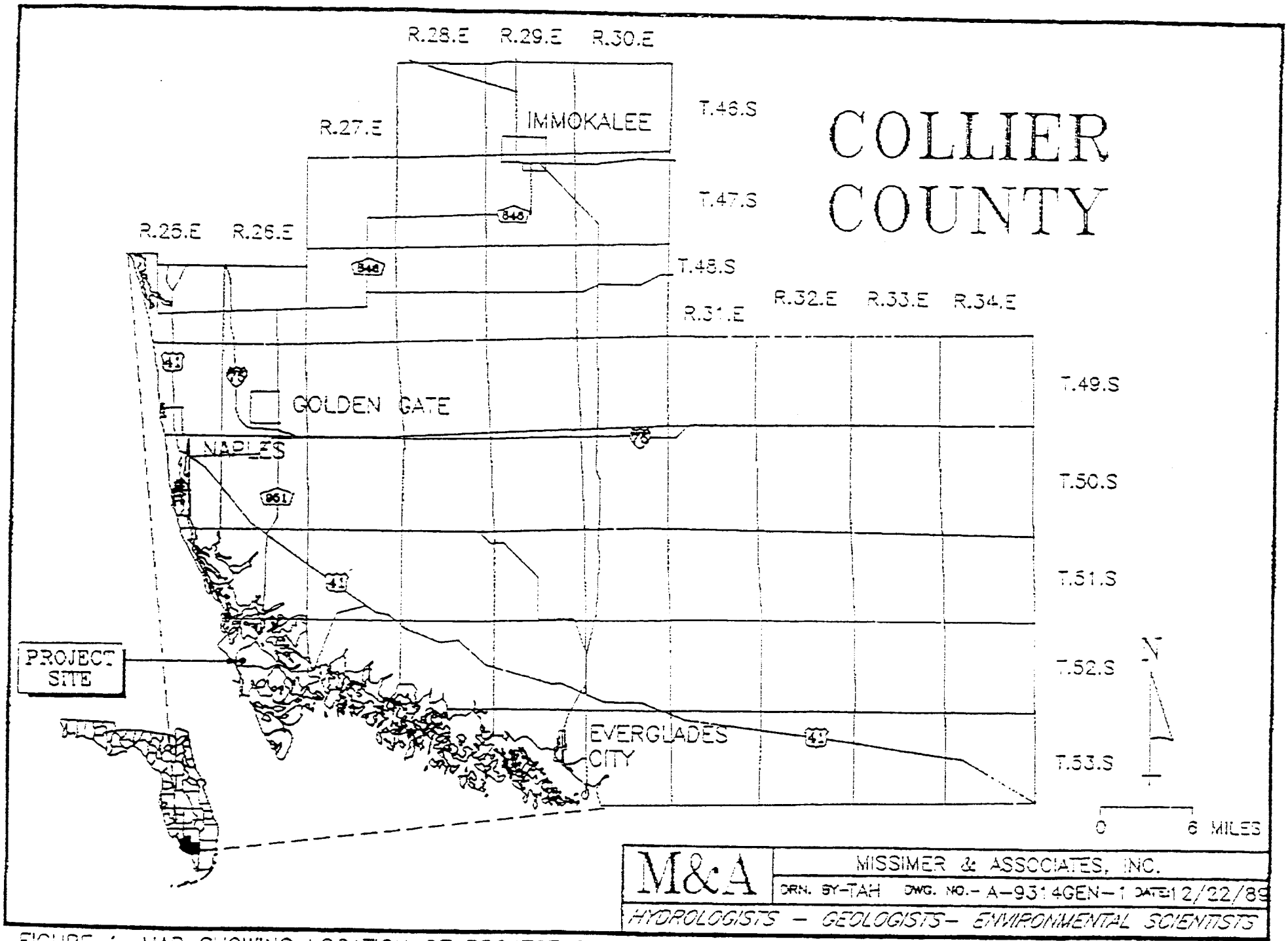


FIGURE 1. MAP SHOWING LOCATION OF PROJECT SITE.

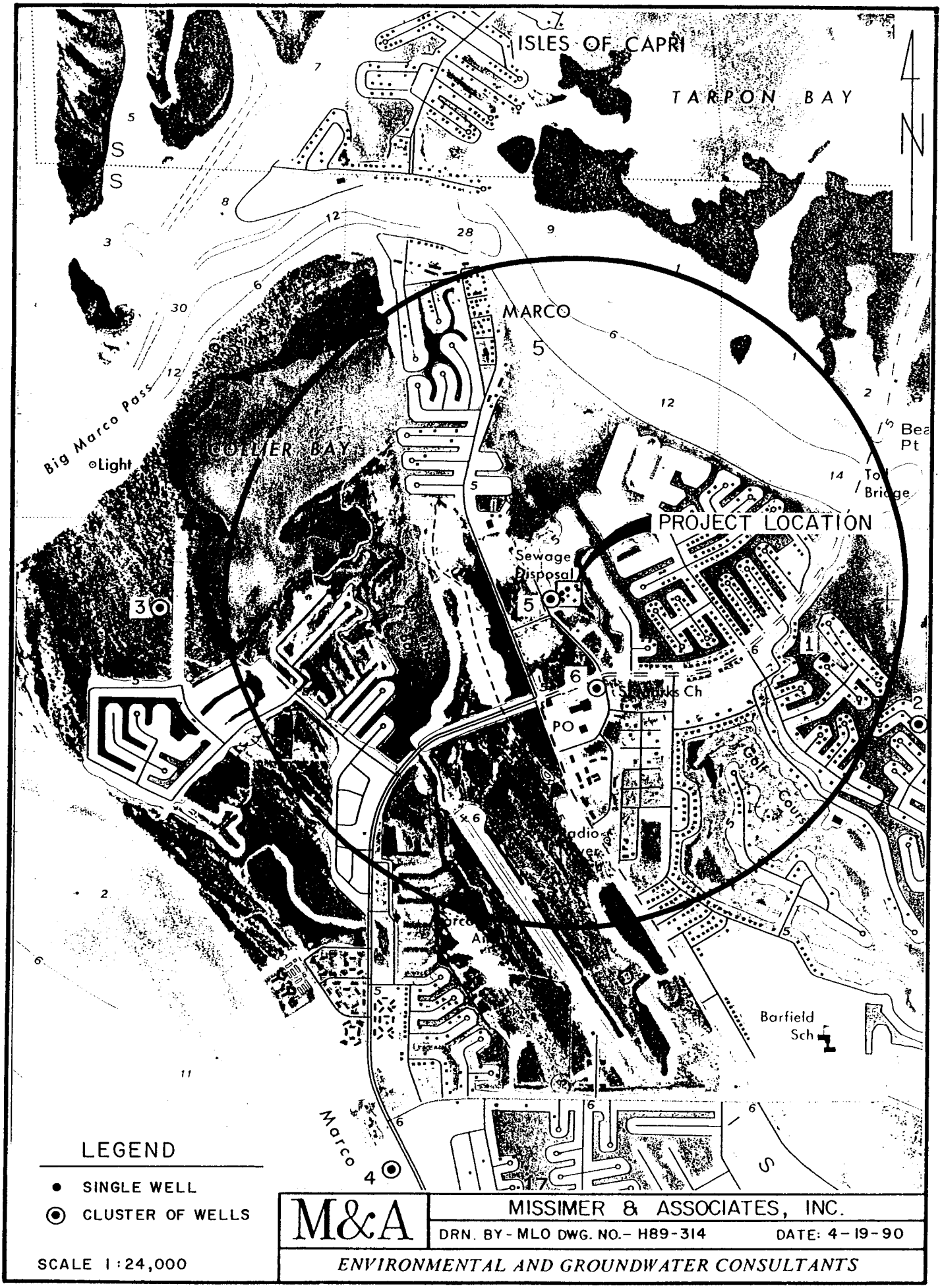


FIGURE 2. AREA OF REVIEW

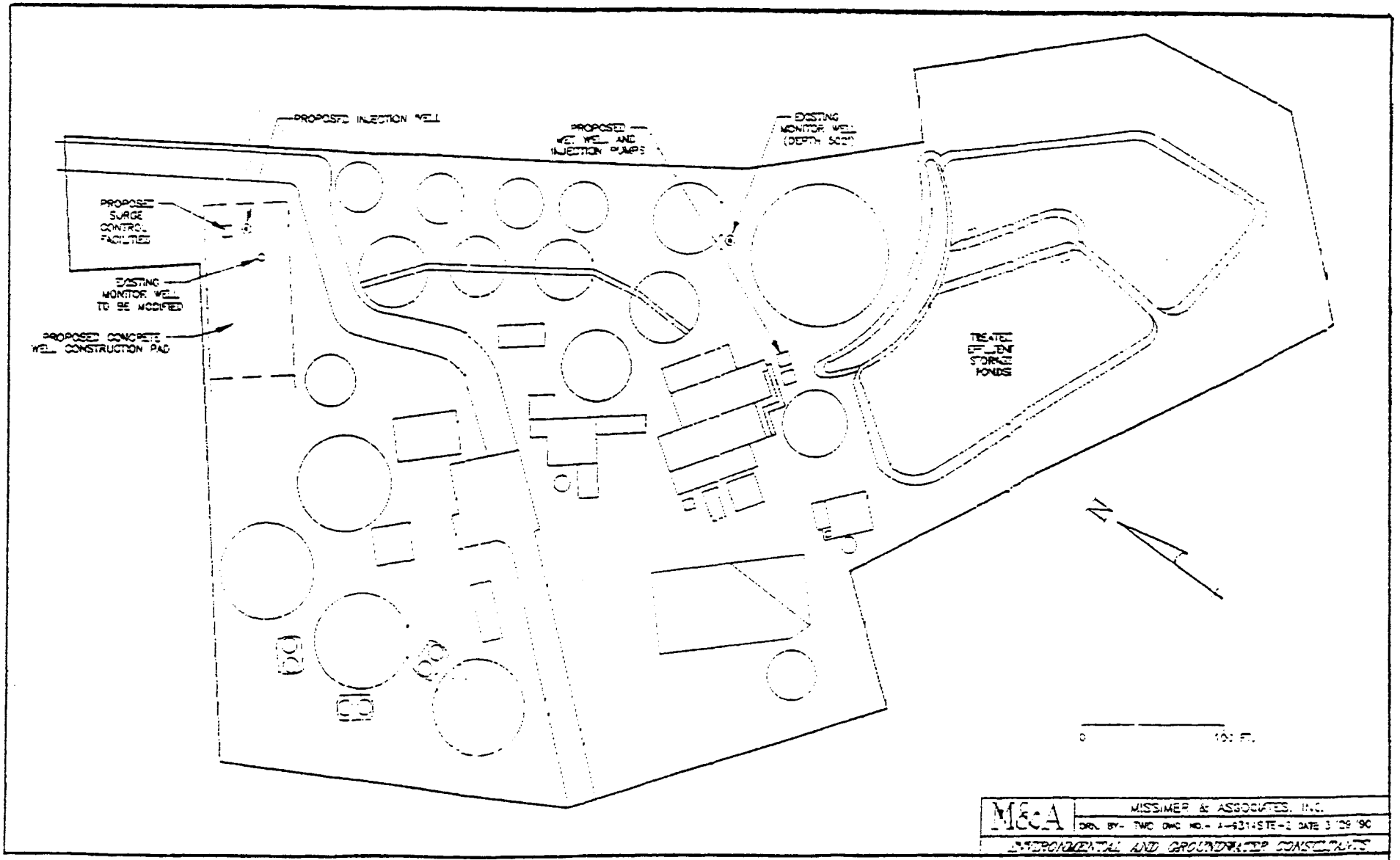


FIGURE 3. SITE PLAN OF EXISTING WATER AND WASTEWATER TREATMENT PLANT SHOWING PROPOSED INJECTION WELL FACILITIES.

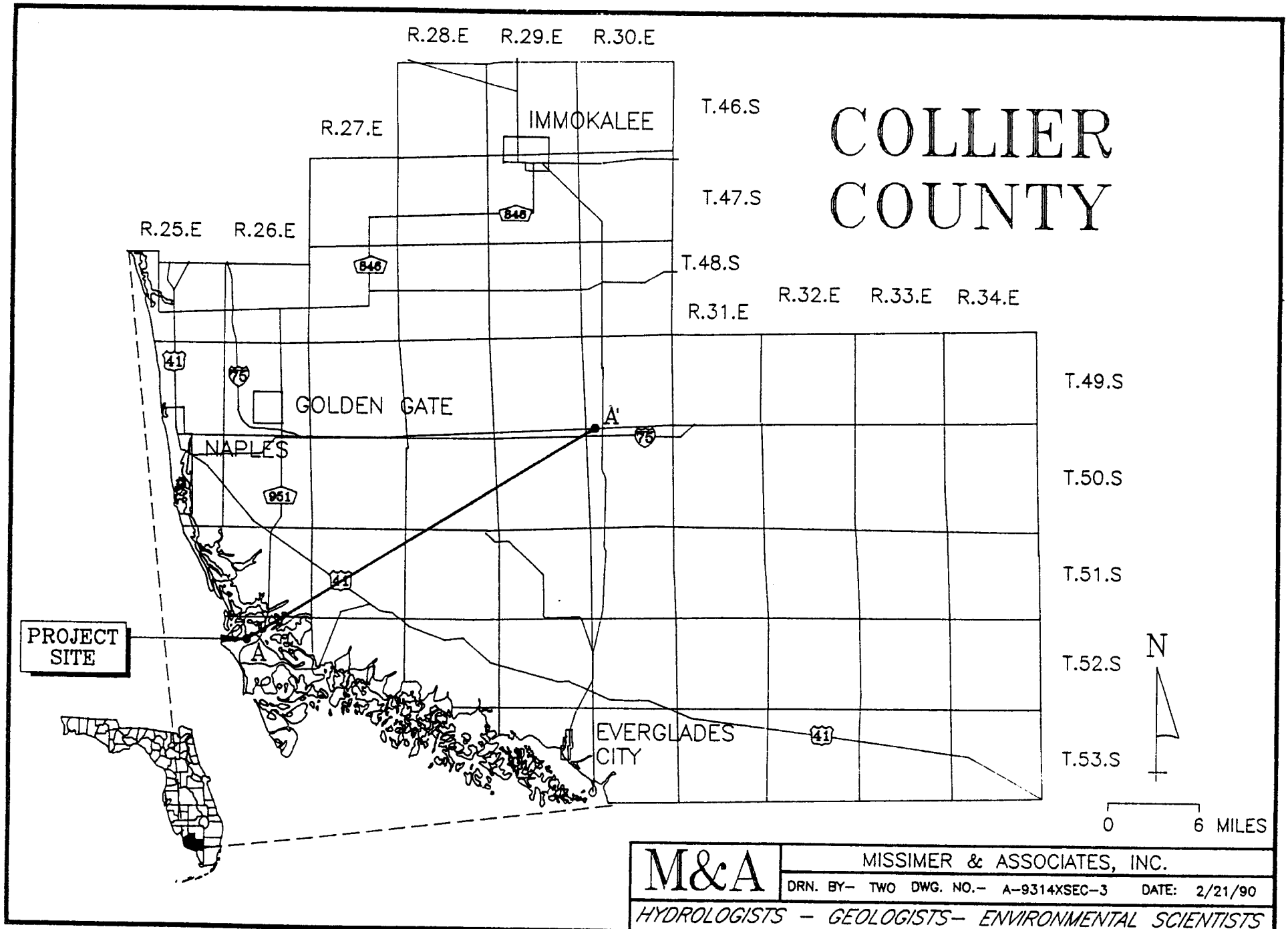


FIGURE 4. MAP SHOWING LOCATION OF GEOLOGIC CROSS-SECTION A-A'.

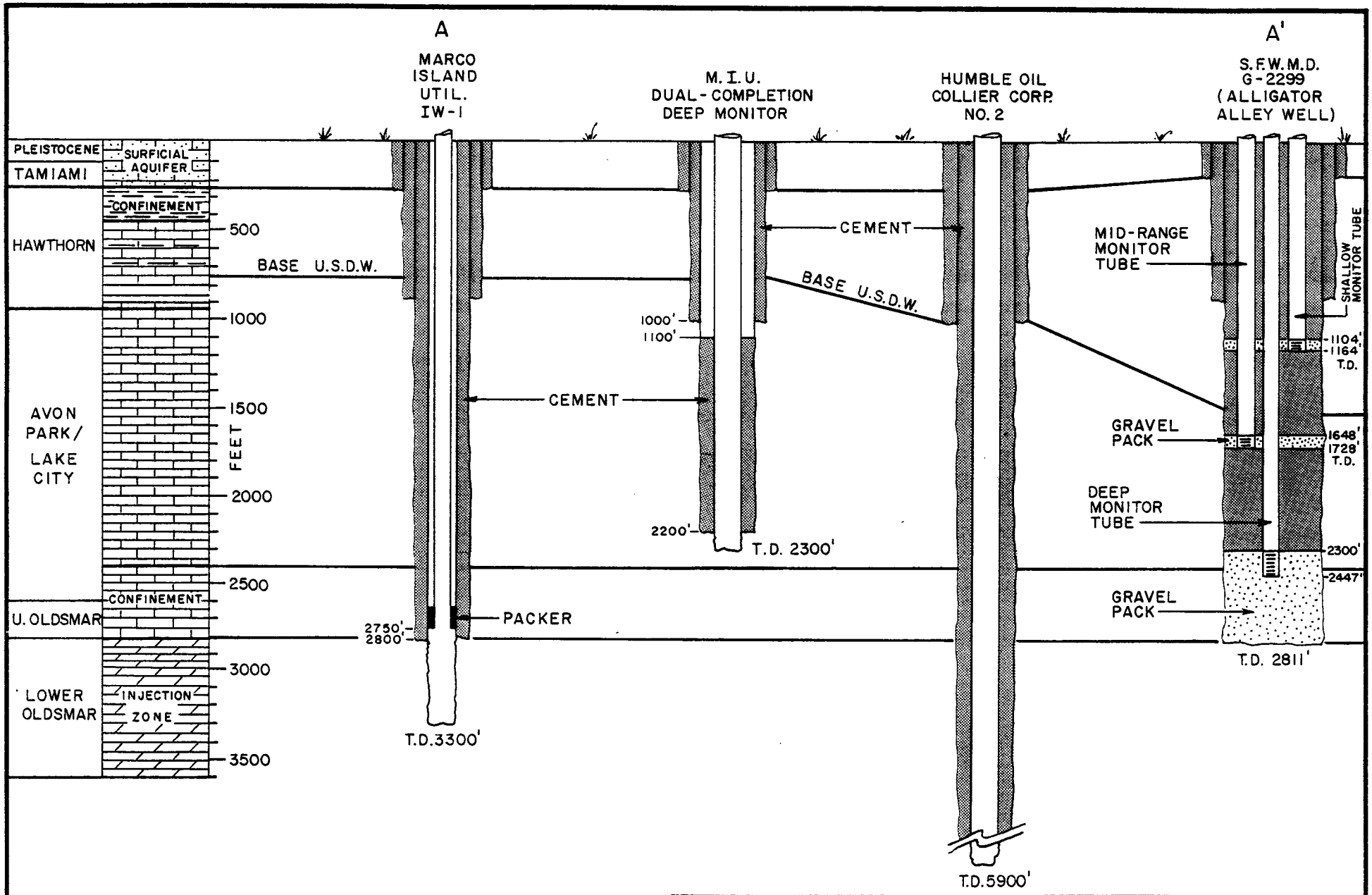
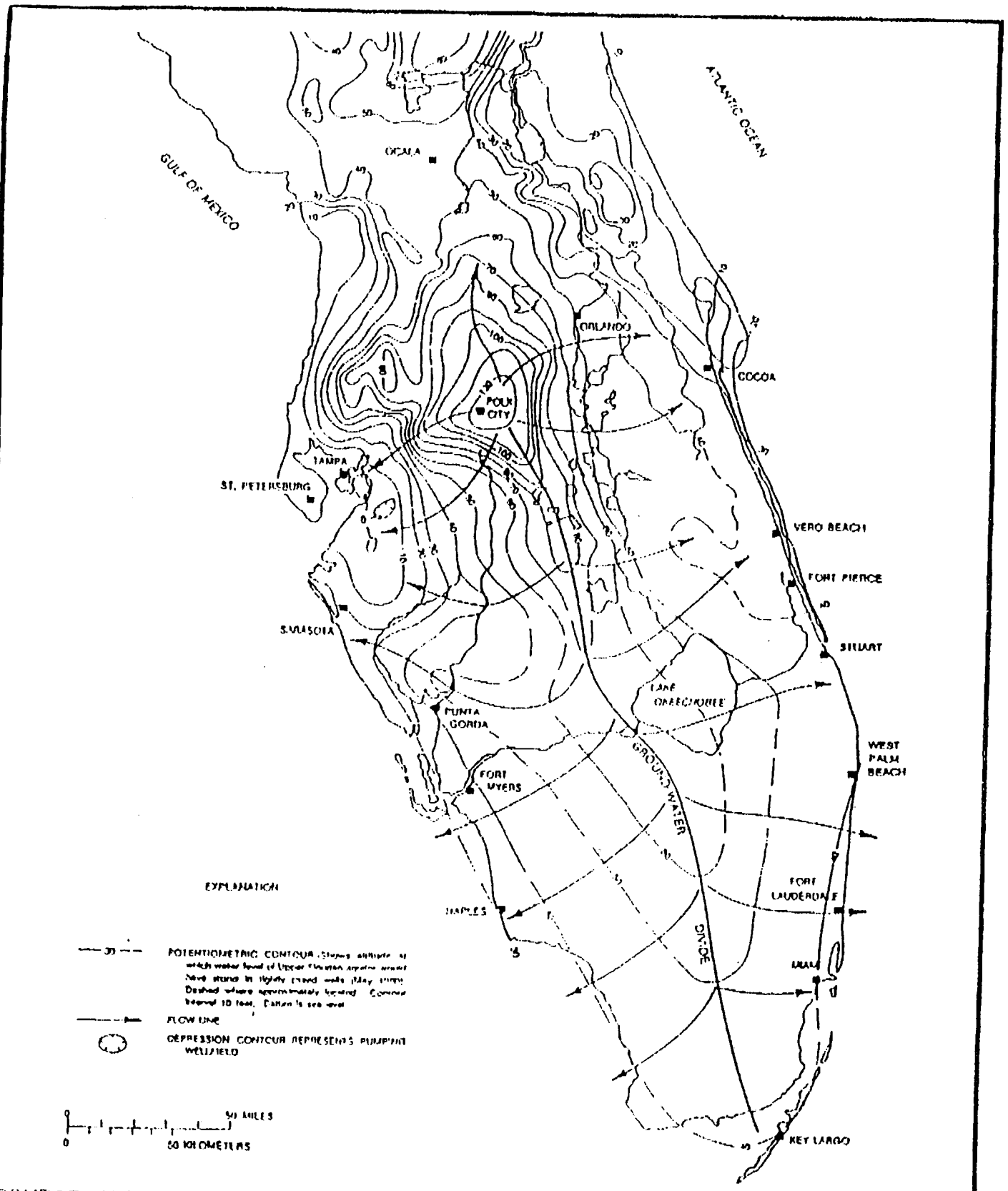


FIGURE 5. GEOLOGIC CROSS-SECTION OF MARCO ISLAND

M&A	MISSIMER & ASSOCIATES, INC.
	DRN. BY– CAM DWG. NO.– A–MH9314CL–1 DATE: 4/3/90
	ENVIRONMENTAL AND GROUNDWATER CONSULTANTS

FIGURE 6. GENERAL DIRECTION OF GROUND–WATER FLOW IN THE SURFICAL AQUIFER.



SOURCE: U.S.G.S., REVISED FROM JOHNSTON AND OTHERS (1981) AND HEALY (1982).

M&A	MISSIMER & ASSOCIATES, INC.
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	ENVIRONMENTAL AND GROUNDWATER CONSULTANTS

FIGURE 7. PENINSULAR FLORIDA SHOWING THE UPPER FLORIDAN AQUIFER POTENTIOMETRIC SURFACE AND FLOW DIRECTION IN MAY, 1980.

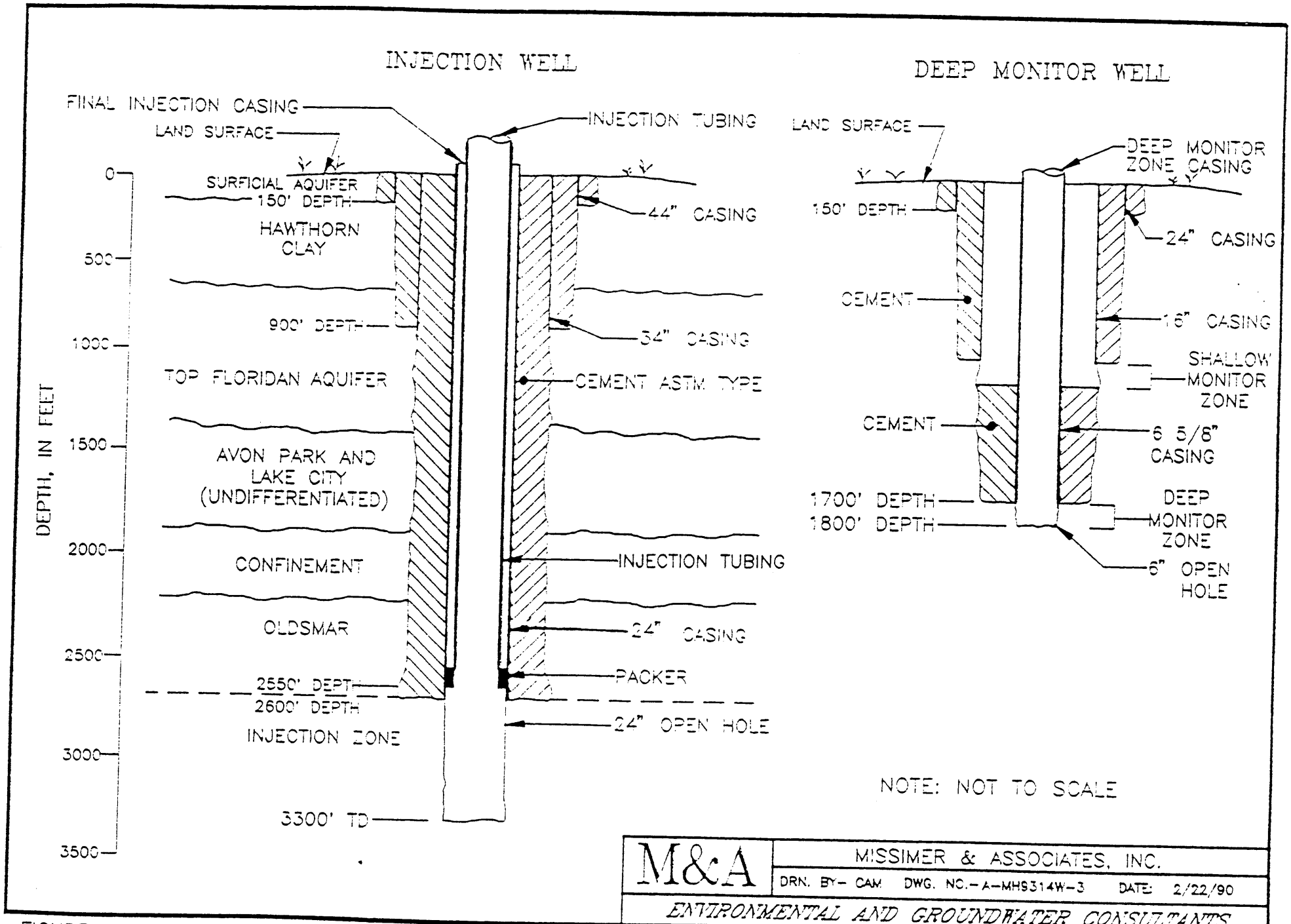
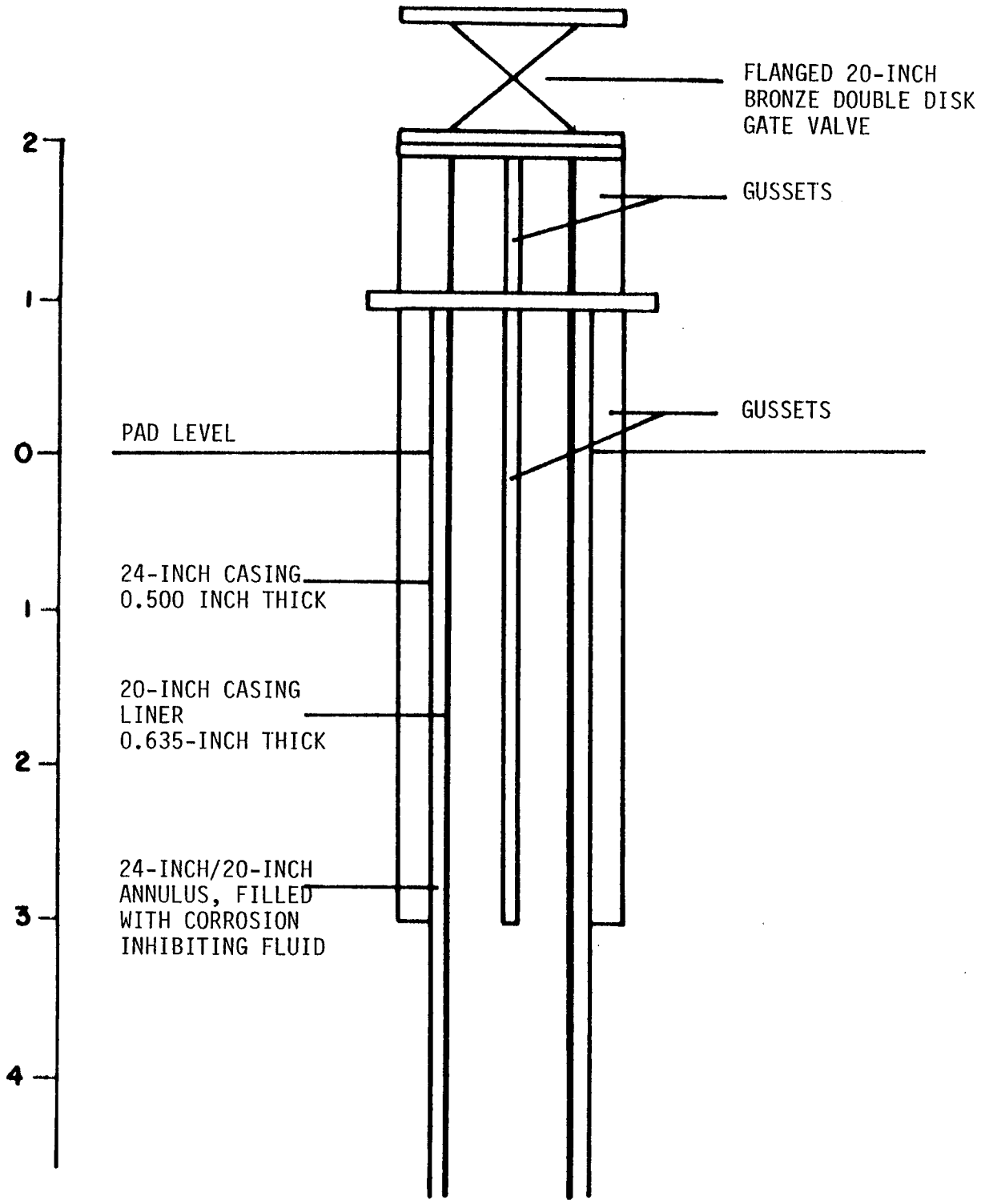
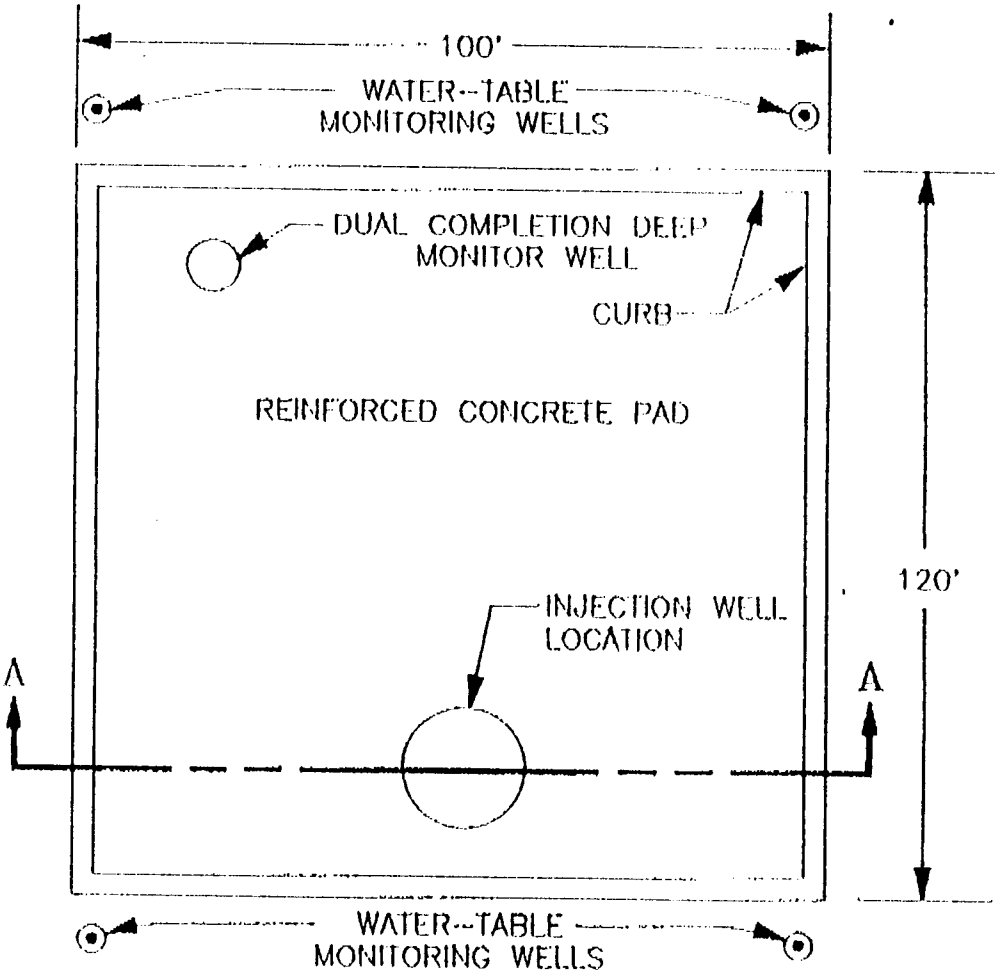


FIGURE 8. PROPOSED CONSTRUCTION DETAILS OF THE INJECTION WELL AND ZONE MONITOR WELL.

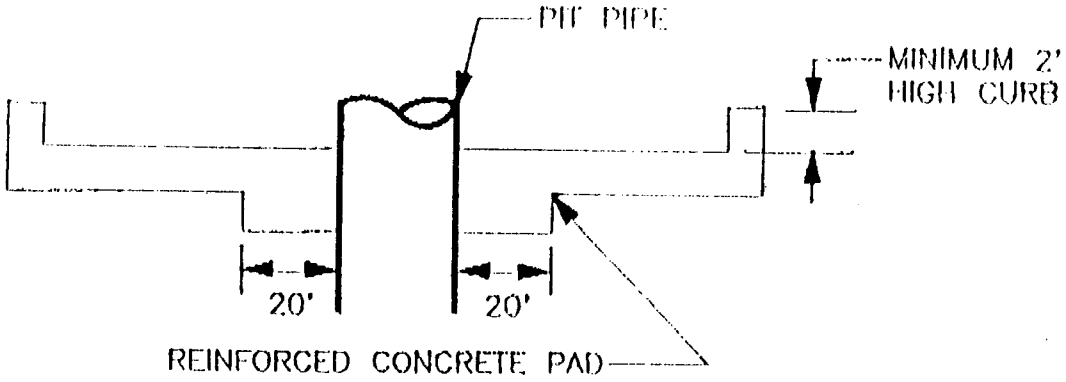


M&A | MISSIMER & ASSOCIATES, INC.
DRN. BY- jem DWG. NO.- h89-314.9/5 DATE: 3/28/90
ENVIRONMENTAL AND GROUNDWATER CONSULTANTS

FIGURE 9. WELL-HEAD CONSTRUCTION DETAILS



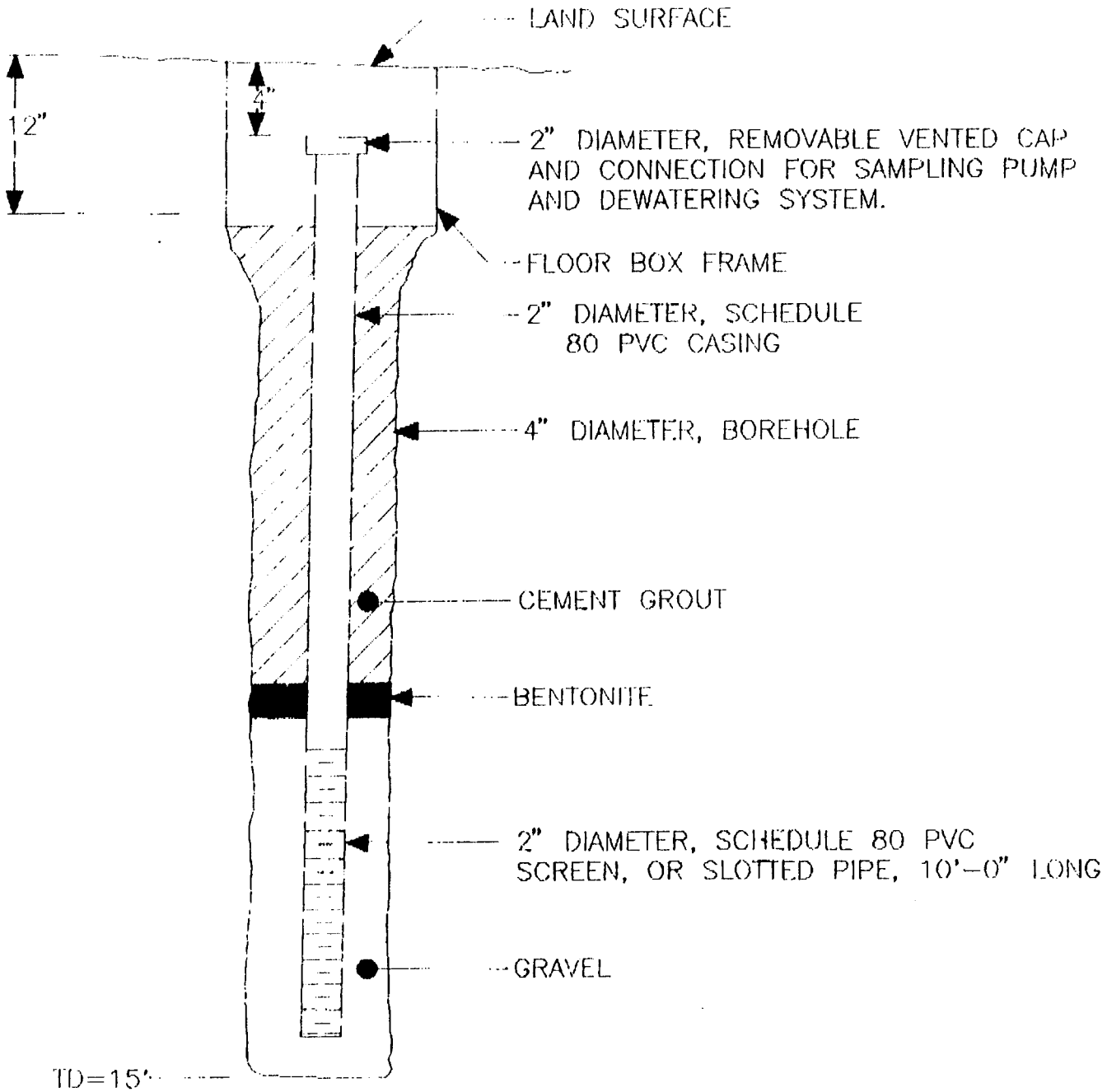
PLAN VIEW



CROSS SECTION A–A

M&A	MISSIMER & ASSOCIATES, INC.
	DRN. BY– CAM DWG. NO.–A–MH9314DP–1 DATE: 12/27/89
	ENVIRONMENTAL AND GROUNDWATER CONSULTANTS

FIGURE 10. TYPICAL DRILL PAD AND MONITORING WELL LOCATIONS



M&A	MISSIMER & ASSOCIATES, INC.
	DRN. BY-TAH DWG. NO.-A-9314WELL-1 DATE: 1/25/90
	ENVIRONMENTAL AND GROUNDWATER CONSULTANTS

FIGURE 11. INJECTION WELL DRILLING PAD WATER-TABLE MONITORING WELL CONSTRUCTION DETAILS.

APPENDIX A

APPENDIX A
WELLS WITHIN AREA OF REVIEW
MARCO ISLAND UTILITIES/SSU SERVICES

Map ID#	Sect.	Well No.	Total Depth Ft.	Diameter Inches	Compl. Method	Compl. Date	Owner
1	9	1	59	2	Open Hole	1/10/88	Sunbrella
2	9	1	69	2	Open Hole	12/9/87	Jerry Hunt
2	9	2	69	2	Open Hole	12/9/87	Jerry Hunt
3	7	1	63	2	Open Hole	3/17/88	Unknown (Private)
3	7	2	63	2	Open Hole	3/17/88	Unknown (Private)
4	20	1	65	2	Open Hole	1/12/88	Princess Del Mar
4	20	2	65	2	Open Hole	1/12/88	Princess Del Mar
5	8	TW #1	800 *	12	Open Hole	03/6/89	M.I.U./SSU Services
5	8	MW #1	502	6	Open Hole	6/29/89	M.I.U./SSU Services
6	8	MW #s 1-4	13	2	Open Hole	07/4/89	Chevron

* Plugged Back to 540'

APPENDIX B

UAE 14 ... WED 16:55 ID:MARCO IS UTILITIES TEL NO:305 394 8157 #042 P04

File

FLOWERS CHEMICAL LABORATORIES

ANALYTICAL & CONSULTING CHEMISTS

Established 1957

Complete Laboratory Service

NEWBURYPORT & 2nd ST.; P. O. BOX 597; ALTAMONTE SPRINGS, FLA. 32701
Winter Park Ph. 305 339-5984

DELTONA UTILITIES

Received From: Marco Island
Box 309
Deltona Florida

Date 4/28/83

For: Sample No 8349
Sewage Effluent
Collected 3/18/83

Laboratory Identification HRS NO 83170

Copy to Ron Kelly

Ralph ... 5/2/83

REPORT OF ANALYSIS FOR PUBLIC DRINKING WATER

SECONDARY STANDARDS

Constituent	mg/L	Constituent	mg/L
CHLORIDE, mg C1/L	545.0	MANGANESE, mg Mn/L	<0.02
COLOR, A.P.H.A. Units	35	ODOR	20
SURFACTANTS, (MBAS) mg LAS/L	0.22	SULFIDE, mg H_2S/L	0.061
IRON, mg Fe/L	0.40	ZINC, mg Zn/L	0.019
COPPER mg Cu/L	0.04	SULFATE mg SO_4/L	115

CORROSION & SCALE FORMATION ANALYSES.

Constituent	mg/L	Constituent	mg/L
CALCIUM, mg Ca/L	51.2	CARBONATES, $CaCO_3$	0
MAGNESIUM, mg Mg/L	30.7	HYDROXIDES, $CaCO_3$	0
TOTAL DISSOLVED SOLIDS	1228.0	CARBON DIOXIDE, CO_2	<1
TOTAL HARDNESS, $CaCO_3$	254.0	STABILITY INDEX	8.08
HARDNESS, CARBONATE, $CaCO_3$	138	pH, LABORATORY	7.24
HARDNESS, NON-CARBONATE, $CaCO_3$	116	pH_s	7.66
TOTAL ALKALINITY	138	SATURATION INDEX	-0.42
BICARBONATES, $CaCO_3$	138		

RECEIVED MAY 1983 MARCO UTILITIES

All Methods in Accordance with "Standard Methods", ASTM, and EPA Methods

FLOWERS CHEMICAL LABORATORIES

ANALYTICAL & CONSULTING CHEMISTS

Established 1957

Complete Laboratory Service

NEWBURYPORT & 2nd ST.; P. O. BOX 597; ALTAMONTE SPRINGS, FLA. 32701

Winter Park Ph. 305 339-5984

Received From: Marco Island
Box 309
Deltona Florida

Date 4/28/83

For: Sample No 8349
Sewage Effluent
Collected 3/18/83

Laboratory Identification HRS NO 83139

REPORT OF ANALYSIS FOR PUBLIC DRINKING WATER

INORGANIC

Contaminant	mg/L	Contaminant	mg/L
ARSENIC, mg As/L	0.001	LEAD, mg Pb/L	<0.05
BARIUM, mg Ba/L	<0.2	MERCURY, mg Hg/L	<0.001
CADMIUM, mg Cd/L	<0.01	NITRATEI, mg N/L	0.17
CHROMIUM, mg Cr/L	<0.01	SELENIUM, mg Se/L	<0.001
FLUORIDE, mg F/L	0.41	SILVER, mg Ag/L	<0.02
Sodium ppm Na	335.0	TURBIDITY NTU	12.0

ORGANIC

Contaminant	mg/L	Contaminant	mg/L
ENDRIN	<0.0001	TOXAPHENE	<0.004
LINDANE	<0.000025	2,4-D	<0.0005
METHOXYCHLOR	<0.001	2,4,5-TP (Silvex)	<0.00025

All Methods in Accordance with "Standard Methods", ASTM, and EPA Methods.

Orlando Laboratories, Inc.

P. O. Box 19127 • Orlando, Florida 32814 • 305/896-8645

GENERAL WATER ANALYSIS FOR
SECONDARY DRINKING WATER REGULATIONS

Marco Island Utilities
Attn: D. Robinson
Post Office Box 197
Marco, Florida 33937

Report: 44285 (6878)
Sampled by: Client(C. Hatfield)
Date Sampled: 04-25-85 @ 2:00 pm.
Date Received: 04-26-85
Date Reported: 06-04-85

IDENTIFICATION: STP Effluent Composite. Water appearance: Cloudy.

METHODS

This water was analyzed according to "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

DETERMINATION	(MCL)	mg/l
Total Dissolved Solids, TDS	(500)	1000
Phenolphthalein Alkalinity, $CaCO_3$		0
Total Alkalinity, $CaCO_3$		185
Carbonate Alkalinity, $CaCO_3$		0
Bicarbonate Alkalinity, $CaCO_3$		185
Carbonates, $CaCO_3$		0
Bicarbonates, HCO_3		226
Hydroxides, as OH		0
Carbon Dioxide, CO_2		14
Chloride, Cl	(250)	290
Sulfate, SO_4	(250)	92.5
Fluoride, F	(1.4-2.4)	1.02
pH (Laboratory)	(6.5-8.5)	7.4
pHs		7.48
Stability Index		7.56
Saturation Index, corrosivity	(±0.2)	-0.08
Color, PCU	(15)	100
Odor Threshold	(3)	1
Turbidity, NTU	(5)	6.2

DETERMINATION	(MCL)	mg/l
Hydrogen Sulfide, H_2S [F-F]		<0.1
Specific Conductance, umhos		1400
Foaming Agents (MBAS)	(0.5)	<0.1
Sodium, Na	(160)	193
Nitrate Nitrogen, N	(10)	<0.02
Total Hardness, $CaCO_3$		191
Calcium Hardness, $CaCO_3$		134
Magnesium Hardness, $CaCO_3$		57.4
Calcium, Ca		53.5
Magnesium, Mg		13.9
Iron, Fe	(0.3)	0.22
Manganese, Mn	(0.05)	<0.05
Copper, Cu	(1.0)	0.01
Zinc, Zn	(5)	<0.05

Our Florida Department of Health & Rehabilitative Services Identification Number is 83141.
Results expressed in mg/l unless otherwise designated. < = Less Than.
MCL - Maximum Contaminant Levels.

Signed: _____
Chemist/Biologist

RECEIVED
JUL 5 1985
MARCO UTILITIES

Sent copy to Ralph V. 7/5/85

Orlando Laboratories, Inc.
P. O. Box 19127 • Orlando, Florida 32814 • 305/896-8645

REPORT OF ANALYSIS

Marco Island Utilities
Attn: Cliff Hatfield
Post Office Box 197
Marco Island, Florida 33937

Report #: 43969 (6557)
Sampled by: Client(Dale Waller)
Date sampled: 03/13-14/85 @ 8:00 am.
Date received: 03-15-85
Data reported: 04-17-85
Page 1 of 6

IDENTIFICATION: Marco Island Waste Water Treatment Plant.

RESULTS OF ANALYSIS

PURGEABLE ORGANICS	SAMPLE
Bromodichloromethane	<0.001
Bromoform	<0.001
Bromomethane	<0.001
Carbon Tetrachloride	<0.001
Chloroethane	<0.001
2-Chloroethylvinyl ether	<0.001
Chloroform	<0.001
Chloromethane	<0.001
Dibromochloromethane	<0.001
1,2-Dibromo-3-chloropropane	<0.001
Dichlorodifluoromethane	<0.001
1,1-Dichloroethane	<0.001
1,2-Dichloroethane	<0.001
1,1-Dichloroethene	<0.001
cis-1,2-Dichloroethene	<0.001
trans-1,2-Dichloroethene	<0.001
1,2-Dichloropropane	<0.001
cis-1,2-Dichloropropene	<0.001
trans-1,2-Dichloropropene	<0.001
cis-1,3-Dichloropropene	<0.001
trans-1,3-Dichloropropene	<0.001
n-Hexane	<0.001
Methylene chloride	<0.001

Results expressed in mg/l unless otherwise designated. < = Less Than.
Our Florida Department of Health & Rehabilitative Service Identification Number is 83141.

Respectfully submitted,
ORLANDO LABORATORIES, INC.

Chemist/Biologist

RECEIVED
APR 19 1985
MARCO UTILITIES

IDENTIFICATION: Marco Island Waste Water Treatment Plant.

RESULTS OF ANALYSIS

PURGEABLE ORGANICS - Cont.	SAMPLE
1,1,2,2-Tetrachloroethane	<0.001
Tetrachloroethene	<0.001
1,1,1-Trichloroethane	<0.001
1,1,2-Trichloroethane	<0.001
Trichloroethene	<0.001
Trichlorofluoromethane	<0.001
Vinyl chloride	<0.001
Benzene	<0.001
Chlorobenzene	<0.001
1,2-Dichlorobenzene	<0.001
1,3-Dichlorobenzene	<0.001
1,4-Dichlorobenzene	<0.001
Ethylbenzene	<0.001
Styrene	<0.001
Toluene	<0.001
ortho - Xylene	<0.001
meta, para - Xylene	<0.001
Acrolein	<0.1
Acrylonitrile	<0.1
ACID EXTRACTABLE ORGANICS	*
4-Chloro-3-methyl phenol	<0.01
2-Chlorophenol	<0.01
2,4-Dichlorophenol	<0.01
2,4-Dimethylphenol	<0.01
2,4-Dinitrophenol	<0.01
2-Methyl-4,6-dinitrophenol	<0.01
2-Nitrophenol	<0.01
4-Nitrophenol	<0.01
Pentachlorophenol	<0.01
Phenol	<0.01
2,4,6-Trichlorophenol	<0.01

* Three non-priority pollutant acid extractable responses were detected.

Results expressed in mg/l unless otherwise designated. < = Less Than.
Our Florida Department of Health & Rehabilitative Service Identification Number is 83141.

Respectfully submitted,
ORLANDO LABORATORIES, INC.

Chemist/Biologist

IDENTIFICATION: Marco Island Waste Water Treatment Plant.

RESULTS OF ANALYSIS

BASE NEUTRAL ORGANICS	SAMPLE
Acenapthene	<0.01
Acenapthylene	<0.01
Anthracene	<0.01
Benzidine	<0.01
Benzo(a)anthracene	<0.01
Benzo(b)fluoranthene	<0.01
Benzo(k)fluoranthene	<0.01
Benzo(a)pyrene	<0.01
Benzo(g,h,i)perylene	<0.01
Benzyl-butyl phthalate	<0.01
bis(2-Chloroethyl)ether	<0.01
bis(2-Chloroethoxy)methane	<0.01
bis(2-Ethylhexyl)phathalate	<0.01
bis(2-Chloroisopropyl)ether	<0.01
4-Bromophenyl phenyl ether	<0.01
2-Chloronaphthalene	<0.01
4-Chlorophenyl phenyl ether	<0.01
Chrysene	<0.01
Dibenzo(a,h)anthracene	<0.01
Di-n-butyl phthalate	<0.01
1,2-Dichlorobenzene	<0.01
1,3-Dichlorobenzene	<0.01
1,4-Dichlorobenzene	<0.01
3,3-Dichlorobenzidine	<0.01
Diethyl phthalate	<0.01
Dimethyl phthalate	<0.01
2,4-Dinitrotoluene	<0.01
2,6-Dinitrotoluene	<0.01
Di-n-octyl phthalate	<0.01
1,2-Diphenylhydrazine	<0.01
Fluoranthene	<0.01
Fluorene	<0.01
Hexachlorobenzene	<0.01

Results expressed in mg/l unless otherwise designated. < = Less Than.
Our Florida Department of Health & Rehabilitative Service Identification Number is 83141.

Respectfully submitted,
ORLANDO LABORATORIES, INC.

Chemist/Biologist

IDENTIFICATION: Marco Island Waste Water Treatment Plant.

RESULTS OF ANALYSIS

BASE NEUTRAL ORGANICS - Cont.	SAMPLE
Hexachlorobutadiene	<0.01
Hexachlorocyclopentadiene	<0.01
Hexachloroethane	<0.01
Ideno(1,2,3-c,d)pyrene	<0.01
Isophorone	<0.01
Naphthalene	<0.01
Nitrobenzene	<0.01
n-Nitrosodimethylamine	<0.01
n-Nitrosodi-n-propylamine	<0.01
n-Nitrosodiphenylamine	<0.01
Phenanthrene	<0.01
Pyrene	<0.01
2,3,7,8-Tetrachlorodi-benzo-p-dioxin (Dioxin)	<0.01
1,2,4-Trichlorobenzene	<0.01
ORGANOCHLORINE PESTICIDES & PCB's	*
Aldrin	<0.001
Alpha-BHC	<0.001
Beta-BHC	<0.001
Delta-BHC	<0.001
Gamma-BHC	<0.001
Chlordane	<0.001
4,4'-DDD	<0.001
4,4'-DDE	<0.001
4,4'-DDT	<0.001
Ortho-DDD	<0.001
Ortho-DDE	<0.001
Ortho-DDT	<0.001
Para-DDD	<0.001
Para-DDE	<0.001
Para-DDT	<0.001
Dieldrin	<0.001

* Several non-priority pollutant pesticide responses were detected.

Results expressed in mg/l unless otherwise designated. < = Less Than.
Our Florida Department of Health & Rehabilitative Service Identification Number is 83141.

Respectfully submitted,
ORLANDO LABORATORIES, INC.

Chemist/Biologist

IDENTIFICATION: Marco Island Waste Water Treatment Plant.

RESULTS OF ANALYSIS

ORGANOCHLORINE PESTICIDES & PCB's - Cont.	SAMPLE
Ortho-DDT	<0.001
Para-DDD	<0.001
Para-DDE	<0.001
Para-DDT	<0.001
Dieldrin	<0.001
Endosulfan I	<0.001
Endosulfan II	<0.001
Endosulfan sulfate	<0.001
Endrin	<0.001
Endrin aldehyde	<0.001
Heptachlor	<0.001
Heptachlor epoxide	<0.001
Kelthane (Dicofal)	<0.001
PCB 1016	<0.001
PCB 1221	<0.001
PCB 1232	<0.001
PCB 1242	<0.001
PCB 1248	<0.001
PCB 1254	<0.001
PCB 1260	<0.001
Toxaphene	<0.001
ORGANOPHOSPHORUS PESTICIDES	
Diazinon	<0.001
Ethion	<0.001
Guthion (Azinphos methyl)	<0.001
Malathion	<0.001
Parathion	<0.001
Tedion	<0.001
Trithion (Carbophenothion)	<0.001
MISCELLANEOUS PRIORITY POLLUTANTS	
Ethylene Dibromide, EDB (ug/l)	<0.02

Results expressed in mg/l unless otherwise designated. < = Less Than.
Our Florida Department of Health & Rehabilitative Service Identification Number is 83141.

Respectfully submitted,
ORLANDO LABORATORIES, INC.

Chemist/Biologist

Marco Island Utilities
Attn: Cliff Hatfield

04-17-85

Report #: 43969 (6557)
Page 6 of 6

IDENTIFICATION: Marco Island Waste Water Treatment Plant.

RESULTS OF ANALYSIS

DETERMINATION	SAMPLE
Temik, ug/l	<5

Results expressed in mg/l unless otherwise designated. < = Less Than.
Our Florida Department of Health & Rehabilitative Service Identification Number is 82161.

Respectfully submitted,
ORLANDO LABORATORIES, INC.

Chemist/Biologist

PRIMARY DRINKING WATER REGULATIONS ANALYSIS (ORG. & INORG.)

Marco Island Utilities
Attn: D. Robinson
Post Office Box 197
Marco, Florida 33937

Report #: 44285 (6878)
Sampled by: Client(C. Hatfield)
Date Sampled: 04-25-85 @ 2:00 pm.
Date Received: 04-26-85
Date Reported: 06-04-85

Identification: STP Effluent Composite.

METHODS & LIMITS: In accordance with Federal Register-Vol. 40, No. 248, Part IV-Wednesday, December 24, 1975. U.S. Environmental Protection Agency, National Interim Primary Drinking Water Regulations.

CONTAMINANT	*MCL	SAMPLE
INORGANIC:		
Arsenic, As	0.05	<0.01
Barium, Ba	1.0	<0.10
Cadmium, Cd	0.010	<0.005
Chromium, Cr	0.05	0.03
Lead, Pb	0.05	<0.01
Mercury, Hg	0.002	<0.0005
Selenium, Se	0.01	<0.005
Silver, Ag	0.05	<0.01
ORGANIC:		
Endrin	0.0002	<0.0001
Lindane	0.004	<0.001
Methoxychlor	0.1	<0.01
Toxaphene	0.005	<0.001
2,4-D	0.1	<0.01
2,4,5-TP (Silvex)	0.01	<0.001

Results are expressed in mg/l (ppm). *MCL - Maximum Contaminant Levels. Our Florida Department of Health & Rehabilitative Services Laboratory Identification Number is 83141.

Respectfully Submitted,
ORLANDO LABORATORIES, INC.

Chemist/Biologist

REPORT OF ANALYSIS

Marco Island Utilities
Attn: D. Robinson
Post Office Box 197
Marco, Florida 33937

Report #: 44285 (6878)
Sampled by: Client(C. Hatfield)
Date sampled: 04-25-85 @ 2:00 pm.
Date received: 04-26-85
Date reported: 06-04-85

IDENTIFICATION: STP Effluent Composite.

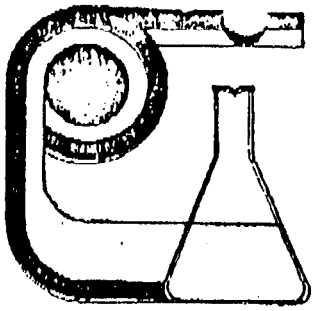
RESULTS OF ANALYSIS

DETERMINATION	Storet #	SAMPLE
Gross Alpha, pCi/l	01501	2.6
Counting error, pCi/l	01502	± 3.0

Results expressed in mg/l unless otherwise designated. < = Less Than.
Our Florida Department of Health & Rehabilitative Service Identification Number is 83141.

Respectfully submitted,
ORLANDO LABORATORIES, INC.

Chemist/Biologist



Applied Environmental Services

990 North Barfield Drive
Marco Island, Florida (33937)
Telephone (813) 394-2795

INVOICE NO.
00336
When Corresponding, Please Quote Above Number.

TO: Marco Island Utilities
P.O. Box 197
Marco Island, Fl. 33937

Attention: Ronald E. Evans

RESULTS SENT TO:
attached

DATE	DESCRIPTION	AMOUNT
1/7/83	Perform sample test of + Nitrate- N & Nitrite- N	$44. 16
	9330 - gas Light 100	
	SENT JAN 14 1983	
	RECEIVED JAN 14 1983 MARCO ISLAND UTILITIES CONSTRUCTION OFFICE	
	MARCO UTILITIES By: C. M. Courtney	
	TOTAL	$44. 16

LABORATORY I.D. #85127
THE MARCO APPLIED MARINE ECOLOGY STATION
990 N. BARFIELD DRIVE, MARCO ISLAND, FLA. 33937
PHONE 813--394-2795

Collection Time and Date 1/4/82 1500 Sample Site Marco Island Utilities Station 1007 - STP E1

Collected by Ronald E. Evans Invoice No. _____ Frequancy _____

Type of Sample Effluent (treated)

Date & Time Received by MAMES 1/4/83 1524 Analysis By: Lisa Marvel

Analysis Date & Time: 1/5/83 1500-1800 Reported By: Charles H. Courtney Director

PARAMETER	RESULT	METHOD** (Ref./Page)	PARAMETER	RESULT	METHOD** (Ref./Page)
AMMONIA-N			MAGNESIUM		
ARSENIC			MANGANESE		
BARIUM			MERCURY		
BOD_5			NICKEL		
CADMIUM			NITRATE-N	.011	2/353.3-1-5
CALCIUM			NITRATE & NITRITE-N		
CARBON, ORGANIC			NITRITE-N		
CHLORIDE			ODOR (+=PRESENT, -=NOT OBSERVED)*		
CHLORINE (RES)			OIL & GREASE		
CHLOROPHYLL (mg/m^3)*			ORTHO-P		
CHLOROPHYLL a (mg/m^3)*			OXYGEN, DIS		
CHROMIUM			pH (Units)*		
COD			PHAEOPHYTIN a (mg/m^3)*		
COLIFORM (Col/100ml)* FECAL			PHENOL		
FECAL STREP			POTASSIUM		
TOTAL			SALINITY (°/oo)*		
COLOR (Units)*			SELENIUM		
CONDUCTIVITY (mmhos/cm)*			SILVER		
COPPER			SILICATE		
CYANIDE			SULFATE		
DIS. SOLIDS			SULFIDE		
FLUORIDE			SULFITE		
HARDNESS			SURFACTANTS		
H_2S (+=PRESENT, -=NOT OBSERVED)*			SUSPENDED SOLIDS		
IRON			TEMP. (°C)*		
LEAD			TKN		
MISC			TOTAL-P		
			TOTAL RESIDUE		
			TURBIDITY (NTU)*		
			ZINC		

* All results in mg/liter except those denoted.
** List of methods available on reverse side.

TABLE 1. ESTIMATED RANGE OF CHEMICAL CONSTITUENTS IN REJECT CONCENTRATE

Aluminum	1.8 - 2.4 mg/l
Barium	.04 - .08 mg/l
Boron	2.6 - 4.0 mg/l
Calcium	550 - 850 mg/l
Chromium	0.6 - 1.0 mg/l
Copper	0.3 - 0.6 mg/l
Iron	0.5 - 0.8 mg/l
Lead	0
Magnesium	650 - 1000 mg/l
Potassium	108 - 160 mg/l
Strontium	30 - 45 mg/l
Chloride	12,000 - 18,000 mg/l
Phosphorus	4 - 6 mg/l
Sulfate	4000 - 6000 mg/l
TDS	25,000 - 35,000 mg/l
Gross Alpha including Radium	60 - 100 pci/l

APPENDIX C

TECHNICAL SPECIFICATIONS

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TECHNICAL SPECIFICATIONS

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TECHNICAL SPECIFICATIONS

1 - GENERAL

1.1 INTRODUCTION & SCOPE: The work described in these Specifications and accompanying plans is for the construction and testing of one Class I injection well and one dual completion monitor well, for Marco Island Utilities / SSU Services, Inc., on Marco Island, in Collier County, Florida. The new injection well system will go "on-line" as soon as it is completed and approved by the Florida Department of Environmental Regulation (FDER).

The wells shall be drilled into aquifers containing saline water under pressure. The shallow aquifer contains potable water at the well site; it is required that the saltier water from the deep aquifers be handled so that there shall be no spills upon the ground. Requirements are set forth in these specifications regarding the handling of salty water, drilling fluids and drill cuttings. Requirements also are set forth for controlling the flow of the well during construction to retain spillage of water from drilling and related operations. Water-table monitor wells will be installed around each pad. Due precautions should be taken to prevent spills; any spillage of fluids shall be returned to the closed circulation system. In the event of any unusual events occurring during construction activities (e.g. on-site spills, artesian flows, large volumes of circulation losses, etc.) the contractor will inform the Consultant so that the FDER and other applicable agencies may be notified.

At the completion of drilling, the Contractor shall remove the closed circulation system and it's appertuances which are not part of the completed well, and leave the site in good condition,

acceptable to the owner. After demobilization is complete, the drilling pad should be clean and free of debris, but it is not intended to be in "like-new " condition at that time.

1.2 OUTLINE SPECIFICATIONS OF WELLS

A. The Contractor shall submit a detailed construction schedule before any site work has commenced. The construction schedule shall include a proposed spud date.

B. Site Preparation and Mobilization

1. Site clearing, excavation, and placing of structural fill as necessary
2. Set pit pipe
3. Construction of pad and water table monitor wells
4. Equipment set-up

C. Drilling and Testing of IW-1

1. Drill nominal 54-inch diameter hole to a depth of approximately 230 feet below land surface. Conduct inclination surveys at 60 feet intervals.
2. Set and cement in place 44-inch diameter, 0.375 inch wall thickness steel casing to approximately 230 feet below land surface. Conduct temperature log after each stage of cementing.

NOTE:Drilling of the Dual Completion Deep Monitor Well beyond this point will not be allowed until the base of the Underground Source Of Drinking Water, (USDW) has been determined in the injection well and approval has been received from the FDER.

3. Drill a 12-1/4-inch diameter pilot hole from approximately 230 feet below land surface to approximately 900 feet below land surface, conducting drill stem tests as directed by the consultant. Conduct inclination surveys at 60 feet intervals.

4. Conduct geophysical logging as directed by the Consultant.

5. Drill a nominal 44-inch diameter hole from 230 feet below land surface to approximately 900 feet below land surface. conduct inclination surveys at 60 feet intervals and run caliper log upon completion.

6. Set and cement in place a 34-inch diameter, 0.375 inch wall thickness steel surface casing to approximately 900 feet below land surface. Conduct temperature log after each stage of cementing.

7. Drill a 12-1/4-inch diameter pilot hole from approximately 900 feet below land surface to approximately 3300 feet below land surface, collecting cores and conducting drill stem tests as directed by the consultant. Conduct inclination surveys at 60 feet intervals.

8. Conduct geophysical logging as directed by the Consultant.

9. Set bridge plug at approximately 2800 feet below land surface and cement in place with a minimum of 20 feet of ASTM Type II sulfate resistent cement.

10. Ream nominal 34-inch diameter hole from the bottom of the 34-inch diameter casing seat to approximately 2800 feet below land surface. Conduct inclination surveys at 60 feet intervals during reaming and conduct caliper log upon completion.

11. Set 24-inch diameter, 0.500 inch wall thickness steel casing to approximately 2800 feet below land surface and cement in place from approximately 2800 feet below land surface to approximately 200 feet below land surface. Conduct temperature log after each stage of cementing.

12. Conduct cement-bond log on the 24-inch diameter casing.

13. Conduct pressure test of 24-inch diameter casing.

14. Cement final 200 feet of 24-inch diameter casing to surface. Conduct temperature log after each stage of cementing.

15. Drill nominal 24-inch diameter hole from the bottom of the 24-inch diameter casing shoe to a depth of approximately 3300 feet below land surface. Conduct inclination surveys at 60 feet intervals.

16. Collect water samples from the injection zone.

17. Conduct video television survey from surface to the total depth of the well.

18. Run casing scraper inside 24-inch diameter casing.

19. Install packer at approximately 2750 feet below land surface.

20. Install 20-inch diameter, 0.635-inch wall thickness injection casing liner to approximately 2750 feet below land surface.

21. Conduct pressure test on annulus between 24-inch diameter casing and 20-inch diameter casing liner.

22. Conduct controlled injection test.

23. Conduct video television survey from surface to the total depth of the packer.

24. Conduct temperature log.

25. Conduct radioactive tracer survey (RATS).

D. Drilling and Testing of the Dual Completion Deep Monitor Well

1. Install pit pipe.

2. Drill nominal 36-inch diameter hole to approximately 230 feet below land surface. Conduct inclination surveys at 60 foot intervals.

3. Set and cement in place 24-inch diameter, 0.375-inch wall thickness steel conductor casing to approximately 230 feet below land surface. Conduct temperature log after each stage of cementing.

NOTE: Drilling on the monitor well beyond this point will not be allowed until the base of the USDW has been determined, and concurrence has been received from the FDER.

4. Drill nominal 24-inch diameter hole from 230 feet below land surface to approximately 1000 feet below land surface. Conduct inclination surveys at 60 foot intervals.

5. Set and cement in place 16-inch diameter, 0.375-inch wall-thickness steel casing to approximately 1000 feet below land surface. Conduct temperature log after each stage of cementing.

6. Conduct cement-bond log on 16-inch diameter casing.

7. Conduct pressure test on 16-inch diameter casing.

8. Drill nominal 16-inch diameter hole from 1000 feet below land surface to approximately 2200 feet below land surface . Conduct inclination surveys at 60-foot intervals.

9. Conduct geophysical logs:

    a). caliper log

    b). gamma-ray log

10. Set 2200 feet of 6-5/8-inch diameter, 0.562-inch wall-thickness steel monitor casing and cement in place to 1100 feet below land surface.

11. Conduct cement bond logs in 6-5/8-inch diameter casing.

12. Conduct pressure test on 6-5/8-inch diameter casing.

13. Drill nominal 6-inch diameter hole to 2300 feet below land surface.

14. Conduct Geophysical Logs:

    a). caliper log

b). gamma-ray log

15. After ensuring that both monitor zones are open to the formation and are producing water, they are to be disinfected.

NOTE: The Contractor must keep in mind that this is a test-injection well program and that the depths are approximate. Also, the Contractor should be aware that the sequence of testing such as coring, geophysical logging, and injection tests described in this outline may be changed in order of occurrence, or deleted, and additional testing may be added.

1.3 LOCAL GEOLOGIC CONDITIONS: It is anticipated that the boreholes will encounter beds of limestone, sandstone, clay and varying amounts of unconsolidated shell and sand to a depth of approximately 230 feet below land surface. Below this depth, clays and marl with variable amount of sand, limestone, and shell are present to a depth of approximately 1000 feet. Permeable zones contain brackish water under pressure and flowing conditions will be present. It is intended that 34-inch-diameter surface casing should case off squeezing clays of the Hawthorn Formation. Below approximately 1000 feet, interbedded layers of limestone and dolomite may be found and cavities may be encountered. Information regarding subsurface conditions is intended to assist the Contractor in preparing his bid. The Owner or Consultant does not guarantee its accuracy or that it is necessarily indicative of conditions to be encountered in drilling the well. The Contractor shall satisfy himself regarding all local conditions affecting his work by personal investigation and neither the information on local

geology, nor that derived from maps or plans nor from the Owner on his agents or employees shall act to relieve the Contractor of any responsibility hereunder or from fulfilling any and all of the terms and requirements of the contract and Specifications.

1.4 SITE PREPARATION: Within the limits of the staging area as shown on the contract drawings, the Contractor shall clear and grub trees (as directed), stumps, down timber, brush, and other objects standing on or protruding from the ground. All roots shall be grubbed and removed to a minimum of 18 inches below the surface of the ground. Holes caused by grubbing operations shall be filled to the elevations shown on the drawings. All material and debris resulting from clearing and grubbing operations shall be burned or otherwise disposed of in a manner approved ny the Consultant. It shall be the responsibility of the Contractor to obtain any permits that are required for these procedures.

The Contractor will be required to construct and maintain an all-weather temporary access road. The Contractor shall include the cost of this road in the lump-sum pay item for mobilization and demobilization.

During site preparation, the Contractor shall have bench mark installed by a registered professional surveyor.

The cost for all site preparation shall be included in the lump-sum pay item for Mobilization and Demobilization , as shown in the Bid Proposal.

1.5 DRILLING PAD At the site of the injection well and deep monitor well, the Contractor shall build a suitable concrete pad as work floor for each drilling rig to retain all drilling fluids in the vertical and horizontal directions. The pads shall have approximate dimensions of 120 feet by 100 feet and be formed with 2 feet of curbing to contain spills of water and drilling fluids including a method of returning them to the required closed-circulation system. The Contractor shall submit complete construction by a professional engineer and receive approval before beginning construction.

The cost of the drilling pad shall be included in the lump-sum pay item for Mobilization and Demobilization of each well.

1.6 WATER SUPPLY: It shall be the responsibility of the Contractor to provide all pumping and piping to perform the injection test. The responsibility shall be upon the Contractor to provide and maintain, at his own expense, an adequate supply of water for domestic consumption at the construction site. Any necessary permits required to obtain a water supply shall be obtained by the Contractor at his expense. A tie-in to an adequate supply of fresh water for the injection test, RATS, TV Survey, and make-up water will be provided by Marco Island Utilities. The cost for all water supply shall be included in the lump-sum price for the injection well.

1.7 ELECTRICITY: All electric current required by the Contractor shall be furnished at his own expense. All temporary lines will be furnished, installed, connected, and maintained by the Contractor at his cost in a workmanlike manner satisfactory to the Owner and Consultant and shall be removed by the Contractor in like manner at his expense at the completion of the work.

1.8 WATER TABLE MONITOR WELLS: The Contractor shall install four small-diameter monitor wells in the area around the injection well drilling pad. The purpose of these wells will be to monitor the water table aquifer for increases in chlorides due to spills of salty water during drilling operations and (possibly) to pump out the shallow aquifer to reduce any containment level to background if a spill occurs. The Contractor shall be financially responsible for the cost of all clean-up activities attributable to his drilling operations at the site including installation and pumping of additional monitor wells, if necessary.

These wells shall be cased with 2-inch-diameter Schedule 80 PVC pipe to a depth approximately 15 feet, or tapping the water table. The bottom five feet of PVC pipe shall be slotted as shown on contract drawings. The size of the slots shall be compatible with the gravel used, and shall be approved by Consultant before installation.

PVC casing shall be lowered into a predrilled hole and cemented in place, in accordance with the detail shown on the drawings. Each

well casing shall be provided with an access box at the surface as called for on the contract drawings.

After completion, each monitor well shall be pumped until the water is clear and a one-quart sample shall be collected, properly labeled, and transmitted to the Consultant. No work other than pad construction may be performed until the monitor wells have been completed and the water samples are received by the Consultant, allowing the Consultant to analyze each water sample for chlorides (mg/L), conductivity (umhos),temperature (F), and water level (msl) and deliver the results to the TAC (Technical Advisory Committee)> Cost of the monitor wells for the entire job will be included in the lump-sum price for the injection well.

1.9 DAILY REPORT: The Contractor shall maintain a detailed log of his operations on each rig during the construction of the injection well and the deep monitor well. The logs shall be on IADC (International Association of Drilling Contractors) forms and shall give a brief description of all formations encountered, footage and size of hole drilled, depth and sizes of all casings installed in the wells, fluid losses, complete record of drilling fluid added, water-level changes and the depths at which they occurred, cementing operations, repair time and other such pertinent data as may be required by the consultant. All depths shall be referred to NGVD (National Geodetic Vertical Datum)> Two copies of each daily log shall be submitted to the Consultant on a daily basis.

1.10 AS-BUILT DRAWING; Upon completion of the work, the Contractor shall supply the Consultant with reproducible record drawing of each well. The drawings shall show hole and casing diameters and depths and other information that may be required by the Consultant and regulatory agencies, including well head details.

1.11 REMEDIAL WORK: If remedial work proves to be necessary to make a well acceptable and come within the regulations and/or Specifications because of accident, loss of tools, defective material, or for any other cause, the Contractor shall propose a method of correcting the problem, in writing Suggested methods shall be reviewed and approved by the Consultant before work proceeds. Such wok shall be performed at no additional cost to the Owner and it shall not extend the length of the Contract. The Contractor is notified that all specifications shall be met, including hole straightness and setting of casings to the points designated by the consultant.

1.12 ABANDONMENT OF WELL BY CONTRACTOR: Any hole in which the Contractor voluntarily stops work, and/or fails to complete in a satisfactory manner, in accordance with the regulations and/or Specifications and approved changes, shall be considered as abandoned by him. If the Owner declares the hole abandoned by the Contractor, then no payment will be made for the abandoned hole. All abandoned holes shall be properly plugged and sealed by the Contractor at his own cost in accordance with federal, state, and local regulations. All salvageable material furnished by the Contractor shall submit his plan of action for abandonment and

plugging. Casings may be removed only with the permission and approval of the Consultant.

1.13 FIELD OFFICE: The Contractor shall provide a suitable, weatherproof field office for the use of the Consultant and his representatives. It shall be located in a position which in the opinion of the Consultant is adequate for supervision and inspection of the work, including at least one full-size window facing the injection-well drilling rig. The Contractor shall furnish an entire field-office trailer consisting of at least three rooms. The trailer shall be supplied with the following: at least one telephone, a private telephone line, outdoor colored light indicating incoming calls, local telephone service, $200 per month in long-distance telephone service, a photocopying machine, two desks (at least one unattached), chairs, a four-drawer legal-size filing cabinet, and janitor service. The cost of this field office and maintenance thereof shall be included in the lump-sum price of the wells. The office shall be fully functional, including utility hook-ups, before any drilling may commence.

1.14 GUARANTEE: The Contractor guarantees that the work and service to be performed under the Contract and all workmanship, materials, and equipment performed, furnished, used, or installed in the work shall be free from defects and flaws, and shall be performed and furnished in strict accordance with the Contract Documents; that the strength of all parts of all manufactured equipment shall be adequate and as specified; and that performance test requirements of the Contract Documents shall be fulfilled. The

Contractor shall repair, correct, or replace all damage to the work resulting from failures covered by the guarantee. The guarantee shall remain in effect for one year from the date of final acceptance by the Owner.

1.15 STANDBY TIME: The Consultant may order the Contractor to stop his operations so that extra work not included in the Specifications such as testing and additional data collected can be performed. The Consultant will advise the Contractor when he proposes to do this and will schedule his request so it causes a minimum delay. The Contractor will be reimbursed at hourly rates which will be listed in the Bid Proposal Form. All extra work must be approved by the Consultant in writing advance.

The Contractor shall include the cost of 120 hours of standby time in the lump-sum price of the injection well, and 60 hours of standby time in the lump-sum price of the monitor well.

2 - OPERATING REQUIREMENTS

2.1 GENERAL: It is essential that salty or brackish water produced from any source during the drilling operations is prevented from contaminating the shallow aquifer which contains fresh water. Any water produced during the drilling shall be confined to the circulation systems and drilling pads.

The drilling will be accomplished using circulation systems designed and constructed so that under no conditions shall there

be an overflow. The Contractor shall be required to take all necessary steps to prevent accidental spillage from occurring. Tanks for the circulation system shall be steel and leak-proof. The entire circulation system for each well shall be within the curbed drilling pad. The Contractor shall submit plans for the circulation system to the Consultant for approval. In no case will a system capable of storing less than 2000 cubic feet (15,000 gallons) of fluid
and cuttings be considered. Written approvals from the Consultant will be required before the Contractor is allowed to proceed.

Flowing conditions in the injection well shall be kept under control at all times. Drilling mud and/or salt may be used as weight material to keep the drilling fluid at a density necessary to suppress the flow. Naturally - occurring brines such as those produced from oil wells shall not be used as drilling fluid or weight material. Any salt for use in these operations must be stored on the drilling pad and an approved waterproof cover provided and used. As flowing conditions are anticipated during the drilling of the injection well and the deep monitor well, the Contractor shall furnish and install a suitable blowout preventer for each well. The blow-out preventer to be provided will be commercially available, hydraulically operated, single annular preventer, or approved equivalent. Manufacturers specifications pertaining to the type of preventer proposed for use by the drilling contractor shall be approved by the Consultant before drilling of each well commences and shall be used during drilling

operations below 34-inch-diameter casing in the injection well and below the 16-inch-diameter casing in the monitor well to ensure the Contractors capability to control potential flowing conditions prior to penetrating the Florida Aquifer. When no work is being done on a well, a preventer shall be put in place. Each crew from each well will also test the operation of the blow-out preventer on the well once per week in the presence of the Consultant to demonstrate proficiency in its operation.

Drill cuttings and drilling fluid shall be removed from each drilling site and disposed of at an approved location. The Contractor shall furnish to the Consultant and Owner, prior to beginning construction, the name and location of his disposal site along with documentation that the site has been approved by the appropriate regulatory agencies. The fluid displaced from the borehole during cementing operations shall be considered excess drilling fluid and shall be disposed of in a approved manner. All costs of disposal shall be included in the lump-sum price of each well.

When all casings are being set and cemented in place, it is the Contractor's responsibility to insure that these operations are conducted in such manner that the casing collapse and burst strengths (with safety factor) are not exceeded and the casings are not caused to fail. A temperature log shall be run at the appropriate time interval after completion of pumping, as per cementing company recommendations.

2.2 EQUIPMENT REQUIREMENTS: Equipment in first-class working order shall be provided. The Contractor shall use his own drilling equipment having the minimum capabilities necessary to do the described work. No unnecessary delays or work stoppages will be tolerated because of equipment failure. They will not be considered a valid reason for extending the length of the contract. The Contractor shall be held responsible and payment may be withheld for damages to a well due to any cause of negligence, faulty operation, or equipment failure.

The Contractor shall provide and operate equipment capable of handling the largest load that will be placed upon the rigs drilling and supporting equipment. If conditions develop in the field that prove the rigs and supporting equipment that had been supplied by the Contractor are incapable of completing a well, the Contractor will be required to provide a larger rig with the necessary capacity at his own cost.

The drilling rigs employed in drilling the injection well and the deep monitor well shall each use a geolograph capable of recording drilling time and weight of the tool string. This information shall be recorded continuously by the Contractor and records or copies furnished to the consultant daily. Each rig's chart recorder shall be fully functional before drilling of the monitor well or the injection well commences, and shall continue to record during all drilling , reaming, cementing, bit trips, and casing runs, etc.

2.3 DRILLING METHODS: The conventional mud-rotary method will be employed for all drilling of each well through the setting of the surface casings, approximately 1000 feet below land surface. All drilling below this point shall be done by the reverse-circulation-rotary method, and there shall be no discharge of drilling fluids and/or formation fluid. During all reaming operations, the Contractor must incorporate the use of a lead bit or stinger and staged drilling assembly to facilitate the tracking of the pilot holes. A closed-circulation system shall be used for the drilling fluids, employing suitable devices such ass screens, shale shakers, and settling tanks to remove cuttings. There are no means of handling or disposing of drilling fluids on the site.

2.4 CONDITIONS AND HAZARDS: The Contractor should be advised and be aware of difficult drilling conditions and problems he may encounter during the drilling, construction, and testing of the wells. Typical examples he may have to cope with include, but are not limited to, lost circulation; cavities and fractured zones in the Floridan aquifer; and squeezing zones and potential sand intervals in the Hawthorne clays with attendant caving problems. A priority requirement of these Specifications is the drilling of straight holes and setting of all casings to specified depths. Hole straightness, which will permit casings to be set at specified depths and facilitate achievement of proper cement seals, shall not be sacrificed for drilling speed. These and other pertinent factors shall be taken into consideration by the Contractor in planning and executing the work. The goal of this program is the successful completion of the two wells described in these Contract Documents.

In the event of any problems or difficulty which, in the Consultant's opinion, may jeopardize the successful completion of a well in accordance with construction permit, current regulations, or Contract Documents and approved changes, it is the Contractor's responsibility to perform such surveys and testing as necessary to demonstrate the problem has been solved and that the well is in compliance with the Contract Documents. The Contractor shall bear all costs of testing, surveys and work deemed necessary by the Consultant, Owner and/or the appropriate regulatory agencies to confirm that the problem has been resolved or corrected and that the construction is in compliance with the Technical Specifications and any approved changes and appropriate regulations. In the event a problem occurs, the Contractor will be notified in writing by the Consultant. The Contractor will submit to the Consultant his plan of action to identify and/or solve the problem and the Consultant will review the plan of action. In the event the problem is considered serious enough to jeopardize successful completion of the well, in accordance with the drawings and Specifications, the Consultant may request technical concurrence from the regulatory and scientific agencies in accordance with the construction permits. No monies will be paid for the time spent by the Contractor during the entire period of review approval. The Consultant will notify the Contractor that:

a. Plan of action is acceptable;

b. Plan of action is acceptable with Consultant's suggested modifications;

c. Plan of action is not acceptable.

Under (a), the Contractor shall proceed with the plan of action. The Contractor shall proceed with the plan of action. The Contractor shall bear all costs of surveys associated with detecting the problem, implementing his plan of action, and tests to confirm the plan of action was carried to successful completion and to obtain approval of the Consultant.

Under (b), the Contractor shall resubmit his plan of action with necessary backup and justification of revised plan of action. The Consultant shall notify the Contractor that the revised plan of action is (a) acceptable or (c) not acceptable.

If the plan of action is not acceptable to the Consultant and the Contractor elects to pursue the unacceptable plan of action, then two options exist for the Consultant.

OPTION 1: If unacceptable plan of action jeopardizes the well construction, completion, or operation in the Consultant's opinion, and the Contractor elects to implement the unacceptable plan of action, the Consultant may declare the well abandoned by the Contractor. A determination shall be made by the Consultant whether to abandon the well or attempt to correct the existing well. The Contractor shall bear all costs of rig time, etc., from original verbal notification and all cost of either abandoning the well or taking steps to complete a successful well.

OPTION 2: If the unacceptable plan of action does not jeopardize the well construction, completion, or operation in the Consultant's

opinion, the Contractor may, at his own risk, proceed with his plan of action. The Contractor shall bear al costs associated with his plan of action including testing, remedies, surveys, and programs to solve the problem. When completed, the Contractor shall notify the Consultant that the problem has been solved. The Contractor shall bear all costs of testing, surveys, and work deemed necessary by the Consultant is satisfied that the problem has been saved by the Contractor, then the Contractor shall proceed with the construction of the well, bearing all costs of the plan of action and the Consultant's program to confirm successful completion.

2.5 STRAIGHT HOLE REQUIREMENTS: Priority requirements of these Specifications is the drilling of straight holes, positive documentable proof that all pilot holes have been wiped out or covered by the reaming operations, and setting the casing to the required depths. The Contractor will be required to perform the schedule of surveys as specified in this section. To insure that the casing and tubing can be set to the required depths and properly cemented, all of the holes shall be drilled so that they are straight. Hole straightness, which will allow setting the casing at the required depths and provide positive documentable assurance that the pilot hole has been wiped out by the reaming operations, shall not be sacrificed for drilling speed or any other reason.

During all drilling in the injection well, the Contractor shall perform inclination surveys at intervals of 60 feet as the drilling and reaming progresses. These survey shall be performed using a

wire-line instrument equipped with an inclination unit having a range of from 0 to 1.5 degrees of inclination from the vertical survey record shall be capable of being read to the nearest 10 minutes of angle.

All holes for the injection well and the monitor well shall be round, straight, and true line. No dog-legs or departures from a straight line shall be permitted which will interfere or prevent casings from being set to their required depths. The maximum allowable inclination from the vertical at any portion of a hole or survey point shall be one (1) degree; the maximum allowable difference between any two successive survey points shall be 0.5 degree (30 minutes). Any deviation greater than one (1) degree or difference greater than 0.5 degree (30 minutes) between two surveys shall be corrected by the Contractor at his own expense.

Should the inclination surveys or the results of the drilling of any of the pilot and/or reamed holes indicate that conditions have been or are being created that would prevent the casings from being set to their prescribed depths and properly cemented or prevent the well from being properly and successfully completed, the Contractor shall take steps to straighten the hole or correct the drift or deviation at his own expense so that casing can be installed to the prescribed depths and allow for proper cementing.

Unless he can demonstrate competence in the use of the surveying equipment, the Contractor shall utilize the services of a qualified technician employed by the survey and in the maintenance of the

equipment. The technician shall remain on the job until the drilling crews are proficient in the use of the equipment, as judged by the Consultant. The equipment shall be kept on the job at all times. The costs for surveys described in this section, including those required to diagnose a problem and demonstrate the effectiveness of any remedial work, or demonstrate that no problem has occurred shall be the responsibility of the Contractor.

The following are the minimum survey requirements:

Injection Well

1. Nominal 54-inch diameter hole from land surface to 230 feet.

   A. Inclination survey at 60-foot intervals during drilling.

2. Nominal 12-1/4-inch diameter hole from 230 feet to 900 feet.

   A. Inclination survey at 60-foot intervals during drilling.

2. Nominal 44-inch-diameter hole from 230 feet to 900 feet.

   A. Inclination survey at 60-foot intervals during drilling.

3. Nominal 12-1/4-inch diameter pilot hole from 900 feet to 3300 feet.

4. Nominal 34-inch diameter pilot hole from 900 feet to 2800 feet.

   A. Inclination survey at 60-foot intervals during drilling.

5. Nominal 24-inch diameter hole from 2800 feet to 3300 feet.

A. Inclination surveys at 60-foot intervals during reaming.

Monitor Well

1. Nominal 36-inch diameter hole from land surface to 230 feet.

   A. Inclination surveys at 60-foot intervals during drilling.

2. Nominal 26-inch-diameter hole from 230 feet to 900 feet.

   A. Inclination surveys at 60-foot intervals during drilling.

3. Nominal 12-1/4-inch diameter pilot hole from 900 feet to 1500 feet.

4. Nominal 16-inch diameter hole from 900 feet to 1500 feet.

   A. Inclination surveys at 60-foot intervals during drilling.

5. Nominal 6-inch diameter hole from 1500 feet to 1600 feet.

   A. Inclination surveys at 60-foot intervals during drilling.

During the drilling operations, the Contractor shall submit the record of each inclination survey to the Consultant on the site. The Consultant shall analyze the data and shall notify the Contractor of the survey results within three hours. In the event other duties delay the Consultant from interpreting the data, the Contractor should have a qualified crew member proficient in the interpretation of the raw data. The Contractor may continue drilling during this three-hour period. In the event the survey

data indicate hole drift of departure in excess of the specified limits, the Contractor shall take the following steps.

1. Run additional surveys to demonstrate that the hole i s within the specified limits.
2. If instrument is indicating that the hole is not meeting the specific limits, then the Contractor shall re-ream the hole and repeat the survey. This process will be repeated or other actions taken by the Contractor to meet the specified limits.
3. If the Contractor feels that the instrument is in error, it will be his responsibility to obtain a new instrument to confirm the survey data. If a new instrument requires 24 hours or less to be shipped to the site, the Contractor may, with the Consultant's approval, continue the drilling operation. However, this does not relieve the Contractor of his responsibility of maintaining the hole within the specified limits. The Contractor shall bear all of the costs of repeated surveys, re-reaming the hole, or other steps required to meet the specified limits. No standby time will be paid for time spent during these procedures.

2.6 FORMATION SAMPLES: Two sets of formation samples shall be collected from each well at intervals of 10 feet and at every formation change and drilling break. The samples shall be preserved in cloth sample sacks to be furnished by the Contractor. The samples containers shall be plainly marked with the well

identification and shall show the depth below the ground surface from which they were taken. The Contractor shall collect the samples, deliver them to the Consultant's field office, and provide facilities for storage while the samples remain on site, in a manner acceptable to the Consultant. Upon completion of drilling and upon authorization by the Consultant, the Contractor shall forward the formation samples to the Florida Bureau of Geology in Tallahassee along with any appropriate well completion reports. If sample storage becomes a problem on the site, samples may be forwarded to the Florida Bureau of Geology as work progresses following accepted procedures and with the approval of the Consultant.

2.7 CEMENTING PROCEDURES: Cementing will be completed by an approved company, expert in well cementing such as Halliburton Services unless the Contractor can demonstrate that he has the equipment and expertise to perform these operations. Cementing will be accomplished in stages by means of a collarless tremie pipe. After each stage of cementing and before next stage, the Contractor shall conduct a temperature log and tag the top of the cement with a collarless tremie pipe. The method of cementing applies to all cementing procedures in all casing.

Cementing procedures shall be continuous for each stage after cementing begins. If loss of circulation or no return of cement is encountered, the Consultant shall be notified immediately of what remedial measures are underway to re-establish the circulation

and complete the cementing program according to well design and specifications.

During the cementing of all strings of casing, the Contractor will be responsible for having a sample from each cement stage collected (both dry and mixed). Mixed cement samples shall include at least three, 2-inch cubes of each blend from each cement stage. The cost of collection and analysis should be included in the lump-sum price and the results should be submitted to the Consultant as soon as they are available. The top 100 feet of annulus in the injection well, between the __-inch-diameter casing and the __-inch-diameter injection casing shall not be cemented until after the completion of the cement bond log. If good bonding between casing, cement, and formation is not obtained, remedial work shall be done to the satisfaction of the Consultant. In addition, the Consultant, may require temperature or cement bond logs to substantiate the effectiveness of any remedial grout work done. These operations shall be performed at the Contractor's expense.

During all stages of cementing, the Contractor will use a pre-flush or spacer. The Contractor shall submit the technical specifications of the pre-flush to the consultant for approval before cementing begins.

When the casings are being set and cemented in place, it is the Contractor's responsibility to insure that these operations are conducted in such a manner that the casing collapse and burst

strengths (with safety factor) are not exceeded and the casings are not caused to fail.

Cement shall be pumped or placed so that excessive pressures will not result and affect the bond.

3 - GEOPHYSICAL LOGGING AND TESTING

3.1 GEOPHYSICAL LOGGING: The Contractor shall employ the services of an approved company to obtain geophysical logs of the injection well and the monitor well. The Contractor shall prepare and condition each hole to insure it is open and can be logged with a minimum of delay. The following logs shall be run in the injection well at the stages listed and their cost shall be included. No payment will be made for logs which are unusable or inaccurate due to poor performance of the logging equipment.

Following the completion of each stage of drilling below the 44-inch diameter conductor casing to a total depth of approximately 3300 feet below land surface, the following geophysical logs will be performed:

Dual-induction

Borehole-compensated sonic - VDL

Caliper

Gamma ray

Temperature

Following the completion of cementing the 24-inch diameter casing in place:

Cement bond

Following the completion of the injection testing and TV Survey:

Temperature

The Contractor also will perform caliper logs on all boreholes before the installation of all casing.

The contractor will perform temperature logs after each stage of cementing on all casings.

In the Deep Monitor Well, following the completion of each of the stages of the 12-1/4-inch-diameter pilot holes below the 24-inch-diameter casing to a total depth of approximately 2200 feet below land surface, and in the nominal 6-inch-diameter open hole below final casing, the following geophysical logs will be performed:

Caliper

Gamma Ray

Following the completion of cementing the 16-inch-diameter casing in place:

Cement bond

The Contractor shall furnish 15 field copies of various logs to the Consultant and shall provide a written evaluation of their quality as well. Twenty copies of the finished logs shall be provided to the Consultant as soon as possible after logging along with copies of the original films or mylar of the logs.

3.2 CONVENTIONAL CORES: Cores shall be taken during the drilling of the 12-1/4-inch-diameter pilot hole in the injection well. Four-inch-diameter cores, at least 10 feet long, shall be taken at points designated by the Consultant (a minimum 10-foot barrel is to be as manufactured by the Christianson Diamond Products Company or approved equal)> The taking of cores will be observed by technicians from the manufacturer of the coring tool unless the Contractor can demonstrate previous experience. Coring points are to be determined from information derived during drilling operations and as directed by Consultant. All cores will be stored in wooden boxes with lids, marked with the appropriate well designation, and the depth from which they are taken. Tops and bottoms of the cores are to be marked. After collection, boxing, and labeling, each core will be furnished to the Consultant. The Consultant will then select maximum of three representative sections of each core on which the Contractor will have laboratory analyses conducted to determine vertical and horizontal permeability, porosity, specific gravity, elastic modules, and compressive strength. The Contractor shall submit the name of the laboratory for approval to the Consultant before analyses. The cost of the five cores and fifteen analyses is to be included in the lump-sum price for the

Injection Well. A credit will be taken into account in the unit price schedule of the contract.

3.3 TELEVISION SURVEY: Following completion of the nominal 16-inch-diameter open hole in the injection well, the Contractor shall have a television survey performed on the entire well from the top of the 16-inch-diameter injection casing to the bottom of the hole, and following completion of the injection test, from the top 13-3/8-inch-diameter injection tubing to the bottom of the tubing Mandril, by a qualified service company using equipment capable of surveying and recording to the required depth. The Contractor may use his own equipment providing it is capable of surveying as required and the Contractor shall furnish proof of capability of the equipment. The television camera shall be provided by the Contractor for distribution. It is the Contractor's responsibility to make all arrangements and scheduling for the television survey.

It is the Contractor's responsibility to insure that the borehole fluid is of sufficient clarity (as determined by the Consultant) to allow a television survey to be conducted. The Contractor shall pump into each injection well a quantity of clear water not less than three volumes of the entire borehole.

While pumping in the water and during the television survey, the well may be under artesian pressure and may flow. The Contractor shall be required to provide and use a stripper head assembly and any other equipment necessary to keep any flow under control at all times.

Costs for pumping clear water into borehole to achieve the desired level of clarity; for the television surveys and tapes (including time spent waiting for the television equipment); and for rig and crew labor for all activities associated with preparing for, performing, and dismantling equipment related to the television survey as shall be included in the lump-sum price of the injection well.

3.4 DRILL STEM TESTS: During drilling of the 12 1/4-inch diameter pilot hole, the Contractor shall perform five drill stem tests in the injection Well as directed by the Consultant. To perform the drill stem tests, the Contractor shall employ the services of an approved company recognized as expert in this form of testing, such as, but not limited to, Baker Tools or TAM International. The open-hole drill stem tests shall be conducted such that the hydrologic properties of the formation can be determined and a representative water sample collected for analysis. The Consultant will select the depth intervals to be tested in conjunction with the service company representative based on evaluation of drilling parameters and other available data.

The tests shall be performed using an open ended inflatable packer installed in the borehole on drill pipe with the upper 250 feet consisting of casing or drill pipe with a six-inch inside diameter to facilitate the installation of a four-inch-diameter submersible pump which shall be set at an elevation of approximately 250 feet below land surface. The Submersible pump shall have the capability

of pumping at rates between 5 and 100 gpm (gallons per minute). An in-line propeller-type flow meter capable of recording total flow and discharge will be used. The internal surfaces of drill pipe, casings, and other fittings used for the packer tests shall be free of rust, scale, and other material that could be dislodged and interfere with a test. Should a test fail because of the presence of any of these materials in the tools or pipe, the Contractor will not be reimbursed for the test and he will be requires to clean pipe, re-set it and the packer, and re-run the test successfully as part of the contract requirements at his own cost.

After successfully inflating and setting the packer and before the Contractor conducts a four-hour pumping test and a three-hour recovery test for each drill stem test, he shall develop each zone so that it is free of any drilling mud/fluids (and producing representatives formation water) and allow the water level in the pipes to return to static conditions to the satisfaction of the Consultant. It is anticipated that rates of between 5 and 100 gpm will be obtained during the pumping tests. The water produced during pumping tests shall be contained by the circulation system and the drilling pad. The Contractor shall be responsible for providing all necessary pumps, prime movers. pipelines, meters, and gauges necessary for testing and will provide access for water-level measurements using M-scope, tape, or electronic probe.

Just prior to completion of each pumping test, the Contractor shall have a State-certified laboratory collect a water sample from the

discharge and have the following analyses performed by a State-certified laboratory acceptable to the Consultant.

Total Dissolved Solids

Chloride

conductivity

Sulfate

The Contractor shall include the cost of five drill stem tests and five sets of water-quality analyses in the lump-sum price for the injection well. If more or less tests are performed, a credit or charge will be provided for in the contract.

3.05 INJECTION TEST: After the completion of the injection well, an injection test shall be run a 24-hour period. The injection test will be performed at a rate of 7070 gpm. Water for the injection test will be potable water from the Water plant and / or the existing test well and / or the Dual Completion Deep Monitor Well. The Contractor shall provide a layout drawing of his piping for approval by the Consultant. Just prior to the last trip out of the hole on the injection well, the Contractor shall collect a five-gallon sample from the discharge of the circulation system and deliver it to the Florida Bureau of Geology in Tallahassee, Florida. Prior to conducting the TV Survey and injection test, the Contractor shall have a water sample collected from the injection zone. The blow-out preventer shall be engaged and the return line from the closed circulation system will be shut, forcing the injection zone to develop when pumping begins. A volume equal to

at least 3 times the volume of the drill pipe must be removed. The Contractor shall then have a water sample collected from the well and have it analyzed for the primary and secondary drinking water standards and organic compounds for EPA (Environmental Protection Agency) Test Method 608, 624, and 625 constituents. The Laboratory will follow all quality assurance guidelines set forth by the State of Florida. Additionally, the following constituents will be included:

Specific Gravity	
Water Temperature	
Total Phosphorus	
PH	Total Nitrogen
Turbidity	Nitrate
Color	Nitrite
Sulfate	Sodium
Iron	Ammonia
Total Dissolved Solids	Conductivity
Total Hardness	Calcium
Hydroxide	Magnesium
Non-carbonate Hardness	Carbonate
Bicarbonate	Potassium
Organic Nitrogen	Chloride

The Contractor shall include the cost for the collection and chemical analyses for one set of samples from the injection zone in the lump sum price of the injection well.

The Contractor shall be responsible for providing all necessary pipelines, meters and gauges necessary for the testing and should include these in the lump-sum price of the injection well.

The Contractor shall furnish and install in the pipeline an in-line propeller-type flow meter capable of recording instantaneous flow rates and of totalizing flow. The flow meter shall have an accuracy of five percent at tested rate. The flow meter shall be sufficiently removed from obstructions in the pipeline, valves, elbows, reductions, to allow the meter to perform within specifications. Manufacturers specifications shall be submitted to the consultant prior to installation for approval.

To the extent possible, the speed of the pump and motor shall remain constant throughout the test. The pumping rate shall be controlled and adjustable by means of a gate valve in the pipeline. The valve shall be installed between the injection pump and the flow meter. The pumping rate shall not be adjusted by changing the speed of the motor or pump, except when absolutely necessary.

During the injection test, bottom-hole pressure and temperature shall be monitored, and recorded at land surface in the injection well. The Contractor shall employ the services of a company specializing in furnishing and operating the equipment used in collecting this information. An approved pressure gauge and recording system capable of accurately measuring and detecting pressure changes of as little as 0.01 psi (pounds per square inch)

such as the Baker Tools RES-300 or Geophysical Research Corp. EPG-520 system will be used. The data recording system shall record in real time and continuous delta time. No interruptions of data recording will be permitted if delta time will re-zero after interruption for equipment service or any other reason. The Contractor shall provide the Consultant with technical data on the pressure-measuring and recording system for approval before the injection tests. The system will be installed in the injection well at top of the injection zone at a depth determined by the Consultant. Access to the monitor well during the test also will be required to allow water levels to be measured. The separate dual-completion monitor well shall be completed before the injection test.

The pressure-recording system will be operated for a period of 24 hours prior to the start of the injection test (to collect information on natural bottom-hole pressure fluctuations), during the injection test, and for a 12-hour period after the injection test. the Consultant shall be furnished a copy of all of the basic data recorded as part of the injection tests in hard copy and in an ASCE II file on 5-1/4-inch disk. During the injection test, well-head pressure and annular pressure gauges must be in good working order and they must be accessible. The Contractor shall submit *verification of pressure-gauge calibration to the Consultant* prior to commencement of the injection test.

The costs for these shall be included in the lump-sum price of the injection well. For time spent more or less, the Contractor shall

be paid or credit given on the basis of an hourly charge to be listed in the Contract.

3.6 MONITOR WELL WATER QUALITY ANALYSES: After disinfection, the monitor zones will be developed by pumping or other approved means until conductivity and chloride measurements of the discharged water from each zone have stabilized as determined by the Consultant, in order to insure that representative formation water samples can be collected. Upon stabilization, the casings will be pumped until 10 times the calculated casing volume has been displaced. If the casings are not open to the formations or are incapable of yielding a representative water sample from the monitor zones, the Contractor shall employ such procedures as are necessary to open up the casing so that representative water samples may be collected. These procedures shall be conducted at no additional cost to the Owner and shall be approved in writing by the Consultant prior to implementation. No standby time will be paid for the time spent during these procedures.

After the monitor casings have been demonstrated to be functioning and have been disinfected, they shall be pumped to remove any fluid that may have been introduced into the disinfection. upon concurrence of the Consultant that representative water is being produced from each monitor zone, the Contractor shall have a State-certified laboratory collect a sample from each tube in the presence of the Consultant's representative and have the following analyses performed on each monitor zone by a State-certified laboratory approved by the Consultant.

The samples collected from the monitor zones shall be analyzed for all constituents listed in the Section 17-22.104 FAC, as primary and secondary drinking water standards, including analysis for microbiological, radionuclides, BOD and constituents listed under EPA Methods 608, 624, and 625 in Section 17-22.105 FAC. The laboratory will follow all quality assurance guidelines set forth by the State of Florida. The constituents are as follows:

Specific Gravity	1,2-Dichloropropane
Water Temperature	Trihalomethane
Arsenic	Trichloroethylene
Barium	Tetrachloroethylene
Cadmium	Carbon Tetrachloride
Chromium	Vinyl Chloride
Lead	1,1,1-Trichloroethane
Mercury	1,2- Dichloroethane
Nitrate (as N)	Benzene
Selenium	Ethylene Dibromide
Silver	Chloride
Sodium	Color
Fluoride	Copper
Endrin	Corrosivity
Lindane	Foaming agents
Methoxychlor	Iron
BOD	N-Nitrosodimethylamine
Toxaphene	Manganese
2,4-Dichlorophenoxyacetic Acid	

2,4,5-TP (Silvex)	pH (in field)
Turbidity	Sulfate
Total Fecal	TDS
Radium 226	Zinc
Radium 228	Bromodichloromethane
Gross Alpha	Bromoform
Beta Particles	Chlorobenzene
Photonradioactivity	Chloromethane
Trichlorofluoromethane	2-Chloroethylivinyl ether
Acenaphthylene	Chloroform
Acenaphthylene	Dibromochloromethane
Anthracene	1,2 Dichlorobenzene
Aldrin	1,3 Dichlorobenzene
Benzol(a)anthracene	1,4 Dichloroethane
Benzol(b)Fluoranthene	1,1 Dichloroethane
Benzol(k)Fluoranthene	1,1 Dichloroethene
Benzol(a)pyrene	trans-1,2-Dichloroethene
Benzol(ghi)perylene	cis-1,3 Dichloropropene
Benzyl butyl Phthalate	trans-1,3 Dichloropropene
α-BHC	Ethyl Benzene
ß-BHC	Methylene Chloride
Γ-BHC	Chloromethane
Bis(2-chloroethy)ether	1,12,2-Tetrachloroethane
Bis(2-chloroethoxy)methane	
Tetrachloroethane	Odor
Bis(2-chloroisopropyl)phthalate	
4-Bromophenol phenyl ether	
1,1,2-Trichloroethane	Toluene

Chlordane	Trichloroethene
2-Chloronaphthalene	Nitrobenzene
4-Chlororphenyl phenyl ether	
N-Nitrosodi-n-propylamine	
Chrysene	PCB-1016
4,4-DDD	PCB-1221
4,4-DDE	PCB-1232
4,4-DDT	PCB-1242
Dibenzo(a,h)anthracene	PCB-1248
Di-n-butyphthalate	PCB-1254
3,3 Dichlorobenzidine	PCB-1260
Dieldrin	Phenanthrene
Dimethyl Phthalate	Pyrene
Dimethyl phthalate	1,2,4 Trichlorobenzene
2,4-Dinitrotoluene	4-Chloro-3-methylphenol
2,6-Dinitrotoluene	2-Chlorophenol
Di-n-octylphthalate	2,4-Dichlorophenol
Endosulfean sulfate	2,4-Dimethylphenol
Endrin aldehyde	2,4-Dinitrophenol
Fluoranthene	2-methyl-4,6-dinitrophenol
Fluorene	2-nitrophenol
Heptachlor	4-nitrophenol
Heptachlor epoxide	Pentachlorophenol
Hexachlorobenzene	Phenol
Hexachlorobutadiene	2,4,6-Trichlorophenol
Hexachloroethane	Benzidine
Indeno (1,2,3-cd)pyrene	Benzidine
Isophorone	Endosulfan I

Naphthalene	Endosulfan II
Hexachlorocyclopentadiene	Bromomethane
N-Nitrosodiphenylamine	

The Contractor shall include the cost for the collection and chemical analyses for one set of samples from the shallow monitor zone and one set from the deep monitor zone in the lump sum price of the monitor well.

3.7 RADIOACTIVE TRACER SURVEY; Upon completion of the injection test and TV survey, a radioactive tracer survey shall be performed in the injection well. The Contractor shall employ the services of a company specializing in furnishing and operating the equipment used in collecting this information . The tests shall be conducted as directed by the consultant, according to the following procedure outline. The costs for these services shall be included in the lump-sum price of the injection well.

The geophysical tool supplied must be capable of ejecting the radioactive tracer and simultaneously monitoring the gamma-ray detectors. Film documentation of the radioactive tracer injection time must be provided and the tracer ejection time must be calibrated to $\pm$ 1 millisecond. No time lag between ejection and monitoring is permitted. A casing collar locator (CCL) shall be positioned below the tool to precisely locate the bottom of the casing. The tool shall be configured such that one gamma-ray detector shall be located above the ejector chamber and two detectors shall be located below the ejector.

The RATS (radioactive tracer survey) testing will be conducted following the injection test.

1). Potable water from the Marco Island Utilities Water System will be used for the 24-hour injection test immediately prior to RATS testing so a sufficient fresh-water "bubble" will be established.

2). The combination gamma-ray / casing collar locator / temperature / radioactive slug ejector tool will be used to log in the hole, recording temperature from surface to a depth approximately 10 feet below the casing.

3). A background gamma ray log will be conducted in the interval beginning at total depth of the temperature log to approximately 1500 feet above the casing seat (bottom of casing). A casing collar locator log will be used.

4). The tracer ejector should be positioned within 1 foot below the bottom of the casing, with one gamma-ray detector above the ejector (GRT), and two gamma-ray detectors below the ejector [(GRM) and (GRB)].

5). Time-drive monitoring will begin without pumping, and a slug of tracer material will be ejected. The tracer material slug will be a volume of Iodine 131 equivalent to approximately 2.0 to 3.0 millicuries. This release may be confirmed by detectors GRM and GRB. Detector GRT, located inside the casing, above the ejector

will monitor the fluid in the casing to confirm the absence of tracer material rising upward inside the casing.

6). Gamma-ray levels will be monitored for 60 minutes; if tracer is detected, by detector GRT, the combination logging tool will be raised to follow the tracer.

7). A gamma-ray log will be run to approximately 1000 feet above the casing seat (or to a depth above the top of he confining sequence - to be determined during the drilling of the injection well).

8). The tracer ejector should be positioned approximately 5 feet above the bottom of the casing, with one gamma-ray detector above the ejector (GRT), and two gamma-ray detectors below the ejector [one inside the casing above the casing seat (GRM) and one outside the casing below the casing seat (GRB)].

9). A low injection rate will be established. The velocity will be approximately 0.1 foot per second, or approximately 88 gallons per minute.

10). Time-drive monitoring will begin and a slug of tracer material (similar to that used in Item 5) will be ejected. This release will be confirmed by detectors GRM and GRB.

11). Gamma-ray levels will be monitors for 60 minutes.

12). A gamma-ray log will be run to the same depth determined in Item 7.

13). The combination logging tool will be repositioned as described in Item 8.

14). A high injection rate (approximately 7070 gal/min) then will be established.

15). Time-drive monitoring will begin; a slug tracer material will be ejected (similar to that used in item 5); and the release of the tracer material will be confirmed by detectors GRM and GRB.

16). Gamma-ray levels will be monitored for sixty minutes.

17). A gamma-ray log will be run to the same depth determined in Item 7.

18). Repeat as necessary.

19). Pumping shall cease.

20). Repeat Items 4, 5 and 6. A larger volume of radioactive material (approximately 4.0 to 5.0 millicuries) will be released.

21). A gamma-ray log will be run up to approximately 1500 feet.

3.8 ADDITIONAL TESTING BY OUTSIDE AGENCIES OR SERVICES; The Consultant and/or the Owner may issue written authorization for additional testing and for logging to be performed by outside agencies, the Consultant's staff, or competent testing firms. The Contractor shall be given due notification of the test program and the firm or agency performing the test. The Contractor shall be given due notification of the test program and the firm or agency performing the test. The Contractor shall be compensated for standby time during any such well testing or logging.

In the event a tool owned by the outside firm or agency is lost in the well and cannot be retrieved, the Contractor shall be compensated for correcting the situation (if necessary). The Contractor shall be reimbursed for all costs incurred for rental of extra tools and equipment used during these operations.

The Contractor shall be responsible for and shall receive no additional compensation for cleaning the well of debris or loose well material which is dislodged during the test. The condition of the well is the Contractor's responsibility and no compensation shall be made for maintaining a clean hole.

3.9 PRESSURE TESTING; Following the cement bond log, the 24-inch diameter casing shall be pressure tested and following the installation of the tubing and packer, the annulus between the tubing and the 24-inch diameter casing shall be pressure tested. In each case, the casing shall be filled with water or water and corrosion inhibiting fluid and place under a minimum of 150 psi

(pounds per square inch) and a maximum of 225 psi. No pressure change in excess of five percent (5%) of the starting test pressure is allowed during sixty minutes. If a pressure change occurs, the test shall be repeated under controlled conditions to the satisfaction of the Consultant and the regulatory agencies. if the pressure changes or if there is some other indication of leakage, the Contractor shall take steps to locate the leak and make repairs in a manner satisfactory to the Consultant. Pressure testing shall be witnessed and certified in writing by the Consultant.

Following the cement bond logs of the 16-inch diameter monitor well casing, the 16-inch-diameter casing shall be pressure tested. The casing shall be filled with water and placed under a minimum of 150 psi and a maximum of 225 psi. no pressure change in excess of five percent (5%) of the starting test pressure is allowed during sixty minutes. If a pressure change occurs, the test shall be repeated under controlled conditions to the satisfaction of the Consultant and the regulatory agencies. If the pressure changes or if there is some other indication of leakage, the Contractor shall take steps to locate the leak and make repairs in a manner satisfactory to the Consultant. pressure testing shall be witnessed and certified in writing by the Consultant.

Following the cement bond logs of the 6-5/8-inch diameter monitor well casing, the 6-5/8-inch diameter casing shall be pressure tested. The casing shall be filled with water and placed under a minimum of 150 psi and a maximum of 225 psi. No pressure change in excess of five percent (5%) of the starting test pressure is

allowed during sixty minutes. If a pressure change occurs, the test shall be repeated under controlled conditions to the satisfaction of the Consultant and the regulatory agencies. If the pressure changes or if there is some other indication of leakage, the Contractor shall take steps to locate the leak and make repairs in a manner satisfactory to the Consultant. Pressure testing shall be witnessed and certified in writing by the Consultant.

The Contractor shall submit verification of pressure-gauge calibration to the Consultant prior to commencement of each pressure test. The cost of the pressure tests of the injection well shall be included in the lump-sum price of the injection well. The cost of the pressure test of the monitor well shall be included in the lump-sum price of the monitor well.

4 - MATERIALS SPECIFICATIONS

INJECTION WELL MATERIALS

4.0 CASING; All injection well casing and tubing shall be new. The Contractor may propose to the Consultant the use of well casing of a higher grade. The casings shall have minimum standards in the following specifications. Before casings are installed in the well, the Contractor shall supply the Consultant with Mill certificates.

4.01 PIT CASING: The Contractor shall install a pit casing with an inside diameter sufficient to accommodate a 50-inch-diameter drilling bit. The material, length, and method of installation shall be at the Contractor's option subject to approval by the

Consultant. The cost of the pit casing shall be included in the lump-sum price of the injection well.

4.02 CONDUCTOR CASING; The conductor casing shall be new, unused, steel, random length, 42-inch-diameter, 0.375-inch wall thickness, and shall conform to API 5L Grade B, ASTM A53 Grade B or Spiral Weld A139 Grade B standards. The casing shall be plain end beveled for welding and shall be joined together by certified welders. The Contractor must provide the Consultant proof of welders' certifications before any welding may be started. The Contractor shall include the cost for 230 feet of conductor casing in the lump-sum price of the injection well.

4.03 SURFACE CASING; The surface casing shall be new, unused steel, random length, 34-inch-diameter, 0.375-inch wall thickness, and shall conform to either API 5L Grade B, ASTM A53 Grade B or Spiral Weld A139 Grade B standards. The casing shall be plain end and beveled for welding and shall be joined together by certified welders. The Contractor shall include the cost for 1000 feet of surface casing in the lump-sum price of the injection well.

4.04 INJECTION CASING; The injection casing shall be new, unused seamless steel, random length, 24-inch diameter, 0.500-inch wall thickness, and shall conform to either API 5L Grade B or ASTM A53 Grade B standards. The casing shall be plain end and beveled for welding. Prior to installation of the final casing in to the well, it shall be sand blasted to remove any traces of mill varnish from its exterior surface. The Contractor shall have sand blasting done

at such a time as to allow the appropriate amount of rust (to facilitate proper cement bond) to have formed before installation of casing. The top 21 feet of injection casing shall be either grade N-80 pipe or otherwise reinforced to ensure support of the well-head and the injection tubing. Any method of reinforcing the top 20 feet of the injection casing other than grade N-80 pipe will require prior approval by the Consultant. The Contractor shall include the cost of 2800 feet of injection casing in the lump-sum price of the injection well.

4.05 INJECTION TUBING; The injection tubing shall be new, unused, seamless, random length, 20-inch diameter, 0.580-inch wall thickness, plain end and beveled for welding and shall conform to either API\5L Grade B or ASTM A53 Grade B standards. The Contractor shall include the cost of 2800 feet of injection tubing in the lump-sum price of the injection well.

4.1 CENTRALIZERS; All casing of the injection well shall be fitted with Halliburton-type centralizers with steel straps at 0, 90, 180, and 270 degrees around the casing at each position. The centralizers shall be located as follows.

Conductor Casing:

1). One at 20 feet above the bottom end of the casing

2). Three at 40-foot intervals above the bottom centralizer and at approximate intervals of 200 feet thereafter

3). The topmost centralizer to be at a depth of 20 feet below land surface

All centralizers shall be in a precise vertical alignment, one above the other, to allow for the placement of tremie pipes in the annuli. The cost of all centralizers shall be included in the lump-sum price of the injection well.

4.2 CEMENT; Sulfate-resistant cement shall be used for all cementing of casings and hole plugging. ASTM Type II, or API Class B, can be used with additives and lost-circulation materials (Flocele and/or gilsonite) as necessary and approved by the Consultant. Gel may be used in concentrations up to a maximum of 12 percent. Cement emplaced at the bottom 100 feet of feet of the intermediate and bottom 200 feet of the surface and final casing in the injection well shall be neat. However, lost-circulation material such as Flocele and gilsonite may be used as needed. At the Contractor's option, all conductor casing may be cemented with neat cement. All cement mixtures shall be approved by the Consultant in advance of placement. Prior to commencement of cementing operations, Contractor shall submit written procedure for each stage of each casing string. Mixed cement shall include cement and al additives and lost circulation material approved by the Consultant. The Contractor shall include the cost of 40,000 cubic feet of mixed cement in the lump-sum price of the injection well.

4.3 WELL-HEAD; The Contractor shall finish the injection well with a reinforced well-head and a flanged 20-inch, bronze double

disk gate valve. As a means of accessing the 24"/20" annulus, two 2-inch gate valves shall be installed on the 24-inch diameter casing. The valves shall provide bi-directional bubble-type sealing at 300-psi differential pressure. The well-head reinforcement shall be provided by gussets as shown in the contract drawings, or other approved design. The gussets shall be located every 45 degrees around the 20-inch and 24-inch casings. The steel used to construct the gussets shall at a minimum be 1-inch thick and shall be welded in place so as to support the additional load of the injection casing liner. Alternate means of supporting the additional load of the injection casing liner shall be proposed in writing and must be approved by the Consultant prior to installation. The 20-inch gate valve shall conform to AWWA-C-504-80. The valve shall provide bi-directional bubble-type sealing at 150-psi differential pressure. The Contractor shall include the cost of these items in his lump-sum price for the injection well.

4.4 INJECTION TUBING / FINAL CASING - ANNULAR FLUID; The fluid placed between the injection tubing and the 24-inch diameter final casing must be potable water treated with a corrosion and bacteria inhibiting product such a NL Baroid's Baracor "A". Any product used must receive prior approval by the Consultant. The Contractor shall include the cost of treating 300 barrels of annular fluid in his lump-sum price for the injection well.

4.5 INJECTION TUBING PACKER; The injection tubing packer shall be retrievable PBR packer with seal bore like a T.I.W. Type LH

Packer with JGS holddowns, polished Teflon coated barrel, and 4-unit seal assembly or approved equal.

MONITOR WELL MATERIALS

4.10 CASING; All monitor well casing and tubing shall be new. The Contractor may propose to the Consultant the use of well casing of a higher grade. The casings shall have minimum standards in the following specifications. Before casings are installed in the well, the Contractor shall supply the Consultant with Mill certificates.

4.101 PIT CASING; The Contractor shall install a pit casing with an inside diameter sufficient to accommodate a 36-inch-diameter drilling bit. The material, length, and method of installation shall be at the Contractor's option subject to approval by the Consultant. The cost of the pit casing shall be included in the lump-sum price of the monitor well.

4.102 CONDUCTOR CASING; The conductor shall be new, unused, steel, random length, 24-inch-diameter, 0.375-inch all thickness, and shall conform to API 5L Grade B or Spiral Weld A139 Grade a B standards. The casing shall be plain end and beveled for welding and shall be joined together by certified welders. The Contractor must provide the Consultant proof of welders' certifications before any welding may be started. The Contractor shall include the cost

of 230 feet of conductor casing in the lump-sum price of the monitor well.

4.103 SURFACE CASING: The surface casing shall be new, unused steel, random length, 16-inch-diameter, 0.375-inch wall thickness, and shall conform to either API 5L Grade B, ASTM A54 Grade B or Spiral Weld A139 Grade B standards. The casing shall be plain end beveled for welding and shall be joined together by certified welders. The Contractor shall include the cost for 1000 feet of surface casing in the lump-sum price of the monitor well.

4.104 MONITOR CASING: The monitor casing shall be new, unused seamless steel, random length, 6-5/8-inch diameter, 0.562-inch wall thickness, and shall conform to either API 5L Grade B or ASTM A53 Grade B standards. The casing shall be plain end and beveled for welding. Prior to installation of the final casing in to the well, it shall be sand blasted to remove any traces of mill varnish from the exterior surface of the bottom 500 feet. The top 1000 (approximate) feet of casing shall be coated with an epoxy-polyamide coating to protect the uncemented portion of the casing. The Contractor shall have sand blasting done at such a time as to allow the appropriate amount of rust (to facilitate proper cement bond) to have formed before installation of casing. The Contractor shall include the cost of 1500 feet of monitor casing in the lump-sum price of the monitor well.

4.11 CENTALIZERS; All casings of the monitor well shall be fitted with Halliburton-type centralizers with steel straps at 0, 90, 180, and 270 degrees around the casing at each position. The centralizers shall be located as follows:

Conductor Casing:

1). One at 20 feet above the bottom end of the casing
2). Two at 40-foot intervals above bottom centralizer
3). One at 20 feet below land surface

All other casings and tubings:

1). One at 20 feet above the bottom end of the casing
2). Three at 40-foot intervals above the bottom centralizer and at approximate intervals of 200 feet thereafter
3). The topmost centralizer to be at a depth of 20 feet below land surface

All centralizers shall be in a precise vertical alignment, one above the other, to allow for the placement of tremie pipes in the annuli. The cost of all centralizers shall be included in the lump-sum price of the monitor well.

4.12 CEMENT: Sulfate-resistant cement shall be used for all cementing of casings and hole plugging. ASTM Type II, or API Class B, can be used with additives and lost-circulation materials (Flocele and/or gilsonite) as necessary and approved by the

Consultant. Gel may be used in concentrations up to maximum of 12 percent. Cement emplaced at the bottom 200 feet of the surface and final casing shall be neat. However, lost-circulation material such as Flocele and gilsonite may be used as needed. At the Contractor's option, all conductor casing may be cemented with neat cement. All cement mixtures shall be approved by the Consultant in advance of placement. Prior to commencement of cementing operations, the Contractor shall submit a written procedure for each stage of each casing string. Mixed cement shall include cement and all additives and lost circulation material approved by the Consultant. The Contractor shall include the cost of 7,500 cubic feet of mixed cement in the lump-sum price of the monitor well.

4.13 COATING: Before the 6-5/8-inch-diameter monitor tubing for the deeper zone is installed in the monitor well, the entire casing string shall be coated with an epoxy-polyamide compound such as Tnemec Series 66 Hi-Build Epoxoline Epoxy-Polyamide Coating. The coating on the monitor tube shall have a minimum thickness of 6.0 mils when dry. The Contractor shall exercise care while making up the tubing and replace any coating that may be damaged during this operation. After all applications of the coating, the Contractor shall have the coating holiday checked and certified as to its integrity before the tubing is installed in the well. The costs of all coating for the 6-5/8-inch-diameter tubing shall be included in the lump-sum price of the monitor well.

4.14 DISINFECTION: Following approval by the Consultant of the tests indicating that the monitor tubes are open and in contact with the formation , the Contractor shall disinfect the monitor tubes accordance with Section 1-7 of the AWWA Standard for Deep Wells. The Contractor shall submit to the Consultant for approval his written procedure for disinfection prior to its implementation. The Contractor shall notify the Consultant in writing at least 24 hours in advance of the implementation of the approved disinfection procedures. The Contractor shall include all costs for disinfection in the lump-sum price of the monitor well.

CONTRACT DRAWINGS

1). Site Plan

2). Injection Well and Deep Monitor Well Construction Details

3). Injection Well, Well-head Construction Details

4). Drill Pad Construction Details

5). Water-Table Monitoring Wells Construction Details

6). Injection Tubing Packer Construction Details

7). Above-Ground Piping Schematic

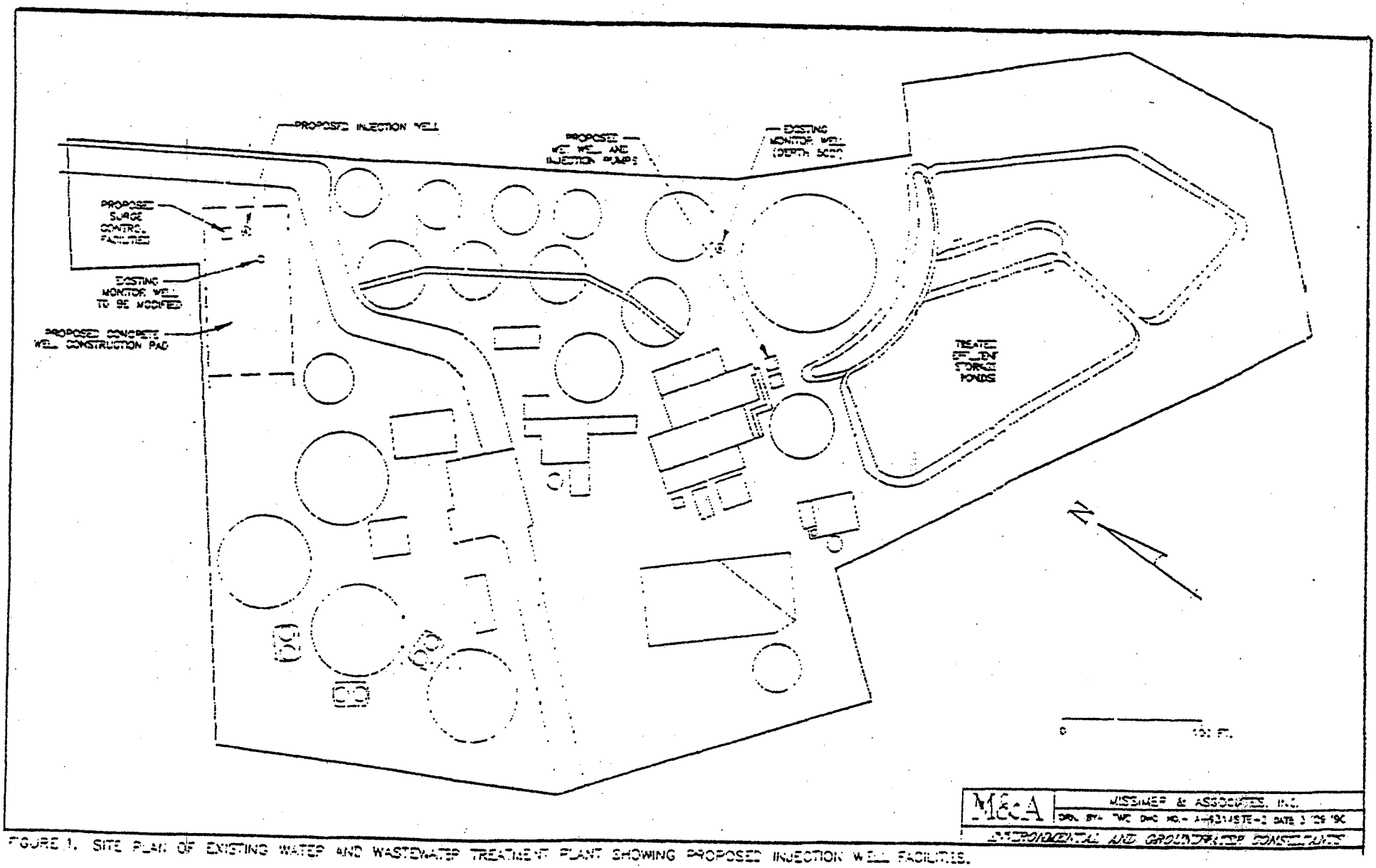

FIGURE 1. SITE PLAN OF EXISTING WATER AND WASTEWATER TREATMENT PLANT SHOWING PROPOSED INJECTION WELL FACILITIES.

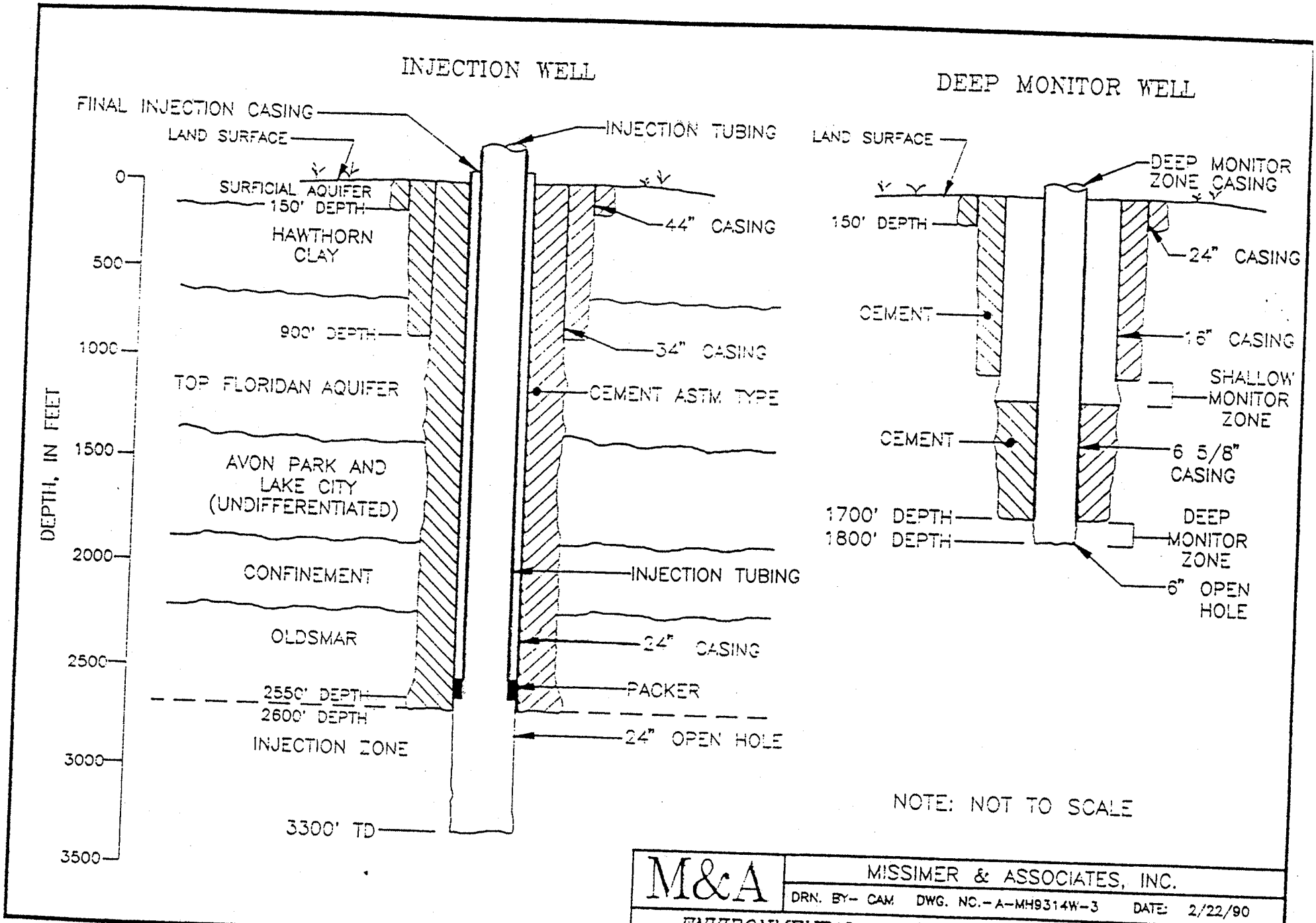

FIGURE 2. PROPOSED CONSTRUCTION DETAILS OF THE INJECTION WELL AND ZONE MONITOR WELL.

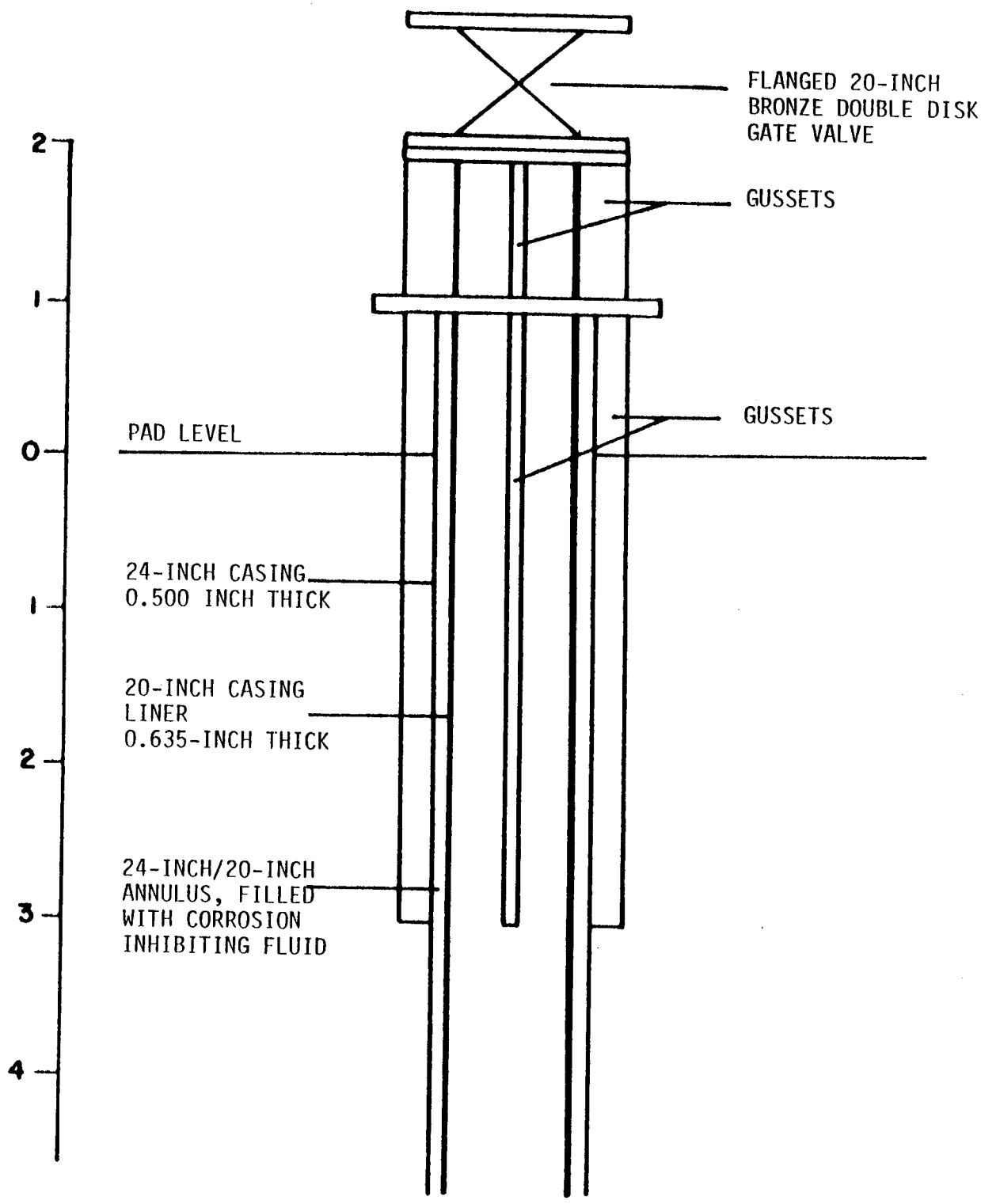

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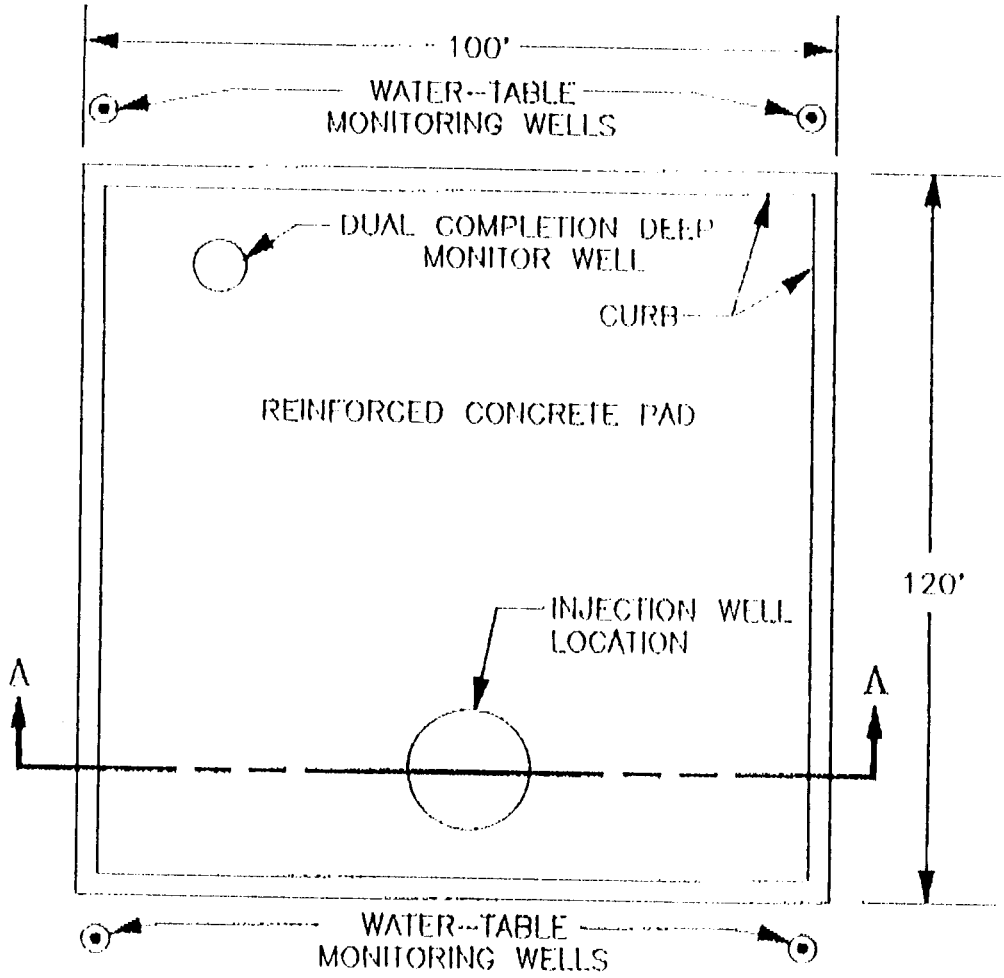
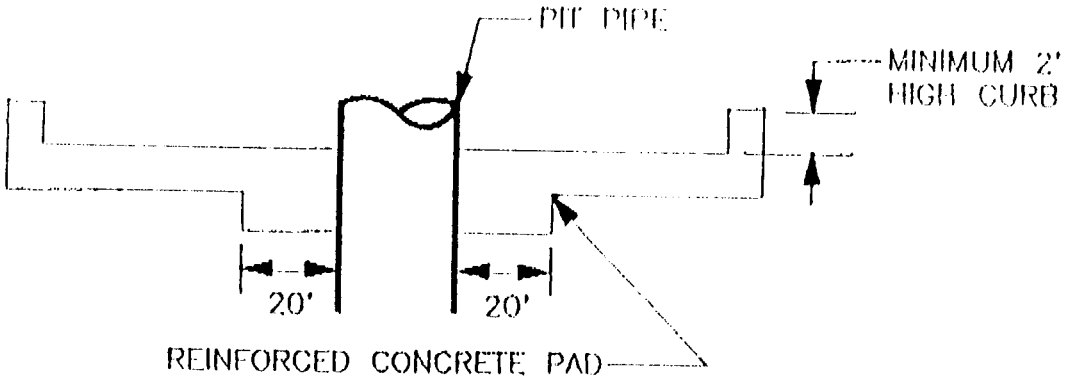
FIGURE 3. WELL-HEAD CONSTRUCTION DETAILS



PLAN VIEW



CROSS SECTION A–A

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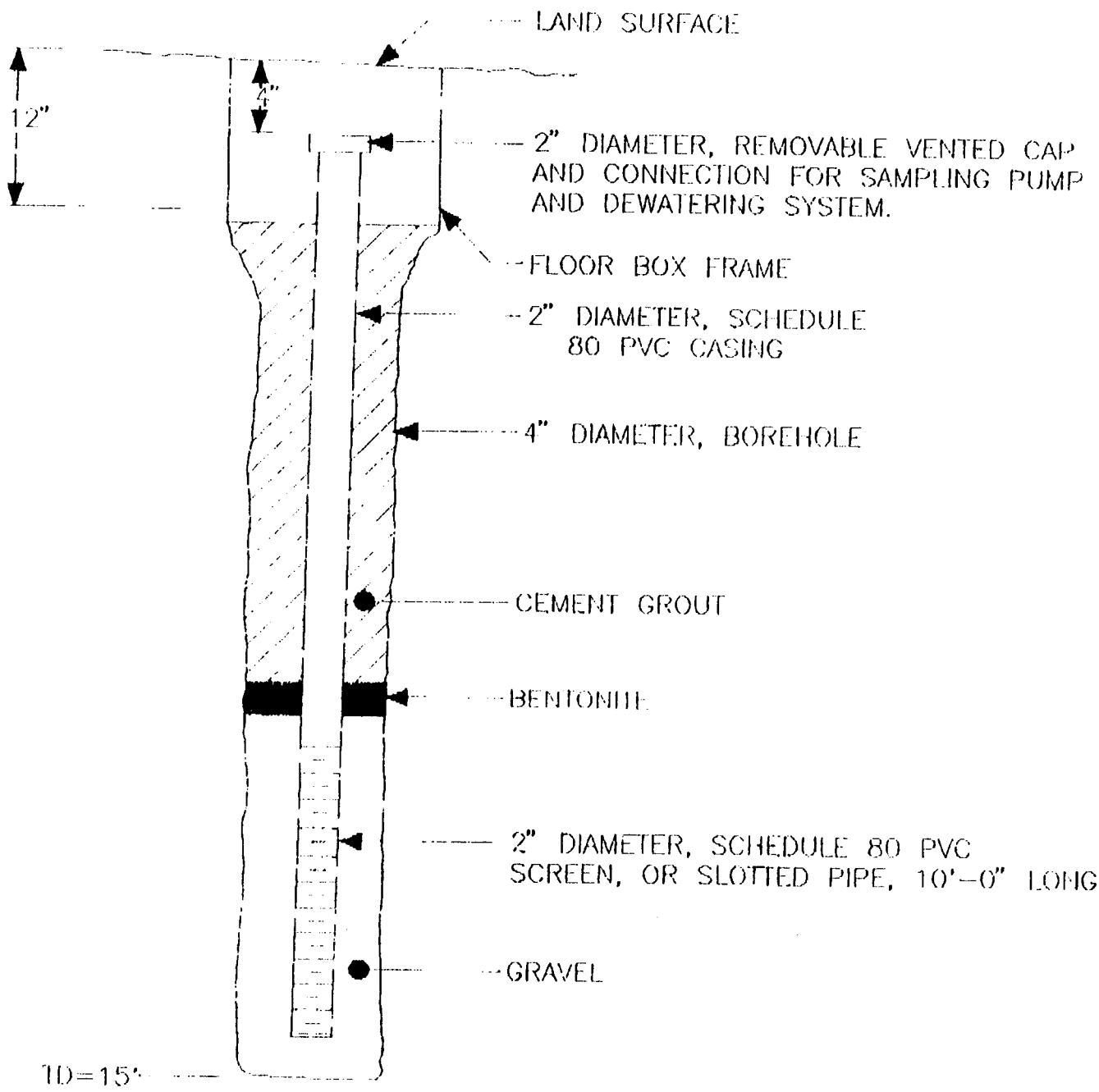
FIGURE 4. TYPICAL DRILL PAD AND MONITORING WELL LOCATIONS



M&A	MISSIMER & ASSOCIATES, INC.
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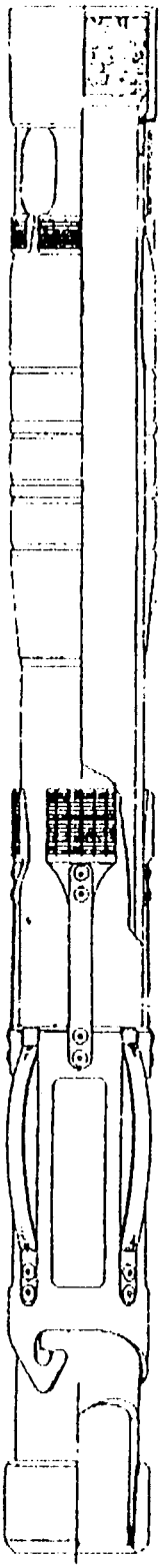
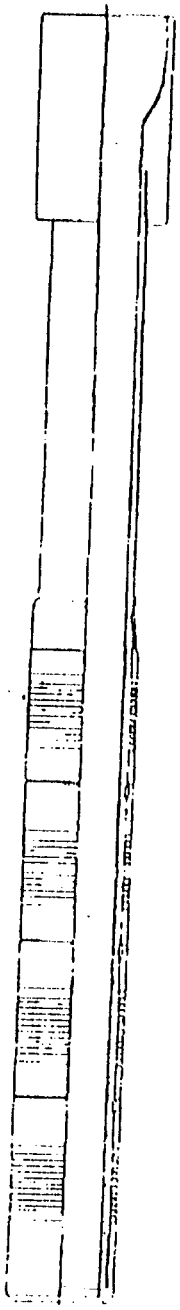
FIGURE 5. INJECTION WELL DRILLING PAD WATER-TABLE MONITORING WELL CONSTRUCTION DETAILS.



TIW TYPE LH PACKER W/IGS HOLDDOWN SLIPS 18-5/8" 112# * 8RPL X 24" 162# N80 W/BEVELED PACKOFF 65 DURO PACKOFF & 6' POLISHED BORE COATED W/TEFLON. HEAVY DUTY DRAG SPRINGS & BEVELED BOTTOM.



TIW TYPE PBR SEAL ASSEMBLY W/ MULESHOE BOTTOM 4 UNITS OF SEALS W/SPACER AND STD LOCATOR SUB 18-5/8" 112# * 8RLF BOX X 20" 133# N80 BEVELED FOR WELD.

* 4140 QUENCHED & TEMPERED TO N80 ID COATED W/TFE

M&A	MARCO ISLAND UTILITIES / SSU SERVICES	3/15/90
	COMBINED WASTE STREAM INJECTION WELL # 1	H89-314
	INJECTION TUBING PACKER	FIGURE # 6

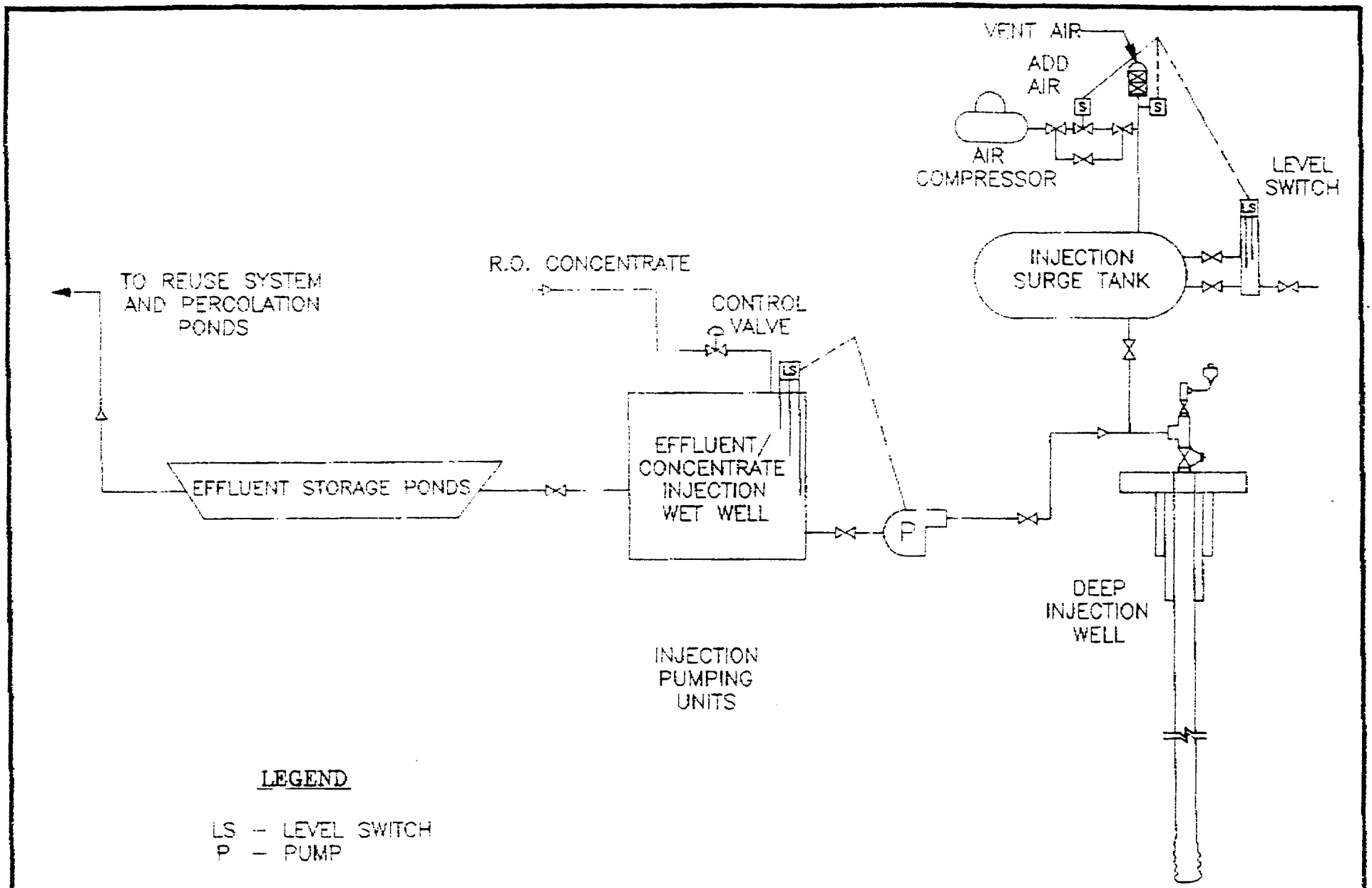


FIGURE SCHEMATIC SHOWING PROPOSED INJECTION WELL PUMPING AND CONTROL FACILITIES.