Exploratory Well near the S-77 Water Control Structure, Moore Haven, Florida

Lake Okeechobee Aquifer Storage and Recovery Pilot Project

Prepared By:

South Florida Water Management District
3301 Gun Club Road
West Palm Beach, Florida 33406

5/18/01
PAUL F. LINTON
42637

In Association With:

U.S. Army Corps of Engineers
Jacksonville District
Jacksonville, Florida

Peter J. Kwiatkowski
Peter J. Kwiatkowski
May 18, 2001

May 2001

SOUTH FLORIDA WATER MANAGEMENT DISTRICT
3301 Gun Club Road, West Palm Beach, Florida 33406 • (561) 686-8800 • FL WATS 1-800-432-2045 • TDD (561) 697-2574
Mailing Address: P.O. Box 24680, West Palm Beach, FL 33416-4680 • www.sfwmd.gov

ADM 02 06

May 18, 2001

Mr. Jose L. Calas, P.E.
Program Administrator, Environmental Affairs
Florida Department of Environmental Protection
400 N. Congress Avenue
P.O. Box 15425
West Palm Beach, FL 33416

Dear Mr. Calas:

Subject: Class V Exploratory Well Permit Application, Moore Haven, Florida, Lake Okeechobee ASR Pilot Project.

Thank you for meeting with the South Florida Water Management District (SFWMD) and U.S. Army Corps of Engineers (USACE) at your office on May 2, 2001 to discuss pre-application issues for the Lake Okeechobee ASR Pilot Project. Enclosed are two (2) copies of the subject application, with additional copies provided to the Technical Advisory Committee (TAC).

As you know, the test well contract has begun, and we anticipate that minor changes in the design of the subject exploratory well will occur based on results of test well construction and testing. As we discussed at our meeting and during the Project Delivery Team meetings, we believe the TAC's early review of the subject application will accelerate the schedule for this most important project.

Please contact me if you or the TAC has any questions or comments regarding the subject permit application. We look forward to working closely with your office – and other Project Delivery Team members – throughout this project.

Sincerely,

Peter J. Kwiatkowski, P.G.
SFWMD Project Manager
Lake Okeechobee ASR Pilot Project

PJK/kh
Enclosures

c: Glenn Landers, USACE-Jacksonville
Michael Fies, USACE-Jacksonville

Florida Department of Environmental Protection

Twin Towers Office Bldg., 2600 Blair Stone Road,
Tallahassee, Florida 32399-2400

DEP Form No:	62-528.900(1)
Form Title:	Application to Construct/ Operate/Abandon Class I, III, or V Injection Well Systems
Effective Date:	
DEP Application No.:	(Filled in by DEP)

APPLICATION TO CONSTRUCT/OPERATE/ABANDON
CLASS I, III, OR V INJECTION WELL SYSTEMS

Part I. Directions

A. All applicable items must be completed in full in order to avoid delay in processing this application. Where attached sheets or other technical documentation are utilized in lieu of the blank space provided, indicate appropriate cross-reference in the space and provide copies to the Department in accordance with C. below. Where certain items do not appear applicable to the project, indicate N/A in the appropriate spaces.

B. All information is to be typed or printed in ink.

C. Four (4) copies of this application and four (4) copies of supporting information such as plans, reports, drawings and other documents shall be submitted to the appropriate District/Subdistrict office. An engineering report is also required to be submitted to support this application pursuant to the applicable sections of Rule 62-528, F.A.C. The attached list* shall be used to determine completeness of supporting data submitted or previously received. A check for the application fee in accordance with Rule 62-4.050, F.A.C., made payable to the Department shall accompany the application.

D. For projects involving construction, this application is to be accompanied by four (4) sets of engineering drawings, specifications and design data as prepared by a Professional Engineer registered in Florida, where required by Chapter 471, Florida Statutes.

E. Attach 8 1/2" x 11" USGS site location map indicating township, range and section and latitude/longitude for the project.

PART II. General Information

A. Applicant Name Joseph A. Schweigart, P.E. Title Director, Programs Mgmt.

Address 3301 Gun Club Road

City West Palm Beach State Florida Zip 33406-4680

Telephone Number 561-682-6102

B. Project Status: ☒ New ☐ Existing

☐ Modification (specify) _____

*"Engineering and Hydrogeologic Data Required for Support of Application to Construct, Operate and Abandon Class I, III, or V Injection Wells"

C. Well Type: ☒ Exploratory Well ☐ Test/Injection Well

D. Type of Permit Application

- ☐ Class I Test/Injection Well Construction and Testing Permit
- ☐ Class I Well Operation Permit
- ☐ Class I Well Operation Repermitting
- ☐ Class I Well Plugging and Abandonment Permit
- ☐ Class III Well Construction/Operation/Plugging and Abandonment Permit
- ☐ Class I Exploratory Well Construction and testing Permit
- ☒ Class V Well Construction Permit
- ☐ Class V Well Operation Permit
- ☐ Class V Well Plugging and Abandonment Permit
- ☐ Monitor Well Only

E. Facility Identification:

Name Moore Haven Exploratory Well

Facility Location: Street S-77 Control Structure Access Road

City Moore Haven County Glades

SIC Code(s)

F. Proposed facility located on Indian Lands: Yes ☐ No ☒

G. Well Identification:

Well No. 1 of 1 Wells
(total #)

Purpose (Proposed Use) Exploratory Aquifer Storage and Recovery

Well Location: Latitude: N 26° 50′ 10″ Longitude: W 81° 05′ 14″
(attach separate sheet(s), if necessary, for multiple wells)

Subpart B. General Project Description:

H. General Project Description: Describe the nature, extent and schedule of the injection well project. Refer to existing and/or future pollution control facilities, expected improvement in performance of the facilities and state whether the project will result in full compliance with the requirements of Chapter 403, F.S., and all rules of the Department. Attach additional sheet(s) if necessary or cross-reference the engineering report.

Project consists of construction and testing of an exploratory ASR well as part of the Lake Okeechobee ASR Pilot Project component of the Comp. Everglades Restoration Plan.

DEP Form No:	62-528.900(1)
Form Title:	Application to Construct/ Operate/Abandon Class I, III, or V Injection Well Systems
Effective Date:	
DEP Application No.:	(Filled in by DEP)

PART III. Statement by Applicant and Engineer

A. Applicant

I, the owner/authorized representative* of South Fla. Water Mgmt. District, certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment. I understand that this certification also applies to all subsequent reports submitted pursuant to this permit. Where construction is involved, I agree to retain the design engineer, or other professional engineer registered in Florida, to provide inspection of construction in accordance with Rule 62-528.455(1)(c), F.A.C.

Signed — 05/18/01
Date

Joseph A. Schweigart, P.E. — 561-682-6102
Name and Title (Please Type) — Telephone Number

*Attach a Letter of Authorization.

B. Professional Engineer Registered in Florida

This is to certify that the engineering features of this injection well have been designed/examined by me and found to be in conformity with modern engineering principles applicable to the disposal of pollutants characterized in the permit application. There is reasonable assurance, in my professional judgement, that the well, when properly maintained and operated, will discharge the effluent in compliance with all applicable statutes of the State of Florida and the rules of the Department. It is also agreed that the undersigned will furnish the applicant a set of instructions for proper maintenance and operation of the well.

Signed — 5/18/2001
42637

Paul Ferguson Linton
Name (Please Type)

South Florida Water Management District
Company Name (Please Type)

(Please Affix Seal)

3301 Gun Club Road West Palm Beach, FL 33406
Mailing Address(Please Type)

Florida Registration No. 42637 Date 05/18/01 Phone No. 561-682-2871

ENGINEERING AND HYDROLOGIC DATA
REQUIRED FOR SUPPORT OF APPLICATION
TO CONSTRUCT, OPERATE, AND ABANDON
CLASS I, III, OR V INJECTION WELL SYSTEMS

The following information shall be provided for each type of permit application.

A. CLASS I TEST/INJECTION WELL CONSTRUCTION AND TESTING PERMIT

1. A map showing the location of the proposed injection wells of well field area for which a permit is sought and the applicable area of review. Within the area of review, the map must show the number or name, and location of all producing wells, injection wells, abandoned wells, dry holes, surface bodies of water, springs, public water systems, mines (surface and subsurface), quarries, water wells and other pertinent surface features including residences and roads. The map should also show faults, if known or suspected. Only information of public record and pertinent information known to the applicant is required to be included on this map.

2. A tabulation of data on all wells within the area of review which penetrate into the proposed injection zone, confining zone, or proposed monitoring zone. Such data shall include a description of each well's type, construction, date drilled, location, depth, record of plugging and/or completion, and any additional information the Department may require.

3. Maps and cross sections indicating the general vertical and lateral limits within the area of review of all underground sources of drinking water, their position relative to the injection formation and the direction of water movement, where known, in each underground source of drinking water which may be affected by the proposed injection.

4. Maps and cross sections detailing the hydrology and geologic structures of the local area.

5. Generalized maps and cross sections illustrating the regional geologic setting.

6. Proposed operating data.

   (a) Average and maximum daily rate and volume of the fluid to be injected;

   (b) Average and maximum injection pressure; and,

   (c) Source and an analysis of the chemical, physical, radiological and biological characteristics of injection fluids.

7. Proposed formation testing program to obtain an analysis of the chemical, physical and radiological characteristics of and other information on the injection zone.

8. Proposed stimulation program.

9. Proposed injection procedure.

10. Engineering drawings of the surface and subsurface construction details of the system.

11. Contingency plans to cope with all shut-ins or well failures, so as to protect the quality of the waters of the State as defined in Rule 62-3 and 62-520, F.A.C., including alternate or emergency discharge provisions.

12. Plans (including maps) and proposed monitoring data to be reported for meeting the monitoring requirements in Rule 62-528.425, F.A.C.

13. For wells within the area of review which penetrate the injection zone but are not properly completed or plugged, the corrective action proposed to be taken under Rule 62-528.300(5), F.A.C.

14. Construction procedures including a cementing and casing program, logging procedures, deviation checks, proposed methods for isolating drilling fluids from surficial aquifers, proposed blowout protection (if necessary), and a drilling, testing and coring program.

15. A certification that the applicant has ensured, through a performance bond or other appropriate means, the resources necessary to close, plug or abandon the well as required by Rule 62-528.435(9), F.A.C.

B. CLASS I INJECTION WELL OPERATION PERMIT

1. A report shall be submitted with each application for a Class I Well operating permit, which shall include, but not be limited to, the following information:

   (a) Results of the information obtained under the construction permit described in A. CLASS I TEST/INJECTION WELL CONSTRUCTION AND TESTING PERMIT, including:

      (1) All available logging and testing program data and construction data on the well or well field;

      (2) A satisfactory demonstration of mechanical integrity for all new wells pursuant to Rule 62-528.300(6), F.A.C;

      (3) The actual operating data, including injection pressures versus pumping rates where feasible, or the anticipated maximum pressure and flow rate at which the permittee will operate, if approved by the Department;

      (4) The actual injection procedure;

      (5) The compatibility of injected waste with fluids in the injection zone and minerals in both the injection zone and the confining zone; and,

      (6) The status of corrective action on defective wells in the area of review.

   (b) Record drawings, based upon inspections by the engineer or persons under his direct supervision, with all deviations noted;

   (c) Certification of completion submitted by the engineer of record;

   (d) If requested by the Department, operation manual including emergency procedures;

(e) Proposed monitoring program and data to be submitted;

(f) Proof that the existence of the well has been recorded on the surveyor's plan at the county courthouse; and,

(g) Proposed plugging and abandonment plan pursuant to Rule 62-528.435(2), F.A.C.

C. CLASS I WELL OPERATION REPERMITTING

1. An updated map showing the location of the injection wells or well field area for which a permit is sought and the applicable area of review. Within the area of review, the map must show the number or name, and location of all producing wells, injection wells, abandoned wells, dry holes, surface bodies of water, springs, public water systems, mines (surface and subsurface), quarries, water wells and other pertinent surface features including residences and roads. The map should also show faults, if known or suspected. Only information of pubic record and pertinent information known to the applicant is required to be included on this map.

2. A tabulation of data on all wells within the area of review which penetrate into the injection zone, confining zone, or monitoring zone. Such data shall include a description of each well's type, construction, date drilled, location, depth, record of plugging and/or completion, and any additional information the Department may require.

3. Maps and cross sections indicating the general vertical and lateral limits within the area of review of all underground sources of drinking water, their position relative to the injection formation and the direction of water movement, where known, in each underground source of drinking water which may be affected by the injection.

4. Maps and cross sections detailing the hydrology and geologic structures of the local area.

5. Generalized maps and cross sections illustrating the regional geologic setting.

6. Contingency plans to cope with all shut-ins or well failures, so as to protect the quality of the waters of the State as defined in Rule 62-3 and 62-520, F.A.C., including alternate or emergency discharge provisions.

7. For wells within the area of review which penetrate the injection zone but are not properly completed or plugged, the corrective action proposed to be taken under Rule 62-528.300(5), F.A.C.

8. A certification that the applicant has ensured, through a performance bond or other appropriate means, the resources necessary to close, plug or abandon the well as required by Rule 62-528.435(9), F.A.C.

9. A report shall be submitted with each application for repermitting of Class I Well operation which shall include the following information:

   (a) All available logging and testing program data and construction data on the well or well field;

(b) A satisfactory demonstration of mechanical integrity for all wells pursuant to Rule 62-528.300(6), F.A.C.;

(c) The actual operating data, including injection pressures versus pumping rates where feasible, or the anticipated maximum pressure and flow rate at which the permittee will operate, if approved by the Department;

(d) The actual injection procedure;

(e) The compatibility of injected waste with fluids in the injection zone and minerals in both the injection zone and the confining zone;

(f) The status of corrective actin on defective wells in the area of review;

(g) Record drawings, based upon inspections by the engineer or persons under his direct supervision, with all deviations noted;

(h) Certification of completion submitted by the engineer of record;

(i) An updated operation manual including emergency procedures;

(j) Proposed revisions to the monitoring program or data to be submitted; and,

(k) Proposed plugging and abandonment plan pursuant to Rule 62-528.435(2), F.A.C.

D. CLASS I WELL PLUGGING AND ABANDONMENT PERMIT

1. The reasons for abandonment.

2. A proposed plan for plugging and abandonment describing the preferred and alternate methods, and justification for use.

   (a) The type and number of plugs to be used;

   (b) The placement of each plug including the elevation of the top and bottom;

   (c) The type and grade and quantity of cement or any other approved plugging material to be used; and,

   (d) The method for placement of the plugs.

3. The procedure to be used to meet the requirements of Rule 62-528.435, F.A.C.

E. CLASS III WELLS CONSTRUCTION/OPERATION/PLUGGING AND ABANDONMENT PERMIT

Construction Phase

1. A map showing the location of the proposed injection wells or well field area for which a permit is sought and the applicable area of review. Within the area of review, the map must show the number or name, and location of all producing wells, injection wells, abandoned wells, dry holes, surface bodies of water, springs, public water system, mines (surface and subsurface), quarries, water wells and other pertinent surface features including residences and roads. The map should also show faults, if known or suspected. Only information of public record and pertinent information known to the applicant is required to be included on this map.

2. A tabulation of data on all wells within the area of review which penetrate into the proposed injection zone, confining zone, or proposed monitoring zone. Such data shall include a description of each well's type, construction, date drilled, location, depth, record of plugging and/or completion, and any additional information the Department may require.

3. Maps and cross sections indicating the general vertical and lateral limits within the area of review of all underground sources of drinking water, their position relative to the injection formation and the direction of water movement, where known, in each underground source of drinking water which may be affected by the proposed injection.

4. Maps and cross sections detailing the hydrology and geologic structures of the local area.

5. Generalized maps and cross sections illustrating the regional geologic setting.

6. Proposed operating data:

   (a) Average and maximum daily rate and volume of the fluid to be injected;

   (b) Average and maximum injection pressure; and,

   (c) Source and an analysis of the chemical, physical, radiological and biological characteristics of injection fluids, including any additives.

7. Proposed formation testing program to obtain an analysis of the chemical, physical and radiological characteristics of and other information on the injection zone.

8. Proposed stimulation program.

9. Proposed injection procedure.

10. Engineering drawings of the surface and subsurface construction details of the system.

11. Contingency plans to cope with all shut-ins or well failures or catastrophic collapse, so as to protect the quality of the waters of the State as defined in Rule 62-3 and 62-520, F.A.C., including alternate or emergency discharge provisions.

12. Plans (including maps) and proposed monitoring data to be reported for meeting the monitoring requirements in Rule 62-528.425, F.A.C.

13. For wells within the area of review which penetrate the injection zone but are not properly completed or plugged, the corrective action proposed to be taken under Rule 62-528.300(5), F.A.C.

14. Construction procedures including a cementing and casing program, logging procedures, deviation checks, proposed methods for isolating drilling fluids from surficial aquifers, and a drilling, testing and coring program.

15. A certificate that the applicant has ensured, through a performance bond or other appropriate means, the resources necessary to close, plug or abandon the well as required by Rule 62-528.435(9), F.A.C.

16. Expected changes in pressure, native fluid displacement, direction of movement of injection fluid.

17. A proposed monitoring plan, which includes a plan for detecting migration of fluids into underground sources of drinking water, a plan to detect water quality violation in the monitoring wells, and the proposed monitoring data to be submitted.

Operation Phase

1. The following information shall be provided to the Department prior to granting approval for the operation of the well or well field:

   (a) All available logging and testing program data and construction data on the well or well field;

   (b) A satisfactory demonstration of mechanical integrity for all new wells pursuant to Rule 62-528.300(6), F.A.C.;

   (c) The actual operating data, including injection pressure versus pumping rate where feasible, or the anticipated maximum pressure and flow rate at which the permittee will operate, if approved by the Department;

   (d) The results of the formation testing program;

   (e) The actual injection procedure; and,

   (f) The status of corrective action on defective wells in the area of review.

Plugging and abandonment Phase

1. The justification for abandonment.

2. A proposed plan for plugging and abandonment describing the preferred and alternate methods.

   (a) The type and number of plugs to be used;

   (b) The placement of each plug including the elevation of the top and bottom;

   (c) The type and grade and quantity of cement or any other approved plugging material to be used; and,

   (d) The method for placement of the plugs.

3. The procedure to be used to meet the requirements of Rule 62-528.435, F.A.C.

F. EXPLORATORY WELL CONSTRUCTION AND TESTING PERMIT

1. Conceptual plan of the injection project. Include number of injection wells, proposed injection zone, nature and volume of injection fluid, and proposed monitoring program.

2. Preliminary Area of Review Study. Include the proposed radius of the area of review with justification for that radius. Provide a map showing the location of the proposed injection well or well field area for which a permit is sought and the applicable area of review. Within the area of review, the map must show the number or name, and location of all producing wells, injection wells, abandoned wells, dry holes, surface bodies of water, springs, public water systems, mines (surface and subsurface), quarries, water wells and other pertinent surface features including residences and roads. The map should also show faults, if known or suspected. Only information of public record and pertinent information known to the applicant is required to be included on this map.

3. Proposed other uses of the exploratory well.

4. Drilling and testing plan for the exploratory well. The drilling plan must specify the proposed drilling program, sampling, coring, and testing procedures.

5. Abandonment Plan.

G. CLASS V WELL CONSTRUCTION PERMIT

(This form should be used for Class V Wells instead of Form 62-528.900(3), F.A.C., when there is a need for a Technical Advisory Committee and an engineering report.)

1. Type and number of proposed Class V Wells:

_____ Wells Receiving Domestic Waste

_____ Desalination Process Concentrate Wells (Reverse Osmosis, etc.)

1 Aquifer Storage and Recovery Wells

_____ Aquifer Remediation Wells

_____ Salt-water Intrusion Barrier Wells

_____ Cooling Water Return Flow Wells Open-looped System

_____ Subsidence Control Wells

_____ Sand Backfill Wells

_____ Experimental Technology Wells

_____ Wells used to inject spent brine after halogen recovery

_____ Radioactive Waste Disposal Wells*

_____ Borehole Slurry Mining Wells

_____ Other non-hazardous Industrial or Commercial Disposal Wells

(explain) _____

_____ Other (explain) _____

*Provided the concentrations of the waste do not exceed drinking water standards contained in Chapter 62-550, F.A.C.

2. Project Description:

(a) Description and use of proposed injection system;

(b) Nature and volume of injected fluid (the Department may require an analysis including bacteriological analysis) in accordance with Rule 62-528.635(2)(b), F.A.C.; and,

(c) Proposed pretreatment.

3. Water well contractor's name, title, state license number, address, phone number and signature.

4. Well Design and Construction Details. (For multi-casing configurations or unusual construction provisions, an elevation drawing of the proposed well should be attached.)

   (a) Proposed total depth;

   (b) Proposed depth and type of casing(s);

   (c) Diameter of well;

   (d) Cement type, depth, thickness; and,

   (e) Injection pumps (if applicable): _____ gpm @ _____ psi

   Controls: _____

   _____

   _____

5. Water Supply Wells - When required by Rule 62-528.635(1), F.A.C., attach a map section showing the locations of all water supply wells within a one-half (1/2) mile radius of the proposed well. The well depths and casing depths should be included. When required by Rule 62-528.635(2), F.A.C., results of bacteriological examinations of water from all water supply wells within one-half (1/2) mile and drilled to approximate depth of proposed well should be attached.

6. Area of review (When required by Rule 62-528.300(4), F.A.C.)

   Include the proposed radius of the area of review with justification for that radius. Provide a map showing the location of the proposed injection well or well field area for which a permit is sought and the applicable area of review. Within the area of review, the map must show the number or name, and location of all producing wells, injection wells, abandoned wells, dry holes, surface bodies of water, springs, public water systems, mines (surface and subsurface), quarries, water wells and other pertinent surface features including residences and roads. The map should also show faults, if known or suspected. Only information of public record and pertinent information known to the applicant is required to be included on this map.

H. CLASS V WELL OPERATION PERMIT

(Final report of the construction that includes the following information may be submitted with the application to operate.)

1. Permit Number of Class V Construction Permit: _____

2. Owner's Name: _____

3. Type of Wells: _____

4. Construction and Testing Summary:

(a) Actual Dimensions:

Diameter (inches)	Well Depth (feet)	Casing Depth (feet)

(b) Result of Initial Testing

5. Proposed Operating Data:

(a) Injection Rate (GPM);

(b) Description of injected waste; and,

(c) Injection pressure and pump controls.

6. Proposed Monitoring Plan (if any):

(a) Number of monitoring wells;

(b) Depth(s);

(c) Parameters;

(d) Frequency of sampling; and,

(e) Instrumentation (if applicable) Flow _____

Pressure _____

I. CLASS V WELLS PLUGGING AND ABANDONMENT PERMIT

1. Permit number of Class V construction or operating permit.

2. Type of well.

3. Proposed plugging procedures, plans and specifications.

4. Reasons for abandonment.

J. MONITOR WELL PERMIT

This section should be used only when application is made for a monitor well only. If a monitor well is to be constructed under a Class I, III, or V injection well construction permit, it is necessary to fill in this section.

1. A site map showing the location of the proposed monitor wells for which a permit is sought. The map must be to scale and show the number or name, and location of all producing wells, injection wells, abandoned wells, dry holes, water wells and other pertinent surface features including structures and roads.

2. Maps and cross sections indicating the general vertical and lateral limits within the area of review of all underground sources of drinking water, their position relative to the injection formation and the direction of water movement, where known, in each underground source of drinking water which may be affected by the proposed injection.

3. Maps and cross sections detailing the hydrology and geologic structures of the local area.

4. Generalized maps and cross sections illustrating the regional geologic setting.

5. Proposed formation testing program to obtain an anlysis of the chemical, physical and radiological characteristics of and other information on the monitor zone(s).

6. Proposed monitoring procedure.

7. Engineering drawings of the surface and subsurface construction details of the monitoring system.

8. Proposed monitoring data to be reported for meeting the monitoring requirements in Rule 62-528.425, F.A.C.

9. Construction procedures including a cementing and casing program, logging procedures, deviation checks, proposed methods for isolating drilling fluids from surficial aquifers, proposed blowout protection (if necessary), and a drilling, testing and coring program

10. Monitor Well Information:

☐ On-site ☐ Multizone ☐ Single-zone

☐ Regional ☐ Other (specify) _____

Proposed Monitoring Interval(s) _____

Distance and Direction From Associated Injection Well _____

_____

Standard Register ®

South Florida Water Management District
P.O. Box 24682 * West Palm Beach, Fl. 33416-4682

CHECK NO. **0243371**

PAYMENT VOUCHER	VENDOR INVOICE NO	VOUCHER DATE	DESCRIPTION	AMOUNT
V5=01000681	23514	05-09-01	PERMIT APP OKEE PILOT	750.00
			TOTAL	750.00

SRC 011 (REV 12/98)

PLEASE DETACH AND RETAIN THIS STATEMENT BEFORE DEPOSITING THE CHECK

VERIFY THE AUTHENTICITY OF THIS MULTI-TONE SECURITY DOCUMENT. CHECK BACKGROUND AREA CHANGES COLOR GRADUALLY FROM TOP TO BOTTOM.

ANTI-FRAUD PROTECTION - PATENTS 5,197,758; 5,340,159

South Florida Water Management District
P.O.Box 24682 * West Palm Beach, FL. 33416-4682
(561) 686-8800 * WATTS 1-800-432-2045

63-202
670

CHECK NO. **0243371**

SouthTrust Bank
Cape Coral, FL

PAY ONLY SEVEN 750 00 FIVE ZERO CTS CTS

DATE: 05-11-01

VOID AFTER 180 DAYS

PAY ■ SEVEN HUNDRED FIFTY DOLLARS AND 00 CENTS **********

CHECK AMOUNT
*********$750.00

TO THE ORDER OF
FL DEPT OF ENVIRON PROTECTION
400 N CONGRESS AVENUE
SE DISTRICT OFFICE
WEST PALM BEACH FL 33406

Nicolas J. Gutierrez
Stal E. Dubi

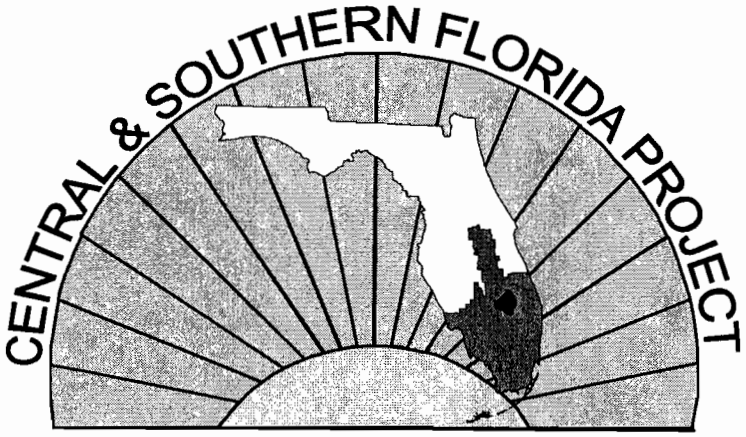
VOID OVER $750.00

⑈0243371⑈ ⑆067012028⑆ 64 052 631⑈

Supporting Information - Class V UIC Well Construction Permit Application

Exploratory Well near the S-77 Water Control Structure, Moore Haven, Florida

Lake Okeechobee Aquifer Storage and Recovery Pilot Project



Prepared By:

South Florida Water Management District
3301 Gun Club Road
West Palm Beach, Florida 33416

In Association With:

U.S. Army Corps of Engineers
Jacksonville District
Jacksonville, Florida

May 2001

Table of Contents

Tables

Figures

Executive Summary

The South Florida Water Management District (SFWMD) -- in association with the U.S. Army Corps of Engineers (USACE) -- is pleased to present this application for a Class V Underground Injection Control (UIC) exploratory well construction permit. The purpose of this application is to construct and test an exploratory well at the site of a proposed aquifer storage and recovery (ASR) facility associated with the Lake Okeechobee ASR Pilot Project – a component of the Comprehensive Everglades Restoration Plan (CERP). Pending the results of a source- and native-water quality characterization program, it is our intention to re-permit this exploratory well, in the future, as part of a functional ASR facility.

The site is located near the Town of Moore Haven, at the confluence of Lake Okeechobee and the Caloosahatchee River in eastern Glades County, Florida. In addition to the required permit application form (FDEP Form No. 62-528.900[1]), supporting information follows the format of *Item (G), Class V Well Construction Permit* as presented on the form. Supplementary information on regional and local hydrogeology, a construction and testing plan, and a plugging and abandonment plan is also provided herein.

Regional hydrogeologic data indicate that favorable conditions exist at the site for construction of ASR well(s) within the Floridan Aquifer System (FAS). Regional data indicates that upper portions of the FAS are brackish, with water quality containing a total dissolved solids (TDS) concentration ranging from 800 to 7,000 milligrams per liter (mg/L). The principal confining unit overlying the FAS is the Hawthorn Group, consisting of relatively impermeable clays that extend from approximately 120 to 800 feet below land surface (bls). These sediments impede upward migration of FAS water into the overlying Surficial Aquifer System (SAS), which extends from land surface to approximately 120 feet bls.

The exploratory well will be completed into permeable zones within the upper FAS. The proposed production zone extends from the base of the Hawthorn Group confining unit at approximately 800 feet bls to 1,600 feet bls. This zone has been correlated with formations of the upper FAS; namely, the Suwannee Limestone, Ocala Limestone, and Avon Park Formation. The actual production zone will be determined during the construction and testing of the exploratory well. The production zone – intended to serve as the future ASR interval -- will be based on several objectives and constraints including:

- Maximize the recharge and recovery pumping rates
- Maximize recovery efficiency
- Maximize upper confinement
- Maximize native water quality (e.g., interval with lower TDS)

- Minimize the depth of the well (i.e., higher costs with greater depth)

Some of these objectives are inter-related. For example, maximizing the recharge/recovery rate and maximizing the recovery efficiency are related. Upper confinement is preferred because it will tend to increase the recovery efficiency by preventing upward movement of stored water. The recovery efficiency is also related with the native water quality of the ASR interval. If the interval has a lower TDS concentration, then more water can be recovered before the water quality limit is achieved (resulting in higher recovery efficiency). The goal during the construction and testing of the exploratory/ASR well will be to evaluate each of these objectives, and install a cost-effective well that meets these objectives. Results from this and other exploratory/ASR wells will be used to refine the evaluation of future CERP ASR wells.

Introduction

The *Central and Southern Florida Project Comprehensive Review Study (Restudy, April 1999)* -- developed jointly by the South Florida Water Management District (SFWMD) and the U.S. Army Corps of Engineers (USACE) – presents a framework for Everglades restoration. Now known as the Comprehensive Everglades Restoration Plan (CERP), this plan contains 68 components, including structural and operational changes to the Central and Southern Florida Project (C&SF). One of these components is the Lake Okeechobee Aquifer Storage and Recovery (ASR) Project. At a planned buildout ASR capacity of 1 billion gallons per day (e.g., 200, 5-mgd wells), this component is designed to better manage Lake Okeechobee water levels, store water in ASR wells during wet periods and recover during dry periods, and minimize high-volume water releases to the St. Lucie and Caloosahatchee River estuaries.

Before initiating this large-scale ASR project, the CERP includes a Lake Okeechobee ASR Pilot Project. The purpose of the Lake Okeechobee ASR Pilot Project is to evaluate the technical and regulatory uncertainties of applying the ASR technology at the scale proposed in the CERP. The project concept is to store partially treated surface water from Lake Okeechobee and/or its tributaries into ASR wells completed into the underlying, confined, brackish Floridan Aquifer System (FAS) for subsequent recovery. Installation and testing of the exploratory/ASR well at Moore Haven – the subject of this permit application – is one of the first tasks to be completed for this project. Further details regarding the Lake Okeechobee ASR Pilot Project are contained in the Project Management Plan, available at the www.evergladesplan.org website.

The Lake Okeechobee ASR Pilot Project will be used to evaluate the effectiveness and limitations of ASR technology at the site. This information will be used to refine the long-term operational goals of these and other ASR wells around Lake Okeechobee, and provide insight for other ASR projects that may be constructed for similar purposes. Information to be collected and evaluated during construction and testing of the exploratory/ASR well includes:

- Lithologic and geophysical properties of potential storage intervals and confining layers
- Identification and evaluation of suitable ASR storage interval(s)
- Aquifer characteristics
- Limitations of recharge and recovery pumping rates
- Water quality of the upper FAS

Site Description

The site is located in the northwestern corner of Section 12, Township 42 South, Range 32 East, near the confluence of the Caloosahatchee River and Lake Okeechobee in the Town of Moore Haven, Florida. The site is located on a SFWMD-owned parcel of land adjacent to the S-77 spillway and lock, which conveys water to and from Lake Okeechobee's interior rim canal and the Caloosahatchee River. A location map for the site is presented in **Figure 1**. The proposed location of the exploratory well is shown in **Figure 2.**

The site was chosen based on several criteria considered important in the planning of an ASR system including:

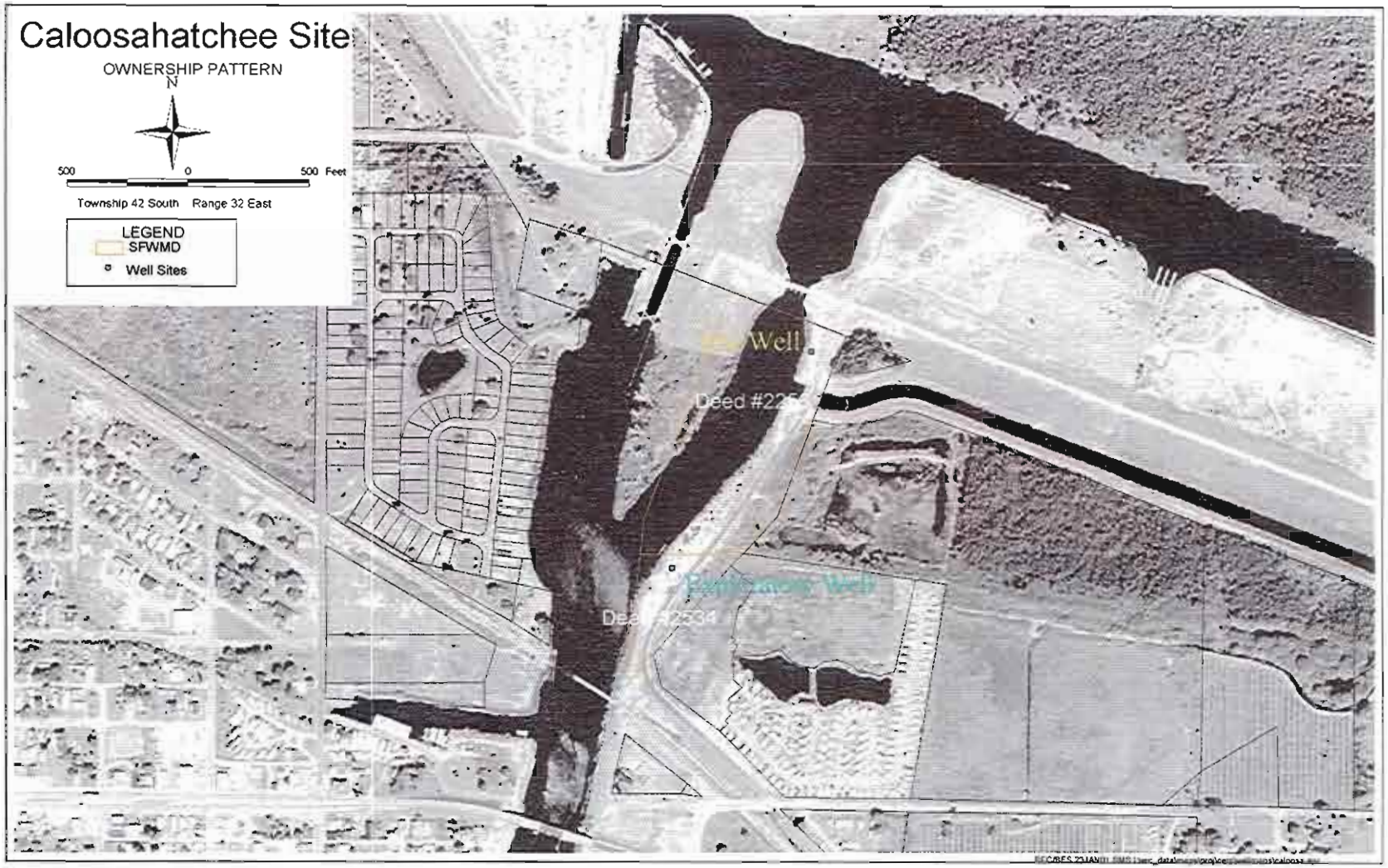
- Land is publicly owned (i.e., no time consuming or costly land acquisition procedures required)
- Site will ultimately provide operational flexibility to recharge or recover water from the Caloosahatchee River and/or Lake Okeechobee
- Site location –coupled with the other exploratory/ASR wells – will provide a broader geographic understanding of subsurface hydrogeology (**Figure 1**)
- Regional hydrogeologic data confirms the confined nature of the FAS, and the strong potential of the existence of permeable zones conducive to ASR implementation
- Proximity of the site to Lake Okeechobee's littoral zone, known to have relatively good water quality (i.e., low suspended solids)
- Site is adjacent to a body of water (Caloosahatchee River) that has flow, considered critical to comply with mixing-zone requirements during well discharge as required by an NPDES permit

Pilot Facility Description

The completed Lake Okeechobee ASR Pilot Project is anticipated to consist of the following components:

- Up to five (5) ASR wells completed into the upper FAS, each with an anticipated capacity of 5 mgd.
- Surficial Aquifer System (SAS) and FAS monitor wells at each site
- Pre-discharge water treatment facility (for water recovered from the ASR wells before discharge to surface-water bodies).
- Piping between ASR wells and discharge points
- Surface facilities (e.g., pumps, valves, electrical, instrumentation, etc.) to operate and monitor the system.

Figure 1. Location Map


Caloosahatchee Site
OWNERSHIP PATTERN
N
500
0
500 Feet
Township 42 South Range 32 East
LEGEND
SFWMD
Well Sites
Well
Deed #2534

Engineering and Hydrologic Data Required for Support of Application to Construct, Operate, and Abandon Class I, III, or V Injection Well Systems

Item (G) Class V Well Construction Permit

(1) Type and number of proposed Class V Wells:

The proposed exploratory well is classified as a Class V, Group 8 well under Chapter 62-528 Florida Administrative Code (FAC). This application is for one exploratory well completed into the Floridan Aquifer System (FAS). No injection is planned for the exploratory well; however, in accordance with 62-528.603(5)(a) FAC, we request the right to conduct limited injection testing with partially treated surface water should temporary treatment systems be available. Please note that responses to *(2) Project Description* questions below describe the proposed Lake Okeechobee ASR Pilot Project and are provided for information purposes only.

(2) Project Description:

a. Description and use of proposed injection system:

The proposed Lake Okeechobee ASR Pilot Project as currently envisioned consists of up to five (5) ASR wells. This application is for the construction of one exploratory/ASR well near the Town of Moore Haven, Florida. The project concept is to store partially treated surface water from the Caloosahatchee River and/or Lake Okeechobee via ASR wells. The exploratory/ASR well will be completed into the brackish, FAS. A location map for the site is presented in **Figure 1**. The proposed location of the exploratory/ASR well is shown in **Figure 2**.

b. Nature and volume of injected fluid:

The injected fluid will be partially treated surface water from the Caloosahatchee River and/or Lake Okeechobee. The surface water is of generally high quality, with all primary drinking water standards (DWS) parameters expected to be met except coliform bacteria. A sampling and analysis plan will be implemented in the next few months to better characterize surface-water quality at the site. The current project conceptualization is that the proposed exploratory/ASR well will be designed to pump 5 million gallons per day (mgd; 3,500 gallon per minute [gpm]).

c. Proposed pretreatment.

Water quality data from the surface water bodies -- proposed as the source water for the ASR systems -- will be reviewed to evaluate the type of pretreatment facilities that may be required. It is envisioned that at least some filtration will be required to minimize the potential for plugging of the aquifer during recharge (injection) due to algae, floating or suspended solids. Pilot testing will be conducted to identify a cost-effective treatment technology that meets project objectives. Again, no long-term injection is planned for the exploratory well; however, in accordance with 62-

528.603(5)(a) FAC, we request the right to conduct limited injection testing for surface facility design purposes, with partially treated water should temporary treatment systems be available.

(3) Water well contractor's name, title, state license number, address, phone number and signature.

A water well contractor has not been selected at this time. During the permit review process, procurement procedures will be initiated to select a qualified, Florida-licensed water-well contractor experienced in the construction of large-diameter wells completed into the FAS. The contractor's name and requested information will be submitted to FDEP upon selection and contract execution. The contract notice-to-proceed will not be issued until the Class V exploratory well permit has been received.

(4) Well Design and Construction Details.

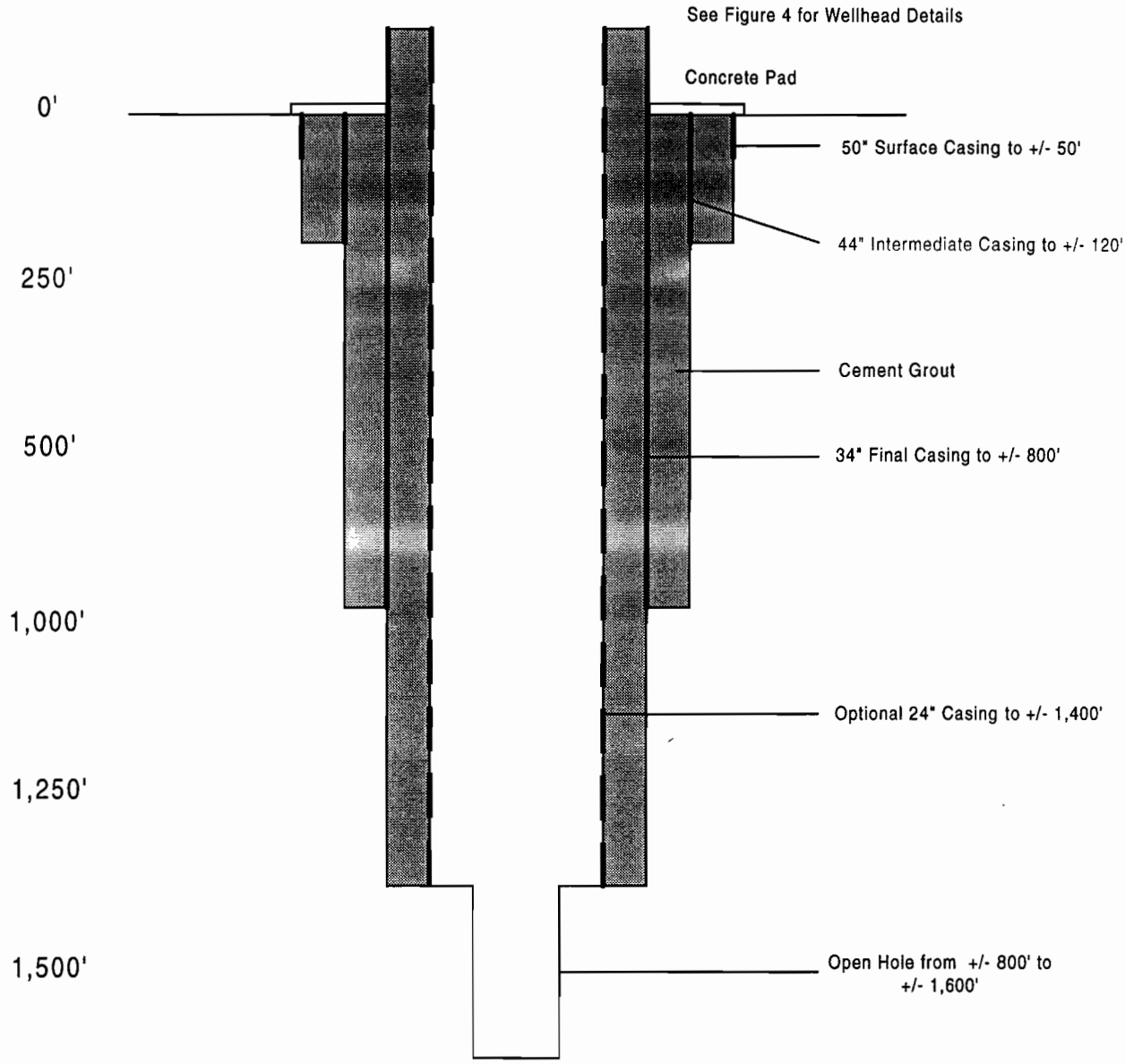
a. Proposed total depth:

The proposed total depth of the exploratory/ASR well is approximately 1,600 feet below land surface (bls). This depth may change based on field conditions, as well as on results of a test well program currently being implemented.

b. Proposed depth and type of casing(s):

The exploratory/ASR well will be constructed according to design and construction standards set forth in Chapter 62-528, FAC. The exploratory/ASR well will consist of concentric, steel casings (50-, 44-, 34-inch and 24-inch [optional] outside diameter) designed to isolate overlying aquifers and maintain confining unit integrity. Construction details of the exploratory/ASR well are provided in **Figure 3**, and a wellhead detail is provided in **Figure 4.** Except for the 50-inch surface casing, all casings will be fully cemented from bottom to land surface. The 44- and 34-inch casings will isolate the well from the SAS and from the overlying Hawthorn Group confining units. The 34-inch casing set to approximately 800 feet bls will isolate the upper FAS from the overlying Hawthorn Group confining units.

The casing diameters for the exploratory/ASR well are based on the flow characteristics of the proposed storage zone, and on the potential to drill, conduct geophysical logging, or perform other work inside the well. Based on the above specifications, a 34-inch-diameter, ½-inch wall thickness, seamless, carbon-steel casing was selected as the final casing for the ASR well. Note that if an additional casing within the FAS is required, provision has been made for a 24-inch-diameter casing as summarized in **Table 1** below.

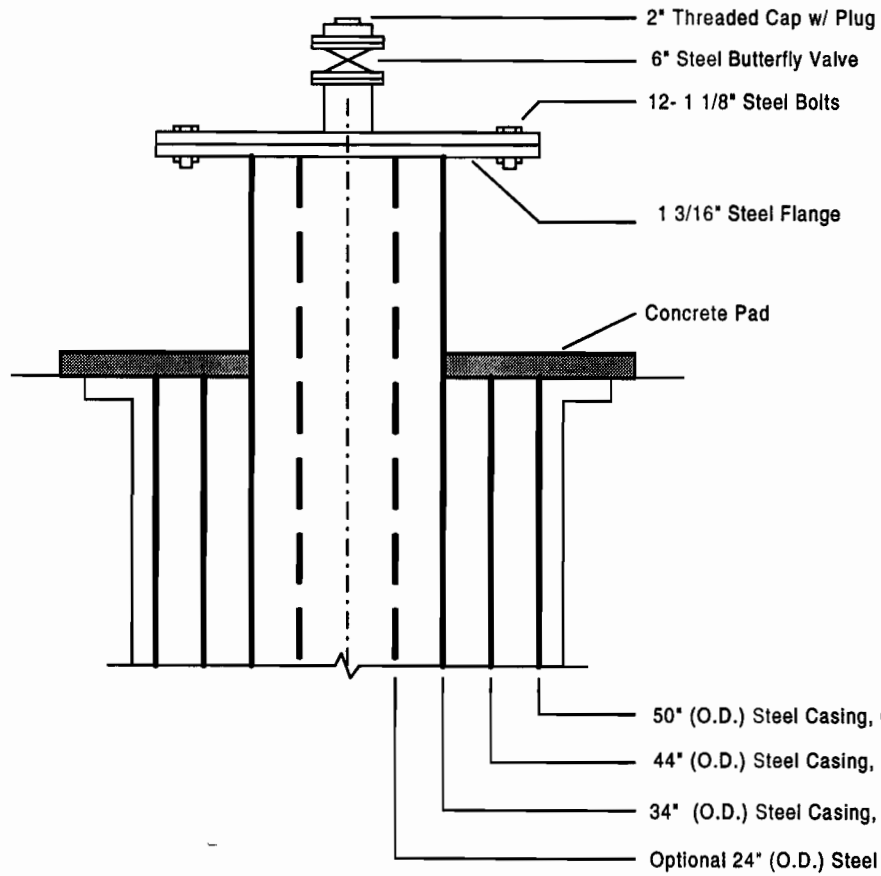


PAUL F LINTON
42637 5/18/01

South Florida Water Managment District
3301 Gun Club Road
West Palm Beach, Florida 33406

Town of Moore Haven
Exploratory ASR Well

Figure 3.
ASR Well Diagram



(Not to Scale)

PAUL F. LINTON
42637 5/19/01

South Florida Water Mamagement District
3301 Gun Club Road
West Palm Beach, Florida 33406

Town of Moore Haven
Exploratory ASR Well

Figure 4.
Wellhead Completion Drawing

Table 1
Summary of Proposed Casing Specifications for the Exploratory/ASR Well

Nominal Diam. (inches)	I.D. (inches)	O.D. (inches)	Wall Thickness (inches)	Material	Depth (feet)	Comments
50	49.50	50	0.250	Carbon Steel	40	Surface Casing
44	43.25	44	0.375	Carbon Steel	120	Isolate Surficial Aquifer System
34	33.00	34	0.500	Carbon Steel	800	Isolate Hawthorn Group Confinement
24	23.00	24	0.500	Carbon Steel	1,400	Optional Final Casing

Notes:
I.D. = Inside Diameter
O.D. = Outside Diameter
Depths are approximate.

Several alternatives regarding casing material have been evaluated. First, for the anticipated depth (800 to 1,400 feet) and required diameter (34 to 24 inches) of the final casing, PVC's properties make it susceptible to rupturing due to the heat of hydration generated by cement curing. Second, budgetary constraints preclude use of the more expensive FRP or stainless steel casing options, especially in light of the non-corrosive nature of surface water at the site. Carbon-steel casing (with a 1/2-inch wall thickness) and a neat-cement sheath in the annulus around this casing are believed to provide adequate corrosion protection for this well. This design has been used successfully at many ASR and deep injection well sites in South Florida.

c. Diameter of well:

The proposed diameter of the final cemented casing is 33 inches (inside diameter [I.D.]/34 inches outside diameter [O.D.]). Should an additional casing be needed – based on results of an ongoing test well program -- provision is made in the design to install a 23-inch I.D./24-inch O.D. casing inside the 34-inch casing.

d. Cement type, depth, and thickness:

The casings will be cemented from bottom to top with Portland Type II neat cement with varying quantities of bentonite as an additive. The lower 200 feet of each casing, at a minimum, will be cemented with neat cement. Above this depth, a bentonite-cement slurry will be pumped from bottom to land surface. The percentage of bentonite additives will be determined in the field based on the properties of the formations encountered; however, the concentration of bentonite will not exceed 8-percent. The nominal cement thickness (annular space between the outside of the casing and the borehole wall) for the final casing string will be 5 inches. For further details, please see the attached well construction drawing (**Figure 3**).

e. Injection pumps (if applicable):_____gpm @_____psi

Injection (recharge) and recovery pumps, piping, valves, flowmeters, pressure transducers, and other instrumentation will be a part of the permanent surface facilities of the proposed ASR system, though not part of the subject application for an exploratory/ASR well. In fact, installation and testing the exploratory/ASR well ahead of time will allow for more efficient surface-facility design given that the hydraulic characteristics of the storage zone will be known ahead of time. Upon completion of the construction and testing program, the wellhead will be sealed with a flanged coupling that will allow for later suppression of the artesian head and installation of the future ASR recovery pump and surface piping **(Figure 4).**

(5) Water Supply Wells

When required by Florida Administrative Code Rule 62-4.27, attach a map section showing the locations of all water supply wells within a one (1) mile radius of the proposed well. The well depths and casing diameters should be included. When required by Rule 62-4.27(2)(g), results of bacteriological examinations of water from all water supply wells within one (1) mile and drilled to approximate depth of proposed well should be attached.

Review of Water Use Permit files at the SFWMD, and the USGS and FGS well databases indicates that no public water supply wells exist within a one (1)-mile radius of the site.

(6) Area of Review (may be required at Department's discretion).

Include the proposed radius of the area of review with justification for that radius. Provide a map showing the location of the proposed injection well or wellfield area for which a permit is sought and the applicable area of review. Within the area of review, the map must show the number or name, and location of all producing wells, injection wells, abandoned wells, dry holes, surface bodies of water, springs, public water systems, mines (surface and subsurface), quarries, water wells, and other pertinent surface features including residences and roads. The map should also show faults, if known or suspected. Only information of public record and pertinent information known to the applicant is required to be included on this map.

A one-mile radius is considered appropriate for the area of review. This is justified by estimating the size of a hypothetical cylinder ("bubble") of fresh water that will be created within the upper FAS beneath the future ASR facility over time. This estimate uses a "plug flow" equation described in Warner and Lehr (1981). The equation variables are listed below:

- volume of injected water,
- aquifer porosity,
- storage-zone thickness, and

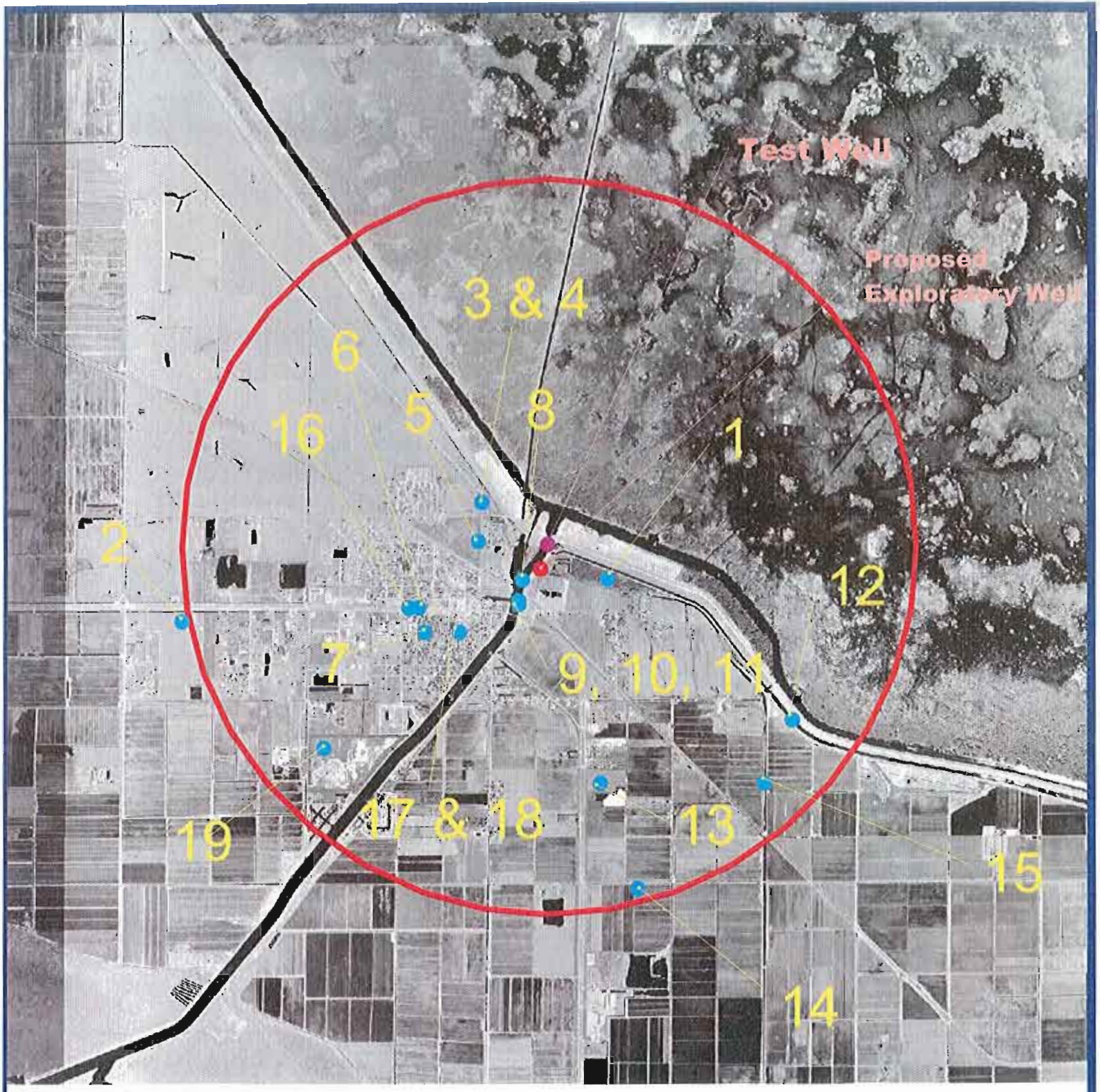
- aquifer dispersivity.

A scenario was conducted assuming a six-month period of injection at a rate of 5 mgd into a 100-foot-thick aquifer with an effective porosity of 25%. The equation yielded a radial distance (including the influence of dispersion) of 1,900 feet. A second scenario was conducted assuming continuous injection over a two-year period, and yielded a radial distance of 3,400 feet. The requested one-mile radius will conservatively encompass the computed cylinder sizes. As described in response to Item 5 above, no public water supply wells exist within a 1-mile radius of the site.

Figure 5 is a map showing cultural features and a more conservative two (2)-mile radius around the proposed exploratory well. A summary of wells located within the 2-mile radius is provided in **Table 2.** Two water use permit holders were identified within the subject area of review, but both use the surficial aquifer system for irrigation purposes only. The remaining wells are monitor wells, with four exceptions. One is the FAS test well currently under construction. Second and third are Wells W-5406 and W-5436, two test wells drilled by Coastal Petroleum. Fourth, an existing FAS test well was installed by SFWMD in themid-1990s to the upper FAS.

Supplementary Information

In addition to the information requested in *Item G., Class V Well Construction Permit* of the Permit Application Form, SFWMD has assembled additional information to assist the reviewer in evaluating the proposed exploratory/ASR well. This information includes a description of regional and local hydrogeology (Appendix A), a construction and testing plan (Appendix B), and a plugging and abandonment plan (Appendix C).



Legend

- Proposed Caloosahatchee exploratory well
- Two-mile radius around proposed exploratory well
- Test well
- Wells within two miles of proposed exploratory well
- Well ID on Table 2

N

Scale

0.5 0 0.5 1 Miles

Figure 5. Wells within a two-mile radius of the proposed exploratory well.

Table 2. Wells within two miles of the proposed Caloosahatchee ASR exploratory well.

Well #	Well Name	Owner	Well Use	Permit Number	Latitude	Longitude	X	Y
1	ALVIN WARD BOAT RAMP FACILITY	ALVIN WARD BOAT RAMP FACILITY	Potable water use*	22-00220-W	265008	810450	629982	909556
2	J.J. WIGGINS YOUTH CENTER	J.J. WIGGINS YOUTH CENTER	Irrigation	22-00229-W	264956	810705	617741	908330
3	GL - 212	City of Moore Haven	Monitoring	NA	265030	810530	626345.0654	911750.9661
4	GL - 212A	City of Moore Haven	Monitoring	NA	265030	810530	626345.0654	911750.9661
5	GL - 213	USGS Monitoring Well	Monitoring	NA	265019	810531	626253.6818	910640.3869
6	GL - 2	USGS Monitoring Well	Monitoring	NA	265000	810550	624531.1793	908723.2863
7	GS - 28	USGS Monitoring Well	Monitoring	NA	264953	810548	624711.8102	908016.3744
8	GL - 209	USGS Monitoring Well	Monitoring	NA	265008	810517	627521.039	909528.8415
9	WATER PLANT HOOVE HAVEN	USGS Monitoring Well	Monitoring	NA	265001	810518	627429.9636	908822.1312
10	PUBLIC SUPPLY MOORE HAVEN	USGS Monitoring Well	Monitoring	NA	265002	810518	627430.034	908923.0988
11	WELL AT MOORE HAVEN FL	USGS Monitoring Well	Monitoring	NA	265002	810518	627430.034	908923.0988
12	GL - 221	USGS Monitoring Well	Monitoring	NA	264928	810351	635309.1348	905485.4588
13	S -1224	USGS Monitoring Well	Monitoring	NA	264910	810452	629781.8695	903671.2137
14	S -1225	USGS Monitoring Well	Monitoring	NA	264840	810440	630867.1628	900641.5125
15	W-5406	Coastal Petroleum (MH#3)	NA	NA	264910	810400	634492.853	903668.467
16	W-5436	Coastal Petroleum (MH#13)	NA	NA	265000	810553	624259.425	908723.496
17	W-12355	City of Moore Haven	Monitoring	NA	264953	810537	625708.26	908015.626
18	W-12373	City of Moore Haven	Monitoring	NA	264953	810537	625708.26	908015.626
19	W-17091/MH-1	South Florida Water Management District	Monitoring	NA	264920	810620	621810.274	904686.758

*Potable water use for restroom facility at boat ramp.
NA - Not available

Well #	Well Name	Total Depth (ft)	Cased Depth (ft)	Diameter (in)	Aquifer	Pump Type	Intake Depth (ft)	Database
1	ALVIN WARD BOAT RAMP FACILITY	40.00	25.00	NA	Surficial Aquifer System	NA	Pump	SFWMD
2	J.J. WIGGINS YOUTH CENTER	100.00	70.00	NA	Surficial Aquifer System	NA	Pump	SFWMD
3	GL - 212	85	NA	6	Surficial Aquifer System	NA	NA	USGS
4	GL - 212A	85	NA	6	Surficial Aquifer System	NA	NA	USGS
5	GL - 213	NA	NA	NA	NA	NA	NA	USGS
6	GL - 2	NA	NA	NA	NA	NA	NA	USGS
7	GS - 28	NA	NA	NA	NA	NA	NA	USGS
8	GL - 209	NA	NA	NA	NA	NA	NA	USGS
9	WATER PLANT HOOVE HAVEN	NA	NA	NA	NA	NA	NA	USGS
10	PUBLIC SUPPLY MOORE HAVEN	NA	NA	NA	NA	NA	NA	USGS
11	WELL AT MOORE HAVEN FL	NA	NA	NA	NA	NA	NA	USGS
12	GL - 221	NA	NA	NA	NA	NA	NA	USGS
13	S -1224	NA	NA	NA	NA	NA	NA	USGS
14	S -1225	NA	NA	NA	NA	NA	NA	USGS
15	W-5406	1000	NA	NA	Floridan Aquifer	NA	NA	FGS
16	W-5436	1010	NA	NA	Floridan Aquifer	NA	NA	FGS
17	W-12355	106	NA	NA	Surficial Aquifer System	NA	NA	FGS
18	W-12373	106	NA	NA	Surficial Aquifer System	NA	NA	FGS
19	W-17091/MH-1	710	660.00	4	Floridan Aquifer	NA	NA	FGS

*Potable water use for restroom facility at boat ramp.
NA - Not available.

Appendix A

GEOLOGY and HYDROGEOLOGY

Regional Geology

South Florida is underlain by Cenozoic-age rocks to a depth of approximately 5,000 feet below land surface (bls) -- comprised primarily of sand, limestone, clay and dolomite (Meyer, 1989). Within this province, Lake Okeechobee lies in a relatively stable structural area, represented by generally flat-lying sediments that accumulated in a quiet marginal-marine setting, similar to the modern-day Bahamas. Numerous wells have been constructed and tested to depths of up to approximately 3,500 feet bls in the general vicinity of the Lake, providing an accurate representation of the geology and hydrogeology of the area.

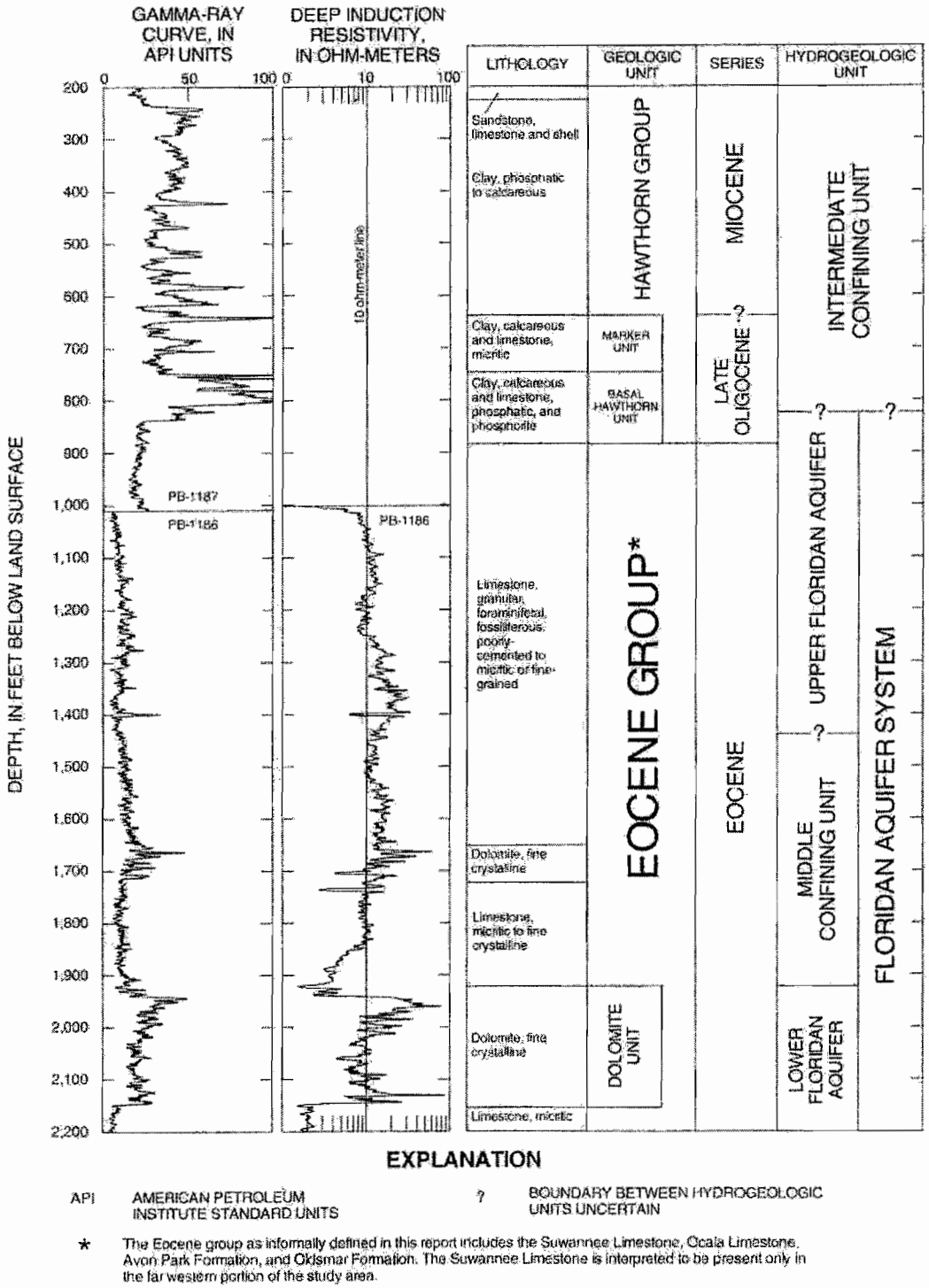
Soils and Plio-Pleistocene Series

From land surface to a depth of up to 10 feet bls, soils in the northern vicinity of the Lake are characterized as poorly drained, sandy "spodosols", currently used for pastures, citrus, and urban development. To the south of the Lake are organic-rich mucky soils underlain by marl, referred to as "histosols". These soils are currently used for sugar cane, sod and pasture.

Below the surficial soils, Plio-Pleistocene-aged sand, sandstone, clay and shells are present to a depth of approximately 200 feet bls. These sediments are representative of the Caloosahatchee, Tamiami, and the Fort Thompson Formations. These formations were deposited from between one to five million years ago.

Miocene Series

The Plio-Pleistocene sediments unconformably overly the dense, phosphatic clays and limey silts of the Miocene-aged Hawthorn Group. The Hawthorn Group sediments are encountered between 200 and 900 feet bls. **Figure A-1** presents a summary of the lithology penetrated from an injection well at the nearby City of Belle Glade wastewater treatment plant as presented in Reese and Memberg, (2000). Near the base of the Hawthorn Group, the limestone and phosphate content of these sediments increase, causing the gamma ray log to record high counts through this interval. This has resulted in the creation of distinctive "marker beds" that are geophysically correlatable throughout the vicinity of the Lake.



Source: Reese, R.S. and Memberg, S.J. 2000. Hydrogeology and the Distribution of Salinity in the Floridan Aquifer System, Palm Beach County, Florida. United States Geological Survey Water Resources Investigations Report 99-4061.

Figure A-1. Hydrogeologic Data from the City of Belle Glade Injection Well.

Oligocene Series

Lying below the Hawthorn Group sediments is the Suwannee Limestone of Oligocene age. It is described by Johnson (1984) as a "white to tan, pure to slightly argillaceous and arenaceous, coquinoid to chalky limestone, with some dolostone and dolomitic limestone present." It is regionally extensive and can attain a thickness ranging from 120 to 300 feet in south Florida (Miller, 1986). A phosphatic zone in the lower portion of this formation shows high natural radioactivity on a gamma log.

Eocene Series

Lying below the Suwannee Limestone at a depth of approximately 800 feet bls are the Eocene-aged Ocala Limestone and Avon Park Limestone. For purposes of this discussion, these formations are undifferentiated, although the Ocala Limestone is typically recognized as present within the uppermost 200 feet of the combined section. These formations are characterized by pale orange to brown-colored, poorly cemented granular limestone. The formations are also occasionally micritic and contain dolomite zones. The fossil content is not significant, although foraminifera and red algae debris is commonly observed. These formations are present to a depth of approximately 1,900 feet bls.

Lying below the Ocala and Avon Park Formations is the Oldsmar Formation. This formation contains significant quantities of hard, yellowish-brown finely crystalline dolomite. This formation is present to depths of nearly 3,500 feet bls.

Regional Hydrogeology

The hydrogeology in most of South Florida consists of a non-artesian shallow aquifer separated from a deeper artesian aquifer by several hundred feet of confining strata. The non-artesian shallow aquifer, generally known as the Surficial Aquifer System (SAS), is approximately 120 feet thick at the site. According to Klein and others (1964), "the shallow sediments in Glades County generally have low to moderate permeability. Thus, most large capacity wells penetrate the Floridan aquifer even though the quality of the water is usually poorer." The Pliocene Tamiami Formation generally forms the base of the SAS.

An Intermediate Confining System underlies the SAS, and is comprised of Hawthorn Group sediments. Confinement is provided by clays and marls that exhibit very low permeabilities, and isolate the SAS from the underlying Floridan Aquifer System (FAS). These Miocene-age confining beds are expected to occur at the site between approximately 120 and 800 feet below land surface (bls).
The FAS can generally be subdivided into several permeable zones, separated by low-permeability limestones. It is composed of limestone and dolostone beds generally dipping to the east and south, and contains brackish to saline water. The

permeable zones within the FAS are regionally grouped into upper and lower units, separated by a middle confining unit. These units are informally designated "upper Floridan Aquifer", "middle Confining Unit", and "lower Floridan Aquifer". The ASR storage interval will be in the upper Floridan Aquifer, based on existing information.

Upper Floridan Aquifer

The upper Floridan Aquifer consists of Oligocene to middle-Eocene formations, including the Suwannee (where present) and Ocala Limestones and the Avon Park Formation. Two predominant permeable zones exist within the upper Floridan Aquifer. The uppermost permeable zone typically lies between 700 and 1,200 feet bls. The most transmissive part of this upper permeable zone usually occurs near the top, coincident with an unconformity at the top of Eocene formations. A second permeable interval has been documented within the Avon Park Formation, ranging in approximate depth from 1,400 to 1,800 feet bls. The base of the upper Floridan Aquifer is located within the Avon Park Formation.

The transmissivity of the upper portions of the FAS in South Florida ranges from about 75,000 to 450,000 gallons per day per foot (gpd/ft; Bush and Johnston, 1988). Some of this variability may be due to variation in the thickness of the interval tested, as well as varying hydraulic properties. Bush and Johnston (1988) provide a range for the storage coefficient for the upper Floridan Aquifer from 1.0×10^{-5} to 2.0×10^{-2}, with the most common values in the range of 10^{-3} to 10^{-4}.

Middle Floridan Aquifer Confining Unit

Upper portions of the Oldsmar Formation and lower portions of the Avon Park Formation (Lake City Limestone) may be considered part of the confining interval between the upper and lower portions of the FAS. This confining sequence -- referred to as the middle Confining Unit -- is expected to occur between 1,800 and 2,100 feet bls. Miller (1986) reports that few differences exist in the lithologies between the middle Confining Unit and the permeable units above and below.

Lower Floridan Aquifer

The lower Floridan Aquifer may also contain several permeable and less permeable zones. Three dolostone layers have been identified by Meyer (1989) within the Oldsmar Formation separated by less permeable limestone layers. Meyer (1989) reported hydraulic connection between the lower and intermediate dolostone layers, but a weak connection between the upper and intermediate layers. The lowest permeable zone is a solution-worked fracture and cavernous interval that occurs in the Oldsmar Formation, and is also known as the "Boulder Zone". The Boulder Zone typically occurs at an estimated depth of 2,500 feet bls, extending to an approximate depth of 3,500 feet bls.

Local Geology and Hydrogeology

A location map of FAS wells used to construct hydrogeologic cross sections is provided as **Figures A-2**. These hydrogeologic cross sections are presented in **Figure A-3** (south to north) and **Figure A-4** (west-to-east), respectively.

Figures A-3 and **A-4** indicate that the regional hydrogeologic formations described above are present beneath the site, and are relatively flat and undisturbed. In general, the top of the FAS follows regional dip of the formations from north to south– a common observation in South Florida. A large gamma peak (interpreted to be the base of the Hawthorn Group) appears to become deeper in the Moore Haven area, but is progressively shallower away from the site.

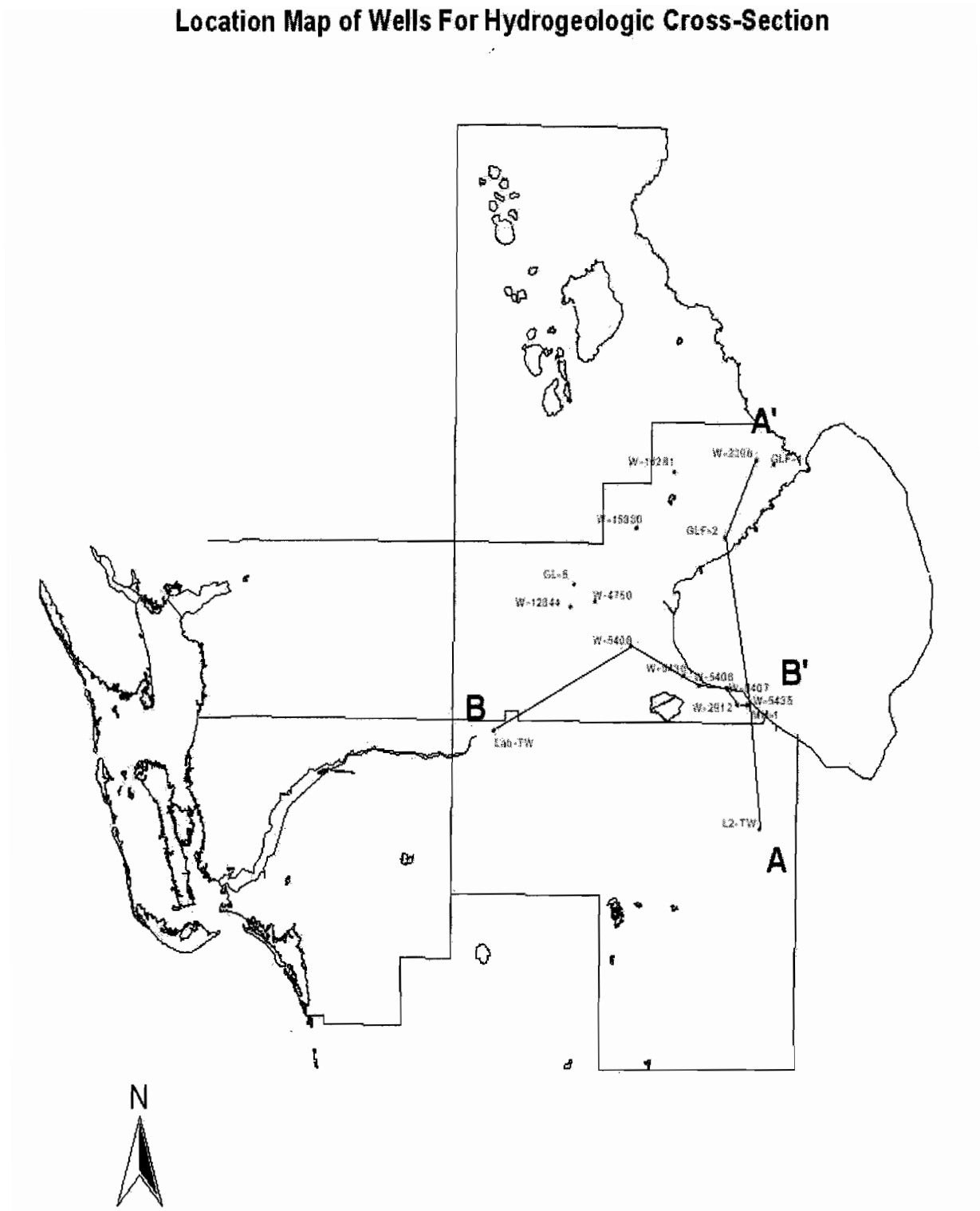
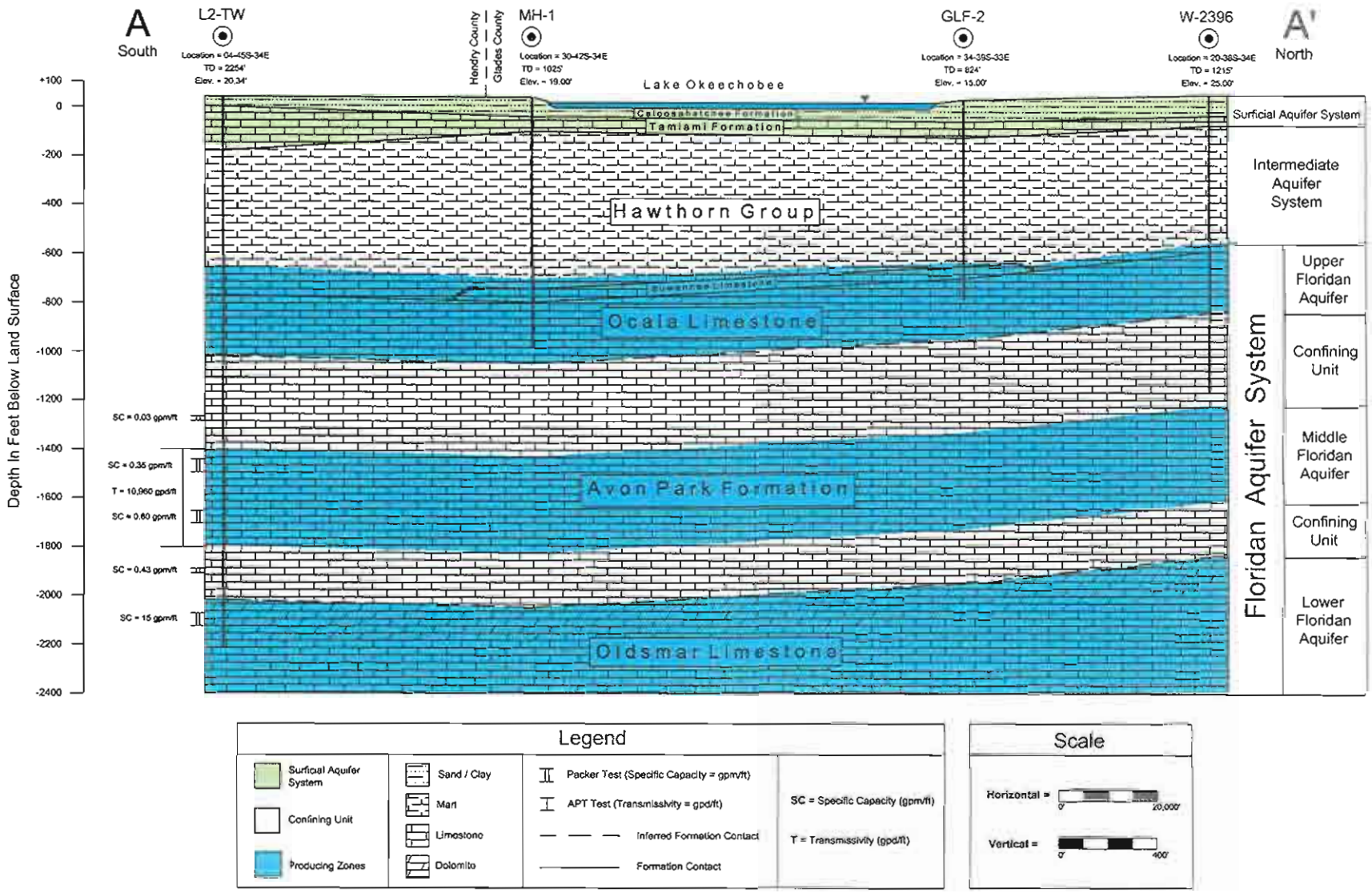


Figure A-2. Location Map showing Wells Used to Develop Hydrogeologic Cross Sections

Hydrogeologic Cross-section from A-A' for Construction of ASR Wells



Legend

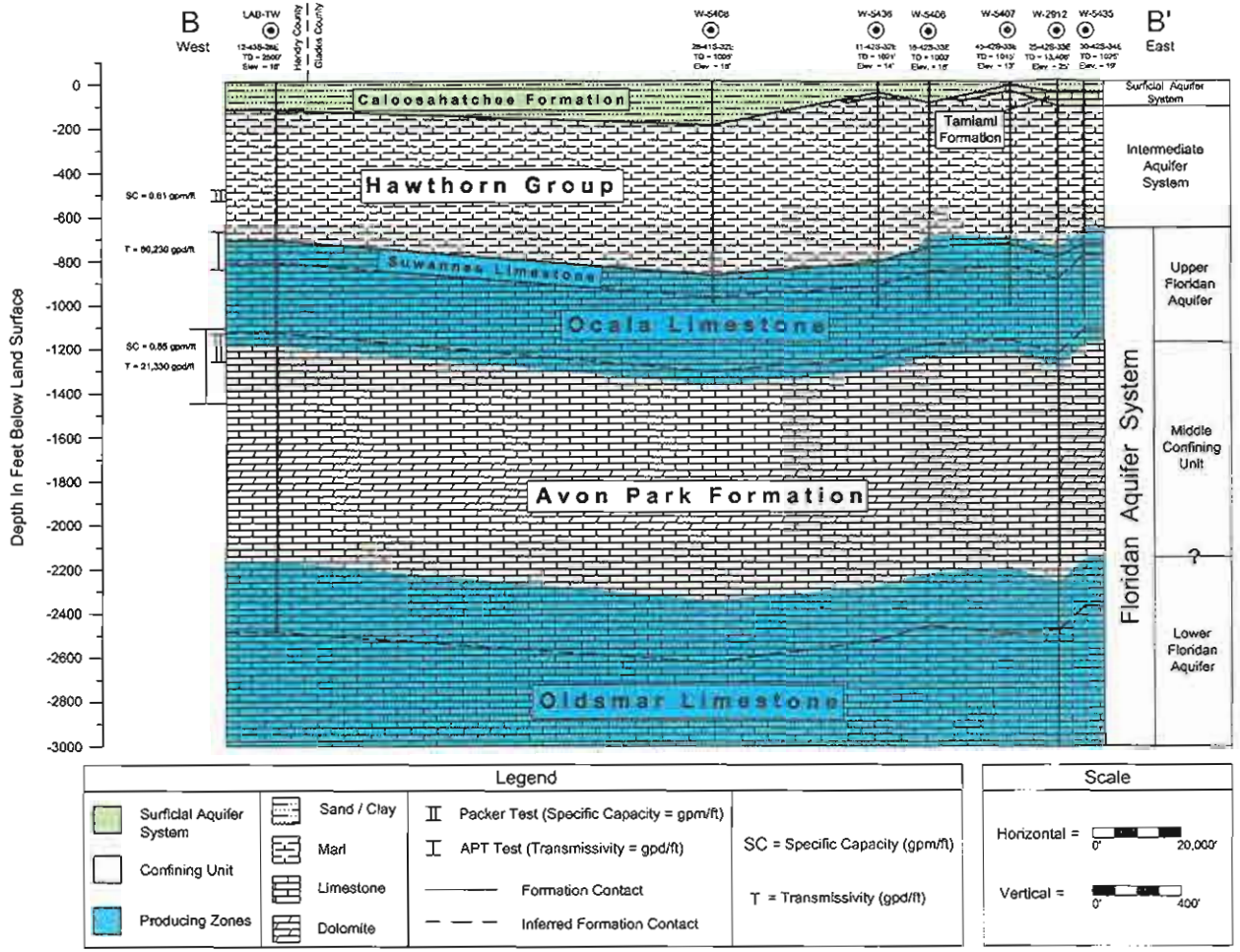
- Surficial Aquifer System
- Confining Unit
- Producing Zones
- Sand / Clay
- Marl
- Limestone
- Dolomite
- Packer Test (Specific Capacity = gpm/ft)
- APT Test (Transmissivity = gpd/ft)
- Inferred Formation Contact
- Formation Contact
- SC = Specific Capacity (gpm/ft)
- T = Transmissivity (gpd/ft)

Scale

Horizontal = 0' 20,000'

Vertical = 0' 400'

Hydrogeologic Cross-section from B-B' for Construction of ASR Wells



The SAS extends from land surface to an approximate depth of 120 feet bls. The Hawthorn Group confining unit extends from 120 to 800 feet bls at the site. The upper Floridan aquifer appears to extend from 800 to 1,800 feet bls. The Middle Confining Unit is estimated to extend from 1,800 to 2,100 feet bls. The Lower Floridan aquifer was not penetrated by any of the wells used to develop the cross sections.

Water Quality in the Upper Floridan Aquifer System

Wells penetrating the upper Floridan aquifer (near a depth of 800 feet bls) in the vicinity of the Lake have yielded information regarding the quality of water contained within the strata. Most wells produce water containing a chloride concentration of between 500 milligrams per liter (mg/L) and 2,000 mg/L. The total dissolved solids (TDS) concentration ranges between 500 and 7,000 mg/L. **Figure A-5** is map indicating TDS concentrations of select FAS wells near the Lake. Hardness and sulfate concentrations, respectively are approximately 180 mg/L and 250 mg/L (SFWMD, 1984).

Wells completed near the base of the upper Floridan aquifer produce water with a chloride concentration of approximately 2,000 to 5,000 mg/L and a TDS concentration of approximately 4,000 to 8,000 mg/L. The base of the Underground Source of Drinking Water (USDW) -- as defined by FDEP as an aquifer with a TDS concentration of less than 10,000 mg/L -- is estimated to range from 1,900 to 2,100 feet bls, based on data from the L-2 Canal FAS monitor well (L2-TW; *SFWMD Lower West Coast Water Supply Plan, April 2000*). Below this depth, the water quality (within the lower Floridan aquifer at a depth of 2,070 feet bls) is very similar in composition to seawater.

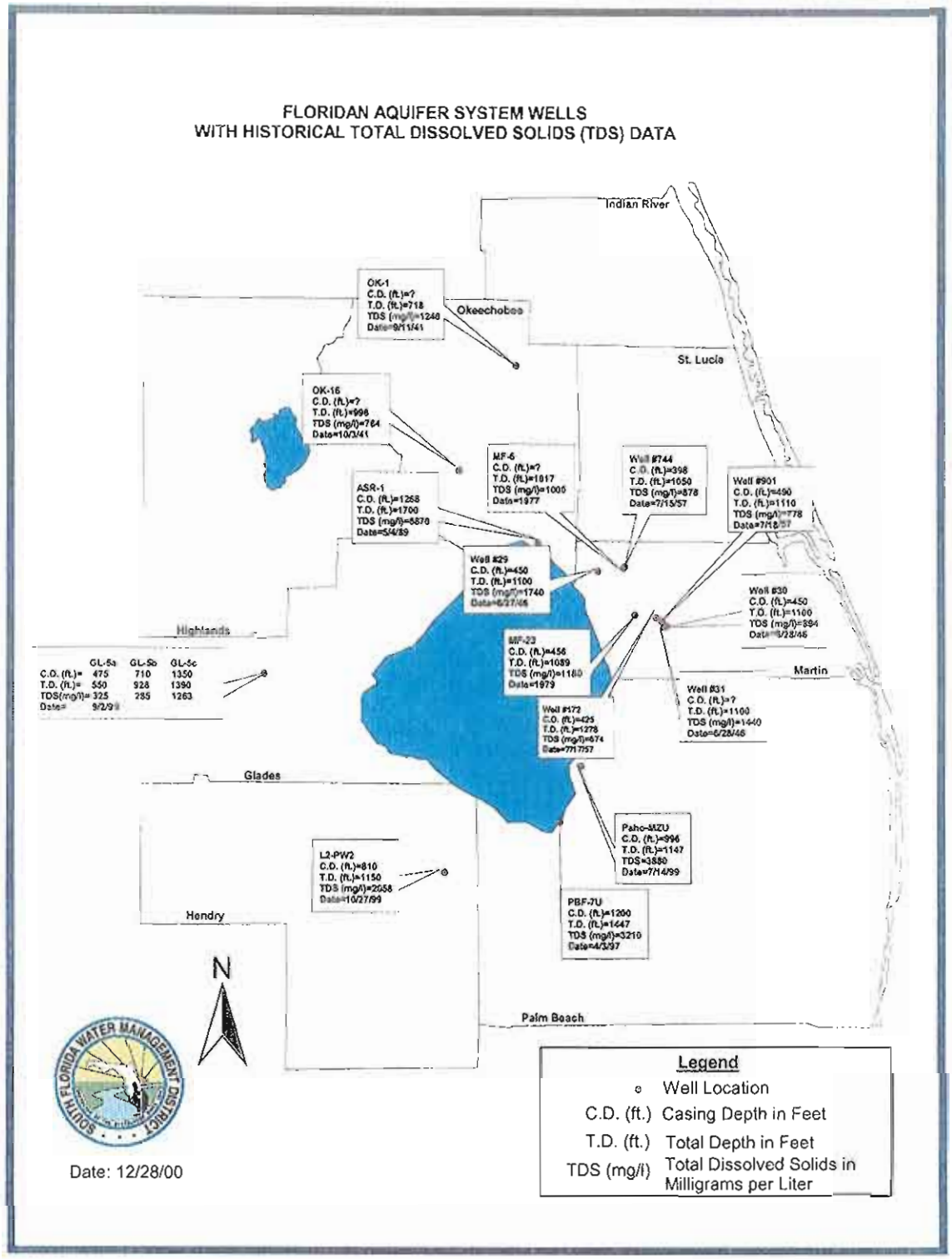


Figure A-5 Historical Water Quality Data From Select Floridan Aquifer System Wells Near Lake Okeechobee

Appendix B

Construction and Testing Plan

General

The exploratory/ASR well will be constructed by advancing the borehole with a pilot hole, conducting geophysical logging, reaming the pilot hole, installing casing, and progressing until total depth of the well is reached. Testing will occur throughout the drilling process, as summarized in **Table B-1**.

Table B-1 – Summary of Testing During Exploratory/ASR Well Construction

Test/Log/Sample	Description
Formation Samples:	
Cuttings	Pilot hole, every 5 feet
Conventional Cores	Collected from the Floridan Aquifer (and Hawthorn Group or Surficial Aquifer, if warranted)
Geophysical Logs:	
Caliper	Pilot and reamed boreholes, cementing, APT
Natural gamma	Pilot and reamed holes, cementing, APT
Spectral gamma	Pilot hole
Spontaneous potential	Pilot hole
Fluid resistivity	Pilot hole, APT
Temperature	Pilot holes, cementing, APT
Borehole-Compensated Sonic	Pilot holes
Dual induction	Pilot holes
Compensated-Density Neutron	Pilot holes
Cement bond	Final casing
Digital Borehole Televiewer	Pilot hole
Video	Pilot hole and Final well
Flowmeter	Pilot hole and/or during specific capacity test or APT
Pumping Tests:	
Packer tests	Zones within the Floridan Aquifer (and Hawthorn Group, if warranted)
Specific capacity tests	Yield of the ASR storage zone
APT	Characteristics of the ASR storage/monitor zone
Water Quality Sampling:	
During drilling	Sample during reverse-air drilling (if conducted)
Packer tests	Major ions and TDS for each interval
Storage zone	Background analysis of ASR zone (see **Table B-3**)
Mechanical Integrity Test:	
Casing pressure test	Test mechanical integrity of the well's final casing
Note: APT = Aquifer Performance Test	

Sequence

The proposed sequence for the drilling and testing program for the exploratory/ASR well is described below.

1. Install temporary, lined pad around well site prior to drill rig set up in accordance with Section *Temporary Drilling Pad.* Install pad monitor wells (PMWs) at four corners of pad. SFWMD staff to sample PMWs weekly during construction and analyze for specific conductivity, chlorides, and temperature. Set up drill rig, shale shaker, aboveground tanks, and appurtenances in accordance with Section *Drilling Procedures.*

2. Install by driving, drilling, or vibrating a minimum 50-inch-diameter surface casing to an approximate depth of 40 feet below land surface (bls); cement the annulus back to land surface if drilled.

3. Drill a 9-7/8-inch-diameter pilot hole with mud circulation to a depth of approximately 120 feet bls (the base of the Surficial Aquifer System). Conduct geophysical logging in accordance with Section *Geophysical Logging Program* and Table B-1, Schedule of Geophysical Logs).

4. Ream pilot hole to a nominal 50 inches, conduct caliper/gamma log, and install 44-inch-diameter steel casing to a depth of approximately 120 feet bls. Cement casing annulus to land surface in stages (primary stage with pressure-grout techniques) in accordance with Section *Casing Grout Program.*

5. Install and maintain blowout preventer (BOP). Resume drilling the 9-7/8-inch-diameter pilot hole with mud circulation from 120 to 800 feet bls. Conduct deviation surveys at 90-foot intervals during pilot- and reamed-hole drilling. Conduct pilot-hole logging in accordance with Section *Geophysical Logging Program.*

6. Ream pilot hole to a nominal 44 inches, conduct caliper/gamma log, and install 34-inch-diameter carbon steel casing to a depth of approximately 800 feet bls. Cement the casing annulus to land surface in stages (primary stage with pressure-grout techniques). Conduct temperature and gamma logs within casing to track height achieved by each stage of cement.

7. Install temporary, inflatable packer if necessary (or use cement plug at base of casing) to conduct 1-hour casing pressure test at approximately 100 psi for mechanical integrity testing of 34-inch casing in accordance with Section *Mechanical Integrity Testing.* Remove packer when complete.

8. Install and maintain blowout preventer (BOP). Resume drilling the 9-7/8-inch-diameter pilot hole with reverse-air circulation from 800 to 1,600 feet bls. Conduct deviation surveys at 90-foot intervals during pilot- and reamed-hole drilling. Conduct geophysical logging on borehole in accordance with Section *Geophysical Logging Program.*

9. Ream pilot hole to a nominal 34 inches in stages and conduct interval tests in accordance with Section *Interval Tests*.

10. If necessary, install 24-inch-diameter carbon steel casing to a depth of approximately 1,400 feet bls. Temporarily back-fill borehole with 3/8-inch diameter crushed limestone. Cement the casing annulus to land surface in stages (primary stage with pressure-grout techniques). Conduct temperature and gamma logs within casing to track height achieved by each stage of cement.

11. If Item 10 (24-inch casing) is installed, install temporary, inflatable packer if necessary (or use cement plug at base of casing) to conduct 1-hour casing pressure test at approximately 100 psi for mechanical integrity testing of final (24-inch) casing in accordance with Section *Mechanical Integrity Testing*. Remove packer when complete.

12. Conduct preliminary specific capacity tests at approximately three (3) pumping rates (2,000, 3,500 and 4,000 gpm) in accordance with Section *Specific Capacity Test*. Measure water levels in well for each pumping rate.

13. Conduct acidization of the open borehole (if necessary) with up to 5,000 gallons of hydrochloric acid in accordance with Section *Acidization*.

14. Conduct long-term (72-hour) aquifer performance test (APT) of the exploratory/ASR well, measuring background, drawdown, and water level recovery data in accordance with Section *Aquifer Performance Test*. Obtain background water quality samples in accordance with Section *Water Quality Testing*.

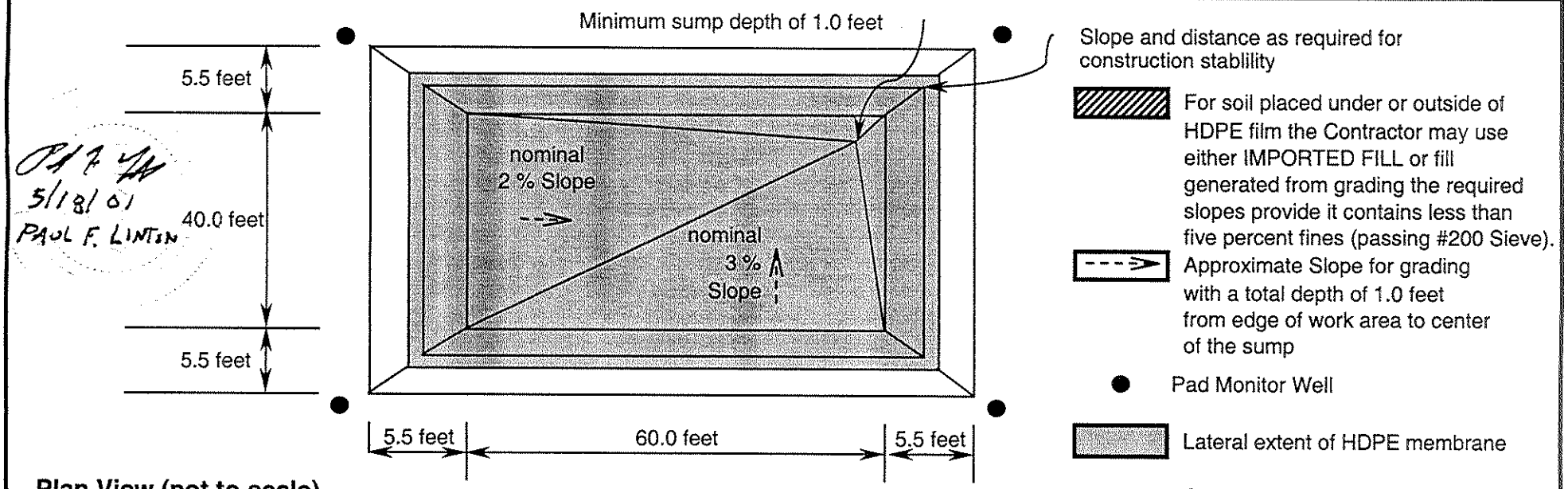
15. Conduct cement-bond log and video survey of completed well.

16. Complete wellhead, remove temporary pad, clean site, and demobilize.

Temporary Drilling Pad

A high-density polyethylene (HDPE)-lined membrane with bermed sides will be set up at the exploratory/ASR well site to contain drilling fluids that might leave the temporary mud tank. **Figure B-1** presents the design of the temporary drilling pad. This containment design has been successfully used in the construction of other FAS wells by SFWMD.

We propose to install four (4) pad monitor wells (PMWs) and that they be placed at the corners of the temporary drilling pads prior to construction of the exploratory/ASR well. **Figure B-2** is a proposed construction detail for a typical PMW. We propose to sample the PMWs weekly during exploratory/ASR well construction and analyze for chlorides, conductivity, and temperature. After well construction is complete, we propose to abandon these PMWs by placing neat cement grout from the well's total depth to land surface.



Slope and distance as required for construction stablility

For soil placed under or outside of HDPE film the Contractor may use either IMPORTED FILL or fill generated from grading the required slopes provide it contains less than five percent fines (passing #200 Sieve).

Approximate Slope for grading with a total depth of 1.0 feet from edge of work area to center of the sump

Pad Monitor Well

Lateral extent of HDPE membrane

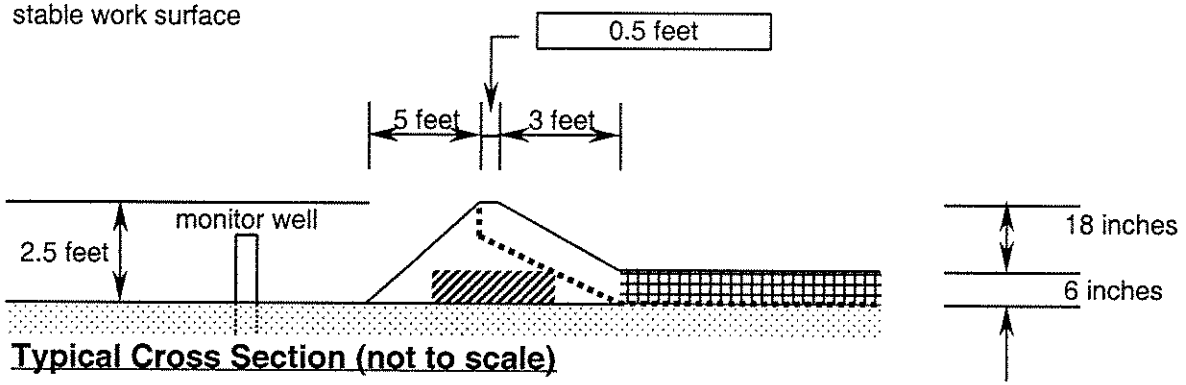
Cross-laminated HDPE membrane with a minimum thickness of 4 mil with a minimum overlap of 5 feet.

Existing soils stripped of organics and graded as shown.

IMPORTED FILL: fill meeting the physical properties and size requirements of Aggregate Size Number 57 of the FDOT Standard Specifications for Road and Bridge Construction with a thickness of at least 6 inches. or a well graded fill with less than 5 percent passing the No 10 sieve.

Plan View (not to scale)

Compact all placed or disturbed fill as required to achieve a stable work surface



Typical Cross Section (not to scale)

Note: the intent of this design is to provide a working pad with underlying membrane to capture and contain fluids generated during drilling and testing as a reasonable good house keeping measure.

Figure No. B-1

Lake Okeechobee Exploratory Well Containment Pad and Membrane
SFWMD

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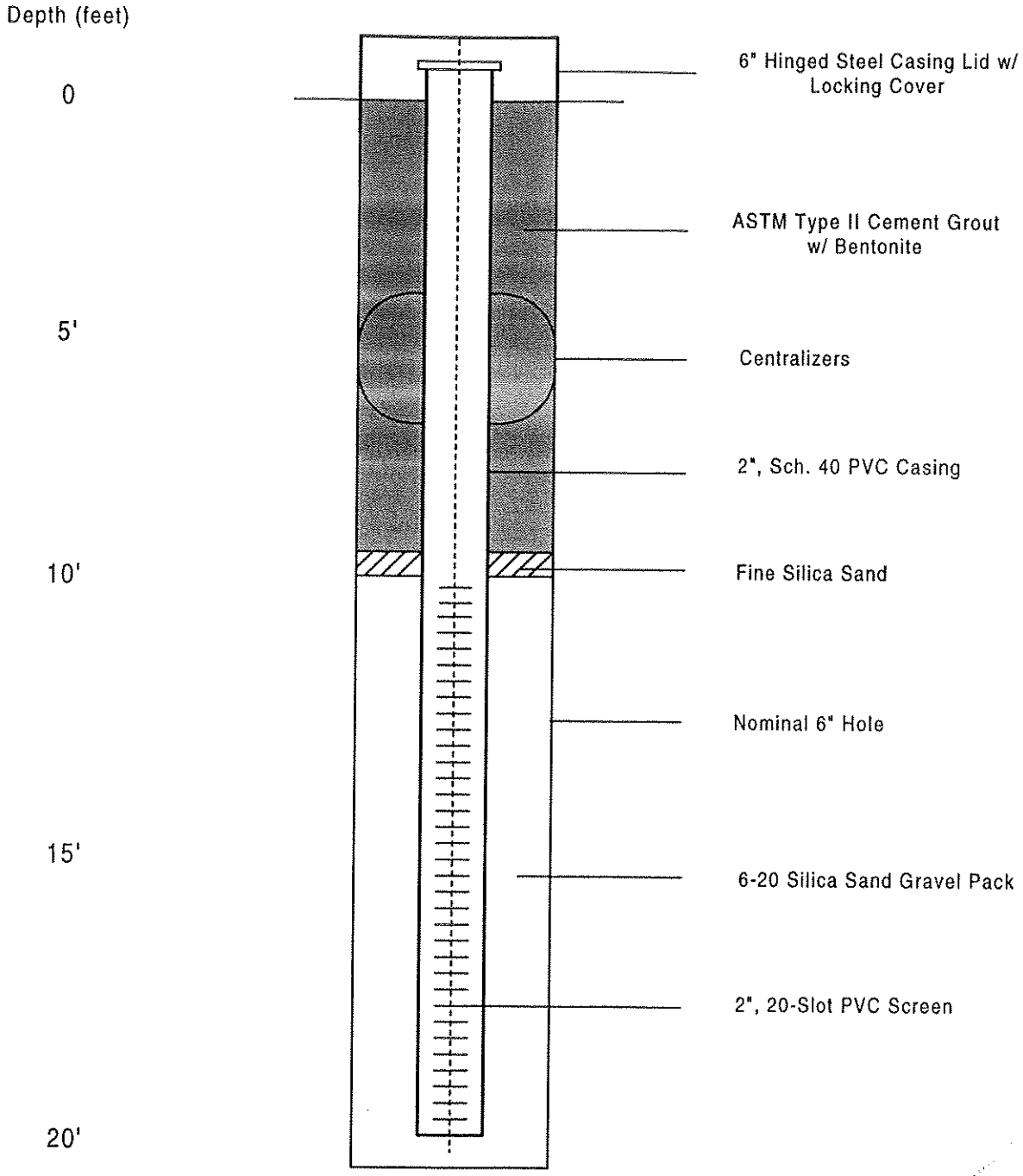

PAUL T. LINTON
42637 5/18/01

South Florida Water Management District
3301 Gun Club Road
West Palm Beach, 33406

Town of Moore Haven
Exploratory ASR Well

Figure B-2.
Pad Monitor Well Schematic

Drilling Procedures

An aboveground circulation system will be used during drilling operations to clean the borehole of mud/cuttings as the drill bit is advanced. Mud/cuttings will be disposed of by the contractor at a FDEP-approved disposal site, with approval occurring prior to beginning drilling.

When drilling in the FAS, reverse-air water, development water, and water derived from interval and aquifer tests is expected to be generated. These brackish waters will be conveyed to an onsite storage tank equipped with baffles and silt screen. This setup allows for suspended sediments to settle out prior to conveyance to the discharge point. A discharge port at the top of the storage tank is the egress point for the water, further enhancing settling to occur. This port provides a good place to conduct preliminary water quality sampling/analysis as necessary. Temporary piping will then be set up to convey water from the storage tank to the proposed point of discharge (POD).

Lithologic Description

Drill cuttings will be obtained every five feet and at every formation change observed during drilling operations. A hydrogeologist will describe cuttings and prepare a lithologic description log. This information will be used in conjunction with other subsurface data described below to determine formation characteristics, contacts between formations, and evaluation of hydrogeologic properties of the aquifers, confining beds, and potential storage zone(s). One set of drill cuttings will be sent to the Florida Geological Survey at 903 West Tennessee Street, Tallahassee FL 32304-7700, phone number (850) 488-9380.

Interval/Packer Tests

Interval/Packer tests will be used to evaluate hydraulic characteristics and water quality within the upper portions of the FAS. The number and depth intervals of the interval/packer tests – and the likelihood that the packers will seat properly to provide a reliable test -- will be determined based on lithologic and geophysical logs. Anticipated intervals include:

- 800 to 1,000 feet bls
- 800 to 1,200 feet bls
- 800 to 1,400 feet bls
- 800 to 1,600 feet bls

Interval tests will be conducted by reaming the pilot hole to the designated depth, followed by removal of the drill string. Next, gravel will be added to fill the portion

of the pilot hole not filled with cuttings from reaming. A 10-foot cement cap will placed via tremie method at the base of the reamed hole to prevent any potential upward fluid movement from the gravel-filled pilot hole. Once the cement is cured, a temporary pump will be installed into the well. The interval will be pumped at a rate commensurate with the flow characteristics of the formation (e.g., 500 to 2,000 gpm) for up to 8 hours, and water levels and flow rates measured prior to, during, and after each interval test. Flow rates and drawdown for each subsequent interval test can be compared to previous tests for analysis.

The interval test provides advantages to traditional packer testing when evaluating large-diameter wells because greater pumping rates can be achieved without the limits of pumping between packers inside drill pipe. In addition, the uncertainty of packer inflation is also addressed because no packer is used. Unforeseen borehole conditions may dictate the need for packers, which will then be utilized accordingly.

Geophysical Logging Program

Geophysical logs will be run for a variety of reasons including:

- Evaluate hydrogeologic/petrologic characteristics of the formations encountered
- Estimate confining and permeable zones (flow profile) of pilot holes
- Estimate water quality characteristics of the formations encountered
- Evaluate borehole diameters of reamed holes prior to cementing casings
- Evaluate height of cement during staged, cementing operations
- Evaluate cement integrity of cemented casings
- Perform visual inspection of casing and borehole

Specific logs to be conducted are tailored to meet the above-mentioned objectives. The proposed geophysical logging program for the exploratory/ASR well is presented in **Table B-2.**

Table B-2
Schedule of Geophysical Logs

Exploratory/ASR Well Logs	Type	Depth (ft-bls)
Caliper, Gamma, Dual Induction, SP	Mud-Filled Pilot Hole	120
Caliper, Gamma	Reamed Hole	120
Caliper, Gamma, Dual Induction, SP, Sonic	Mud-Filled Pilot Hole	800
Caliper, Gamma	Reamed Hole	800
Gamma, Temperature	Each Cement Stage	800
Caliper, Gamma, Dual Induction, SP, Sonic, Density-Neutron, Fluid Resistivity, Video Temperature, Flowmeter	Pilot Hole	1,600
Caliper, Gamma	Reamed Hole	1,400
Gamma, Temperature	Each Cement Stage	1,400
Caliper, Gamma, Fluid Resistivity, Flowmeter Temperature, Cement Bond Log, Video	Final Well	1,600

Notes:
1. Ft-bls = feet below land surface
2. SP = Spontaneous Potential

Casing Grout Program

Prior to cementing, the boreholes will be conditioned through circulation of drilling fluids to optimize the casing/cement bond and prevent channeling. After each casing is set, it will be cemented in place by a multi-staged process using ASTM Type II neat cement with 0- to 8-percent bentonite. The cement formulations are typically based on the fluid-loss properties of the formations being cemented. Lighter formulations (i.e., higher percentage of bentonite) are used when highly permeable formations are encountered, or when cementing a casing inside another casing.

Cement placement shall be in accordance with American Water Works Association (AWWA) Standard for Water Wells, Section A100-90. After each casing is positioned at the setting depth, a grout pipe is lowered inside the casing to within 25 feet above the casing bottom, and a header is installed on the casing to seal the grout pipe and casing. The first stage of cement is pumped through the grout pipe, out the bottom of the casing, and upward into the annulus. This first stage typically uses neat cement for the greater structural integrity required to support the casing.

After the first stage of cement has set, the top of the cement will be confirmed by geophysical logging (i.e., temperature and gamma logs), and tagging the top of the cement in the annulus with a grout pipe. Subsequent cement stages containing blends of from 0- to 8-percent bentonite will be pumped simultaneously through

two grout pipes in the annular space. Staged cementing will continue until cement is observed in the annulus at land surface.

Mechanical Integrity Test

Mechanical Integrity Tests (MIT) for Class V wells are typically limited to a casing pressure test, cement bond log (CBL), and video survey. This is because the injection (storage) zone coincides with an underground source of drinking water (USDW), thereby prohibiting a radioactive tracer survey. A location map and site map for the facility are provided in **Figures 1** and **2** of the application

Sequence

1. Ensure well's artesian pressure is neutralized by mixing and injecting a brine solution into the ASR well, if necessary.
2. Notify FDEP at least 72 hours prior to start of official pressure test.
3. Install a temporary, retrievable, inflatable packer into the well. Lower the packer to the desired depth on drill pipe or tubing. Install ½-inch nominal diameter steel, flexible tubing and connect to packer to facilitate packer inflation. *NOTE: The cement plug at the base of the casing that results from cementing operations may be used as an alternative to the inflatable packer.*
4. Set packer within 20 feet of base of casing (approximately 800 feet bls for 34-inch casing; approximately 1,400 feet bls for 24-inch casing [if necessary]).
5. Inflate packer with compressed air via ½-inch steel tubing. Repeat as necessary to ensure an effective seal is obtained.
6. Install temporary, steel header with port for drill pipe, pressure gauge, etc.
7. Provide and install calibrated pressure gauge with minimum 0.5-psi increments, 0 to 200 psi scale. Provide calibration certificate to SFWMD/USACE one week prior to preliminary test.
8. Pressurize casing using water and high-pressure pump.
9. Seal leaks at wellhead, re-install and re-inflate packer, as necessary, to conduct successful test.
10. Set test pressure to 100 psi and conduct preliminary test. Notify SFWMD/USACE representative and FDEP of successful preliminary test. Schedule official test with SFWMD/USACE and FDEP representatives.
11. Conduct official casing pressure test for 1 hour, allowing maximum 5 percent deviation. SFWMD/USACE to provide certified pressure test signed and sealed by qualified, State of Florida professional engineer (PE) to FDEP.
12. Bleed off pressure (water) into 5-gallon bucket, or equal, to measure water volume equal to 100-psi test pressure.
13. Remove header, deflate and remove packer, and reinstall blowout preventer (BOP) as necessary.
14. Conduct cement bond log to evaluate cement bond around casing.
15. Conduct video survey to visually inspect casing and open hole.

Specific Capacity Test

A specific capacity test will be performed on the well to evaluate well yield, and assist in design of the recharge and recovery pumps.

Sequence

1. Install temporary, vertical turbine pump (powered by diesel-driven motor or temporary electric) into exploratory/ASR well with appurtenances (shut-off valve, discharge pressure gauge, wellhead pressure gauge).
2. Set up onsite, baffled tank and temporary piping system with silt screen to convey pumped waters to Caloosahatchee River. Comply with requirements of FDEP-issued NPDES Permit.
3. Install temporary, 1-inch PVC standpipe to facilitate water level measurement. Set up HERMIT 3000 data logger to facilitate test. Install 100-psi submersible pressure transducer inside standpipe in exploratory/ASR well to approximately 100 feet. Connect pressure transducer to data logger via electronic cable.
4. Measure water levels/pressures continuously before, during, and after the pumping phase of the specific capacity test. Back-up measurements will be collected by hand (electronic water-level indicator or wetted-tape methods). All measurements will be referenced to National Geodetic Vertical Datum (NGVD) of 1929.
5. Begin pumping exploratory/ASR well at three rates (2,000, 3,500, and 4,000 gpm), approximately 2 hours each step.
6. Measure water levels/pressures at logarithmic frequency during each pumping step.
7. Stop pumping; begin measuring recovery data for approximately 6 hours or until water levels recover to 90 percent of pre-pumping conditions.
8. Download data from data logger via laptop PC. Graph and analyze data.

Acidization

Should the specific capacity test indicate unfavorable well yields, acidization of the open borehole may be conducted. The process of acidization involves the reaction of hydrochloric acid with the calcium carbonate ($CaCO_3$) formations (e.g., limestone) of the target zone. This process results in dissolution of the formation, and increased openings (pores, fractures, and cavities) that can accept/release fluids. By accomplishing this task, flow rates should increase under a given pressure. The proposed acidization procedure is outline below.

Sequence

1. Neutralize well's artesian pressure by mixing/injecting brine solution to develop a salt wafer in the well.

2. Install temporary header at wellhead with injection ports, pressure gauges, and pressure-relief valves. Install temporary piping, flowmeters, etc.
3. Install 2-inch-diameter freshwater injection tubing to approximately 500 feet bls (or below salt wafer in well).
4. Install 2-inch-diameter acid injection tubing to target depth
5. Inject freshwater into freshwater tubing for ½ hour at an approximate rate of 200 gpm and evaluate flow versus wellhead pressure.
6. Continue freshwater injection.
7. Begin acid injection of up to 5,000 gallons of 32-percent hydrochloric acid at an approximate rate of 100 gpm, and monitor wellhead pressure and acid flowrate.
8. Upon completing acid injection, continue freshwater injection in both tubings for 1 hour.
9. Shut in well overnight to allow acid to react with the formation, and release wellhead pressure as necessary.
10. Pump/flow the well to evaluate effectiveness of procedure. Repeat if necessary.
11. Remove tubings and temporary header, and install wellhead cap.

Freshwater flow maintains a positive pressure in the well (thereby reducing the chances of acid migrating upward towards the casing) and forcing acid into the formation. Header pressures typically increase following acidization, due to the aggressive chemical reaction between the acid and the carbonate formation, yielding carbon dioxide gas buildup.

Aquifer Performance Test (APT)

An aquifer performance test (APT) will be conducted to evaluate aquifer characteristics. A submersible pressure transducer will be installed in the 1-inch PVC pipe installed in the well. The apparatus used to conduct the test will be the same as that outlined in *Specific Capacity Test* above. The pumping rate will be the design rate of 3,500 gpm, depending on results of the specific capacity test. Background water levels and barometric pressure will be measured at least 48 hours prior to the test. Test duration will be 72 hours pumping (if possible due to NPDES permit constraints) followed by approximately 48 hours to allow water levels to recover to background conditions. Water levels, flowrate, and pump-discharge pressure will be measured during the test. Drawdown versus time graphs will be developed using standard analytical solutions to estimate aquifer transmissivity, storativity, and leakance (depending on existence of monitor wells in the storage zone).

Sequence

1. Install temporary, vertical turbine pump (powered by diesel-driven motor or temporary electric) into exploratory/ASR well with appurtenances (shut-off valve, discharge pressure gauge, wellhead pressure gauge).

2. Set up temporary piping system with silt screen to convey pumped waters to Caloosahatchee River. Comply with requirements of FDEP-issued NPDES Permit.
3. SFWMD/USACE to set up HERMIT 3000 data logger to facilitate test. Install 50-psi submersible pressure transducer in the exploratory/ASR well to approximately 100 feet. Connect 30-psi pressure transducers to monitor well. SFWMD/USACE to connect pressure transducers to data logger via electronic cable.
4. SFWMD/USACE to measure water levels/pressures continuously before, during, and after the pumping phase of the aquifer performance test (APT). Back-up measurements will be collected by a second set of pressure transducers.
5. SFWMD/USACE to conduct background measurements (water levels/pressures, barometric pressure) for 48 hours prior to pumping phase of test.
6. SFWMD/USACE to measure static water level prior to pumping phase in all wells/zones.
7. Begin pumping exploratory/ASR well (constant rate) at approximately 3,500 gpm (5 mgd) for 72 hours. Measure instantaneous pumping rates by circular orifice weir and totalized flow using calibrated, in-line, propeller-type flowmeter or approved equal.
8. SFWMD/USACE to measure water levels/pressures at logarithmic frequency during the first 10-minutes of the test and at 5-minute intervals thereafter.
9. Stop pumping. SFWMD/USACE to begin measuring recovery data for approximately 48 hours or until water levels recover to 90 percent of pre-pumping conditions.
10. SFWMD/USACE to download data from data loggers via laptop PC. SFWMD/USACE to graph and analyze data with analytical techniques appropriate to the aquifer type to estimate aquifer parameters.

Water Quality Testing

The primary purpose of water quality testing is to obtain background water quality data on the proposed storage zone(s). This information will be used to evaluate compatibility of proposed recharge water from the SAS and the native fluid. This data will also be used to evaluate the location of the 10,000 mg/L interface, above which is classified as an USDW by FDEP.

Water quality samples will be obtained after the final casing is set and the well developed to determine background water quality. The subject zone(s) will be allowed to flow to flush out any non-native water. To establish background water quality in the storage zone, sample(s) will be obtained for a suite of parameters, as shown in **Table B-3**. In addition, a 5-gallon unacidized representative sample of native water from the ASR storage zone will be obtained and sent to FDEP-Tallahassee.

Table B-3 – Water Quality Parameter List

Primary Drinking Water Standards			
Inorganics	**MCL (mg/L)**	**Organics**	**MCL (ug/L)**
Antimony	0.006	**Pesticides/PCBs**	
Arsenic (Total and Inorganic)	0.05	Alachlor	2
Asbestos	7 MFL	Atrazine	3
Barium	2	Simazine	4
Beryllium	0.004	Endrin	2
Cadmium	0.005	Lindane	0.2
Chromium	0.10	Methyoxychlor	40
Cyanide	0.20	Toxaphene	3
Fluoride	4.0	Chlordane	2
Lead	0.015	Heptachlor	0.4
Mercury	0.0002	Heptachlor Epoxide	0.2
Nickel	0.1	PCBs	0.5
Nitrate (as N)	10.0	**Herbicides**	
Nitrite (as N)	1.0	2,4-D	70
Selenium	0.05	2,4,5-TP (Silvex)	50
Sodium	160	Pentachlorophenol	1
Thallium	0.002	Picloram	500
Turbidity	1 NTU	Dalapon	200
Coliform, Total (col/100 ml)	4	Dinoseb	7
Volatile Organics	**MCL (ug/L)**	**Base Neutrals**	
		Hexachlorobenzene	1
THMs (Total)	100	Hexachlorocyclopentadiene	50
Trichloroethene	3	Benzo(a)pyrene	0.2
Tetrachloroethene	3	Di(2-ethylhexyl)phthalate	6
Carbon Tetrachloride	3	Di(2-ethylhexyl)adipate	400
Vinyl Chloride	1	**Other Organics**	
1,1,1-Trichloroethane	200	Carbofuran	40
1,1,2-Trichloroethane	5	Oxamyl (Vydate)	200
1,2-Dichloroethane	3	Endothall	100
Benzene	1	Glyphosate (Roundup)	700
Cis-1,2-Dichloroethene	70	Diquat	20
1,1-Dichloroethene	7	**Radionuclides**	
1,2-Dichloropropane	5	Radium 226 and 228	5pCi/l
Ethylbenzene	700	Gross Alpha	15pCi/l
Monochlorobenzene	100		
1,2-Dichlorobenzene	600		
1,4-Dichlorobenzene	75		
Styrene	100		
Toluene	1,000		
Trans-1,2-Dichloroethene	100		
Xylenes (Total)	10,000		
Dichloromethane (Methylene Chloride)	5		
1,2,4-Trichlorobenzene	70		
Ethylene Dibromide	0.02		
Dibromochloropropane	0.2		

Note: mg/l = milligrams per liter
ug/L = micrograms per liter

Table B-3 – Water Quality Parameter List (cont.)

Secondary Drinking Water Standards			
	MCL (mg/L)		**MCL (mg/L)**
Aluminum	0.2	Odor	3 TON
Chloride	250	pH (at Collection Point)	6.5 - 8.5
Copper	1.0	Corrosivity	NA
Color	15 PCU	Silver	0.1
Fluoride	2.0	Sulfate	250
Foaming Agents (MBAS)	0.5	Total Dissolved Solids (TDS)	500
Iron	0.3	Zinc	5
Manganese	0.05		
Other Parameters			
Ammonia (ionized and unionized)	NA	Aldrin	NA
Total Kjeldahl Nitrogen (TKN)	NA	Dieldrin	NA
Total Phosphorous (TP)	NA	Ethion	NA
Orthophosphate (soluble)	NA	Bromacil	NA
Conductivity	NA	Ametryn	NA
Temperature	NA	Hexazinone	NA
Total Suspended Solids (TSS)	NA	Alkalinity	NA
Total Nitrogen (TN)	NA	Calcium	NA
BOD (5-day)	NA	Magnesium	NA
Dissolved Organic Carbon (DOC)	NA	Potassium	NA
Dissolved Oxygen (DO)	NA	Bicarbonate	NA
Total Mercury	NA	Carbonate	NA
Methyl Mercury	NA	Fecal Coliform	NA
Sulfide	NA	Giardia Lamblia	NA
Bromide	NA	Cryptosporidium	NA
Uranium (234 and 238)	NA	Enterococci	NA
Strontium	NA	Coliphage	NA
Tritium	NA	Clostridium Perfringens	NA

1. Maximum Contaminant Level (MCL) per Rules 62-550.310 and 62-550.320, FAC.
2. Mg/L = milligrams per liter

Appendix C

Plugging and Abandonment Plan

Exploratory/ASR Well

1. Mobilize rig and crew and stop artesian flow from the well with brine solution to lower the well's hydrostatic head below land surface.
2. Place limestone gravel with an average diameter not larger than 1 inch down the well to fill the open hole from 1,600 feet below land surface (bls) up to approximately 20 feet below the base of the 34-inch casing at 800 feet bls.
3. Place Class H neat cement through grout pipe, from approximately 20 feet below the base of the 34-inch casing to land surface.

Cost Estimate in 2001 Dollars

1.	Mobilize drill rig and neutralize well's artesian head	$15,000
2.	Fill the open hole of the exploratory well with gravel (approximately 200 cubic yards at $60/yd)	$12,000
3.	Place neat cement through grout pipe from 20 feet below base of the 34-inch casing of the exploratory well to land surface (4,200 sacks at $25/94-lb. sack)	$105,000
	Subtotal	$132,000
	10 Percent Contingency	$13,200
	Total Estimated Cost	**$145,200**

Certification of Financial Responsibility

The South Florida Water Management District, a special taxing district established by the Florida legislature, hereby certifies that it has unconditionally obligated itself to have the financial resources necessary to close, plug, and abandon its Class V underground injection well as required by Chapter 62-528, Florida Administrative Code. It is further understood that the cost estimate to conduct plugging and abandonment, established on March 13, 2001, shall be reviewed on an annual basis, and this obligation shall incorporate accumulated inflation costs. An annual adjustment exceeding ten (10) percent in any one year shall require submission of an updated certification form.

List of Injection Wells Covered by this Agreement:
(For each injection well list the following information)

Facility Name:	Lake Okeechobee ASR Pilot Project
Facility Address:	
Facility Contact:	Mr. Peter Kwiatkowski, P.G.
Phone Number:	(561) 682-2547
Latitude/Longitude of Injection Well:	N 26° 50' 10", W 81° 05' 14"
DEP/EPA Identification Number:	NA
Current Plugging and Abandonment Cost Estimate (March 13, 2001)	$145,200.00

It is hereby understood that the cancellation of this certification may not take place without the prior written consent of the Secretary of the Florida Department of Environmental Protection.

Joseph A. Schweigart
(Signature)

Mr. Joseph A. Schweigart
(Print Name)

Director, Program and Project Management
(Title)

5/21/01.
(Date)