MONTGOMERY WATSON

November 5, 1993

Mr. Alfred Mueller, P.E., P.G.
Florida Department of Environmental Protection
Underground Injection Control
1900 South Congress Avenue
West Palm Beach, Florida 33406

SUBJECT: Response to FDEP Request for Information
Regarding: Operating Permit Application Renewal
Permit No. UO 56-237554
North Port St. Lucie Injection Well IW-1

Dear Mr. Mueller:

On behalf of St. Lucie County Utility Services Department (SLCUSD), Montgomery Watson is pleased to submit three copies of the response to the Florida Department of Environmental Protection (FDEP) Request for Information (RFI) regarding Operating Permit Application for Injection Well IW-1 at the North Port St. Lucie Injection Well System, Permit No. UO 56-237554, dated October 8, 1993.

The FDEP RFI Items, numbered 1 through 9, are included below in boldface type, followed by Montgomery Watson's response. Copies of materials referenced by Montgomery Watson are included in Attachments A through J.

1. **As required by Rules 17-28.130(4) and (5), and 17-28.340(1), F.A.C., a map showing the location of the injection well field and the applicable area of review is needed for this facility. Within the area of review, the map must show the number or name, 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. Any wells identified on this map should be listed on a table with owner, location and depth identified. 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.**

   Provided in Attachment A, Figure 1, excerpted from the initial Operating Permit Application for Injection Well IW-1 at the North Port St. Lucie Injection Well System

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(NPSLIWS), Permit No. UO 56-237554, dated April 1988, shows the location of the injection wellfield and the applicable area of review. This map shows wells identified within the area of review which penetrate the injection zone, confining zone, and/or monitoring zones, and is accompanied by a table listing the well owners, locations, diameters, and permit numbers. Copies of South Florida Water Management District (SFWMD) Well Completion Reports on file for wells constructed in or near the area of review since 1985 have been included in Attachment B. The well completion reports do not provide a specific location for each well and, as a consequence, have not been located on a map or listed on a table. All of these wells are completed in the surficial aquifer.

A tabulation of data on all wells within the area of review which penetrate the injection zone, confining zone, or monitoring zones is also needed. The data must include a description of each well's use, construction, date drilled, location, total depth, casing depth, casing size and record of plugging and/or completion. As required by Rule 17-28.130(5), F.A.C., if any of these wells, not including the South Port St. Lucie and Stuart monitor wells which are already discussed in item (C) (1) (a) 6, are improperly sealed, completed or abandoned, the applicant must submit a plan consisting of the steps or modifications that will be accomplished to prevent movement of fluid into underground sources of drinking water (corrective action).

Please refer to the Table in Attachment A, page 2-2 from the initial Operating Permit Application for Injection Well IW-1 at the NPSLIWS. In review of the information from the public record, no other wells within the area of review penetrate the injection zone, confining zone, or monitoring zones, or are believed to be improperly sealed, completed, or abandoned.

2. **As required by Rules 17-28.210(1) (a) and (2) (a), F.A.C., an applicant for an injection well shall demonstrate the adequacy of confinement between the injection zone and the zones above the injection zone. This data will come from the information obtained during construction of the wells, but as required by Rule 17-28.340(1) (c), F.A.C., must be provided in this application so that it can be approved on its own merit. Within the area of review, maps and cross sections detailing the local geology and hydrogeology including the vertical and lateral limits of all underground sources of drinking water (USDW) are needed. Maps and cross sections illustrating the regional geologic setting are also needed.**

The confinement between the injection zone and the zones above the injection zone was proven to be adequate in the initial operating permit application for Injection Well IW-1 at the NPSLIWS. Please see Attachment C, pages 3-1 through 3-6 of the Hydraulic

Testing section excerpted from the CH2M Hill report entitled "Drilling and Testing of the Deep Injection Well System," dated October 1987. In addition, review of NPSLIWS monitoring data in Attachment D, Figures 10 through 14 from the Montgomery Watson report entitled "Mechanical Integrity Testing of North Port Class I Injection Well," dated August 1993, and the conclusions from that report confirm confinement between the Injection Zone and the Lower Monitor Zone.

Maps and cross sections of the regional geologic setting, from the initial Operating Permit Application for Injection Well IW-1 at the NPSLIWS, are provided in Attachment E. Cross sections of local geology and hydrogeology are provided in Attachment F, Figure 2-3, from the CH2M Hill report entitled "Drilling and Testing of the Deep Injection Well System," dated October 1987.

3. **As required by Rule 17-28.210(3), F.A.C., an applicant for an injection well shall demonstrate the adequacy of the injection zone. This data will come from the information obtained during construction of the wells, but as required by Rule 17-28.340(1) (c), F.A.C., must be provided in this application so that it can be approved on its own merit.**

The injection zone was proven to be adequate in the initial operating permit application for Injection Well IW-1 at the NPSLIWS. Please see Appendix C, pages 3-1 through 3-6 of the Hydraulic Testing section excerpted from the CH2M Hill report entitled "Drilling and Testing of the Deep Injection Well System," dated October 1987. In addition, review of NPSLIWS monitoring data in Attachment G, Figures 7, 8, and 9, and "Specific Injectivity" found on pages 8 and 9, from the Montgomery Watson report entitled "Mechanical Integrity Testing of North Port Class I Injection Well," dated August 1993, confirms the adequacy of the injection zone as permitted.

4. **As required by Rules 17-28.340(1) (c) and 17-28.330(2) (f) 3, F.A.C., the sources and a current analysis of the injection fluid must be submitted. The injection fluid should be analyzed for primary and secondary drinking water standards and minimum criteria (list attached).**

The injection fluid is treated domestic wastewater. An analysis of the injection fluid for primary and secondary drinking water standards is being submitted under separate cover by SLCUSD.

5. **As required by Rule 17-28.340(1) (c) 2, F.A.C., an "as-built" drawing for the injection well and monitor well must be submitted for the operating permit application. The as-built drawings must be to scale, signed and sealed by an engineer and include casing thickness, depths,**

diameters (OD or ID identified) and identify the stratigraphic units intersected by the wells.

A copy of the "as-built" drawing for the injection well and monitor well, as submitted for the original operating permit application, has been included in Attachment F.

6. **As required by Rule 17-28.340(1) (c) 2, F.A.C., a record drawing of the location of the injection well in reference to the monitor well, to scale and with the north direction indicated, is needed for the application to be complete.**

A copy of the record drawing for the location of the injection well and monitor well, as submitted for the original operating permit application, has been included in Attachment H.

7. **As required by Rule 17-28.230(3), F.A.C., an operation and maintenance (O&M) Manual (dated February 1988) has been submitted. This O&M Manual needs to be revised to include the following:**

   a) **The injection flow rate data listed on Table 3-1 should include total monthly flow.**

   b) **The injection pressure data listed on Table 3-1 should include monthly minimum, maximum, and average pressure.**

   c) **The monitor well water elevation data listed on Table 3-1 should include monthly averages for the upper and lower monitoring zones.**

   d) **The chemical and physical parameters listed on Table 3-1 must reflect what is currently being monitored. Total phosphorus and sulfate should be added to this list.**

   e) **As part of the injectivity test (page 3-12) a quarterly pressure fall-off test is required.**

   f) **On page 3-5, second paragraph, it should be specified that the monthly operating reports are to be sent to the Department of Environmental Protection's Underground Injection Control Program in the West Palm Beach District (P.O. Box 15425, West Palm Beach, FL 33416), and Tallahassee (2600 Blair Stone Road, Tallahassee, FL 32399-2400) offices.**

g) **Figure 1-1 of the O&M Manual shows the monitor well due west of the injection well, however, Figure 2 of the March 24, 1993 "Mechanical Integrity Test Plan" discrepancy should be rectified.**

These items have been addressed by SLCUSD and are presented in Attachment I.

8. **As required by Rule 17-28.270(7), F.A.C., the final or innermost casing must be filled with neat cement. This rule also states that the Department may require or allow the use of other fillers in the open hole portion of the well. This language is interpreted to mean that the open hole below the innermost casing must be filled, but fillers other than cement may be allowed or required. Generally sand or gravel is used, rather than cement, as a filler in the open hole portion of the well. The plugging and abandonment plan is one which proposes filling the open hole with sand or gravel to approximately ten feet below the bottom of the deepest casing. The Rule 17-28.270(2), F.A.C., new plugging and abandonment plans reflecting the filling of the open hole portion of the injection and monitor well, including volumes of material along with cost estimates for the material and on for work to complete abandonment of the wells, plus a contingency fee, must be submitted. A new financial responsibility demonstration for this permit application must be submitted to Mary Woodworth, FDEP, Bureau of Drinking Water and Ground Water Resources, 2600 Blair Stone Road, Tallahassee, FL 32399-2400. A copy of the transmittal letter for any financial responsibility documentation should also be sent to the TAC chairman.**

Please refer to Attachment J, Plugging and Abandonment Plan. This plan has been revised and updated in November 1993. A copy will be forwarded to Mary Woodworth, FDEP, Bureau of Drinking Water and Ground Water Resources, with updated information demonstrating financial responsibility.

9. **Please respond to the above questions and comments within 30 days as per consent order number 92-0105.**

The operating permit renewal for the NPSLIWS is not referenced in the Consent Order No. OGC 92-0105. Paragraphs 71 through 74 of the Consent Order pertain to the mechanical integrity testing of the North Port Class I Injection Well, but do not make any specific references to the North Port Class I Injection Well Operating Permit renewal. It is Montgomery Watson's understanding that the Operating Permit renewal is not bound by the terms and conditions of the above referenced Consent Order; however, this response is submitted within 30 days of receipt of the RFI sent by FDEP.

Should there be any questions, please do not hesitate to call.

Sincerely,

Helen Madeksho P.G. for

Leonard H. Allen, Jr. P.E.
Principal Engineer

JTS:jd
Attachments

cc: David McNabb, FDEP-UIC, (WPB)
J.P. Listick, FDEP-UIC (WPB)
Cathy Conrardy, FDEP (Tallahassee)
Vincent Quinones-Aponte, USGS (Miami)
Jose Lopez, DERM
Jean Dove, USEPA (Atlanta)
Steve Anderson, SFWMD (WPB)
Sam Amerson, Utility Engineer and Acting Utility Administrator, SLC
Jim Lancaster, Assistant County Attorney, SLC
Daniel Sneed, Facilities Operations Director, SLC
Carl Norton, Chief Operator North Port Wastewater Treatment Plant
Helen Madeksho, Montgomery Watson
John Skowronek, Montgomery Watson
File No. 2624.0320/3.1.6

ATTACHMENT A

Section 2
AREA OF REVIEW

Submitted to Fulfill
Rule 17-28.330(a)(2):

(a) 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 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;

(b) 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;

(m) 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 17-28.130(5), FAC.

Section 2
AREA OF REVIEW

(a) A one-mile radius Area of Review search was performed based on information of public record (Figure 1). No wells as described are located in the one-mile Area of Review. Four of the GDU well field's wells are located within the Area of Review, but all are less than 125 feet deep.

(b) No wells as described are located within the one-mile radius Area of Review. Three Floridan aquifer wells are reported approximately 1-1/4 miles northeast of the injection well site (Figure 1). South Florida Water Management District records report that they are all flowing Floridan aquifer wells, but their depths are unknown.

The Floridan aquifer wells are estimated to be approximately 1,000 feet deep. A summary of the above wells is as follows:

Owner	Well Number	Diameter	Permit Number	Date
D.L. Scott & Company, Inc.	1 2	6" 5"	20118	4/19/79
Donald E. Martin	--	4"	28072	11/19/79
General Development Utilities	1 through 18	8"	56-00142-W	8/9/84

Two Amerada Petroleum Company test oil wells are located in Section 19, Township 36S, Range 40E. More exact locations were not available from the Bureau of Geology files or publications. Amerada 2 Cowles Magazine (Bureau of Geology Accession No. W-4323) is reported in Puri and Winston (1974)

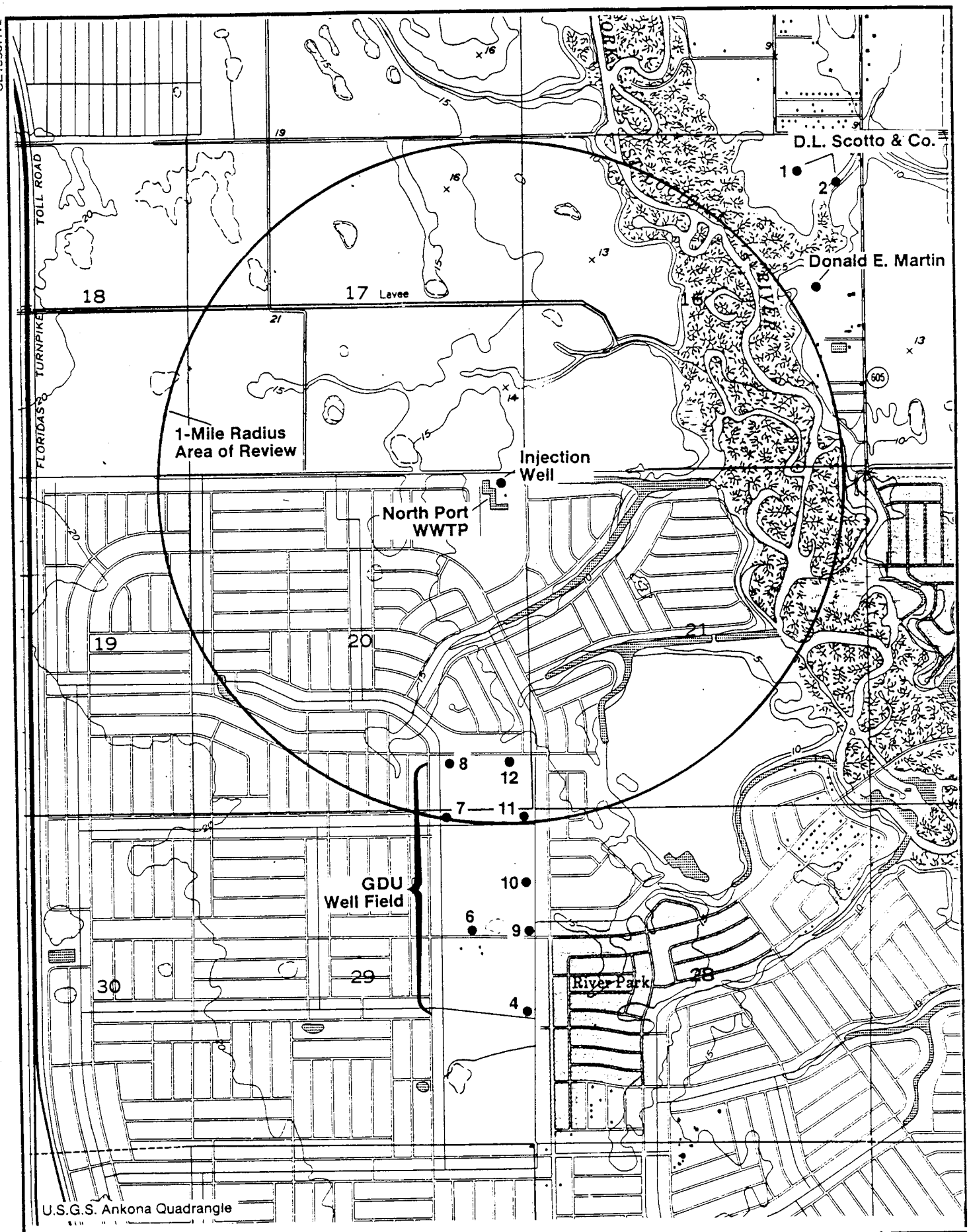

FIGURE 1.
GDU North Port WWTP and 1-Mile Radius Area of Review.

at a depth of over 3500 feet. Amerada Petroleum Co. Cowles Magazine Inc. No. 1 (Bureau of Geology Accession No. W-4086) is reported in Chen (1965) at a depth of 5,159 feet.

(c) No corrective action is proposed.

Chen, C.C., 1965. The Regional Lithostratigraphic Analysis of Paleocene and Eocene Rocks of Florida. Florida Geological Survey Bulletin No. 45, 105 pp.

Puri, H.S., and G.O. Winston, 1974. Geologic Framework of the High Transmissivity Zones in South Florida. Florida Geological Survey Special Publication No. 20, 101 pp.

Section 3
MAPS AND CROSS SECTIONS OF USDW'S

Submitted to Fulfill
Rule 17-28.330(2)(c):

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.

Section 3
MAPS AND CROSS-SECTIONS OF USDW'S

The Underground Sources of Drinking Water (USDW's) identified within the one-mile Area of Review are the surficial aquifer and the upper Floridan aquifer. The general vertical and lateral limits of these USDW's within the Area of Review and their position relative to the injection formation are shown in Figure 2-3 of the Engineering Report.

A surficial nonartesian aquifer is present throughout the county and consists of the Pleistocene Pamlico Sand and the Anastasia Formation. The highest yields (up to 350 gpm) are from the Anastasia Formation, at depths from 40 to 130 feet (Bearden, 1972). The surficial aquifer at the site occurs to a depth of 150 feet. The direction of groundwater flow may be determined from Figure 1 in Section 2 of this application, based on the topographic contours. The flow is toward the Ocean Breeze Canal north of the site and toward the North Fork of the St. Lucie River.

The upper portion of the Floridan aquifer is also a USDW at the site. The general vertical and lateral limits are shown in Figures 2-3 and 2-5 of the Engineering Report. The general direction of water movement is to the northeast, as shown in Figure 2.

Bearden, H.W., 1972. Water Available in Canals and Shallow Sediments in St. Lucie County, Florida. Florida Geological Survey Report of Investigations No. 62, 50 pp.

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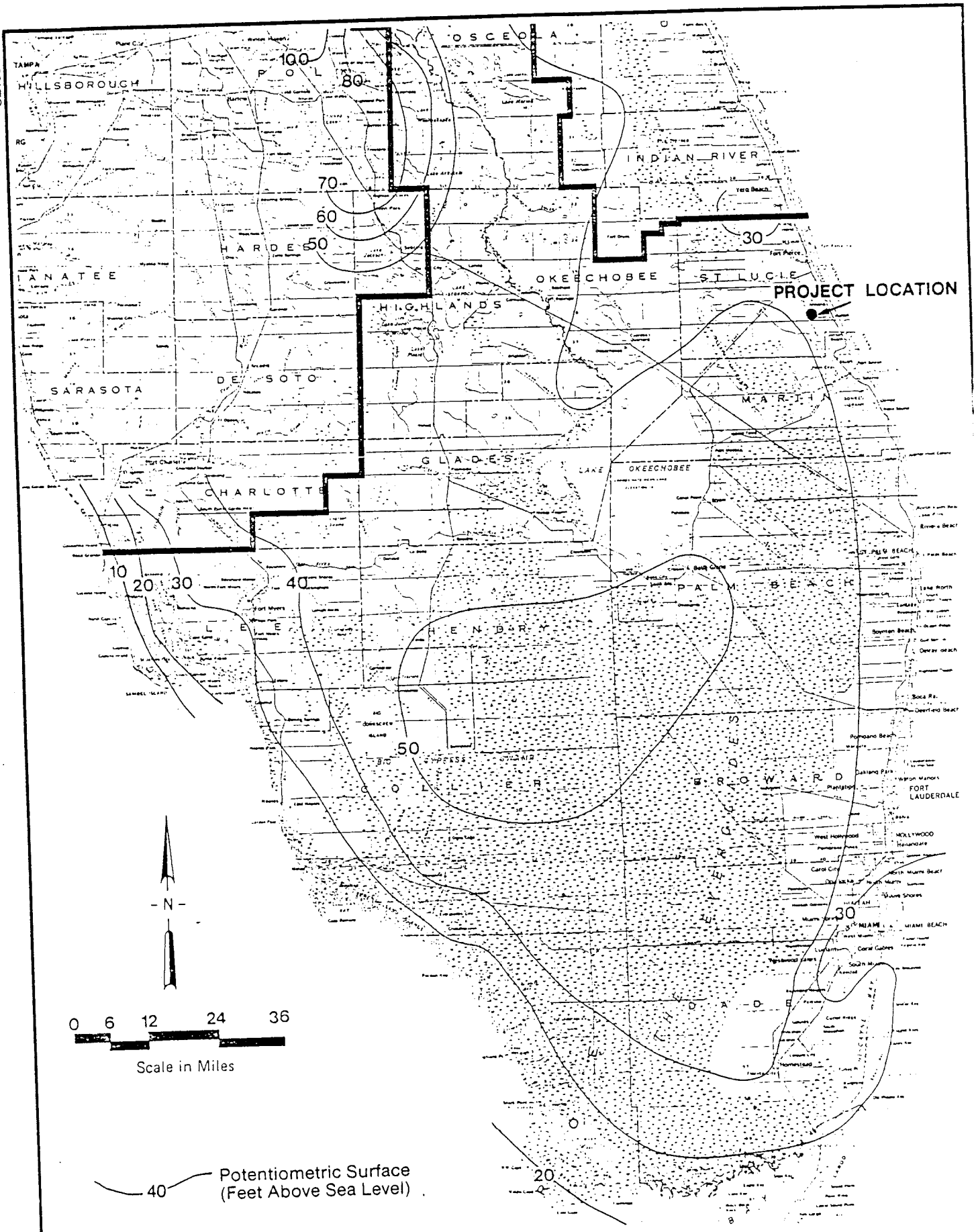
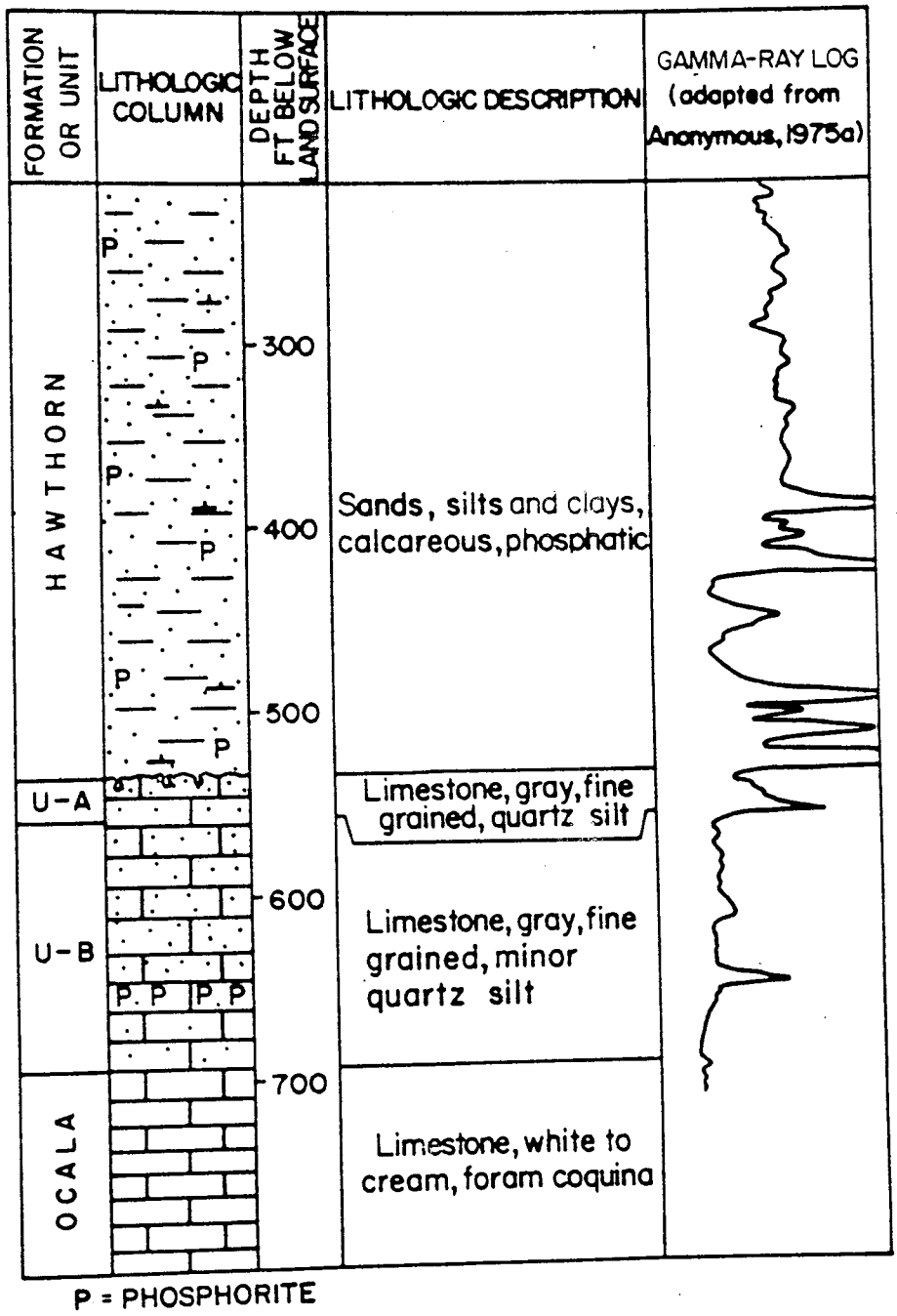


FIGURE 2.
Potentiometric Surface of the Upper Floridan Aquifer, SFWMD.

Section 4
MAPS AND CROSS SECTIONS OF THE LOCAL AREA

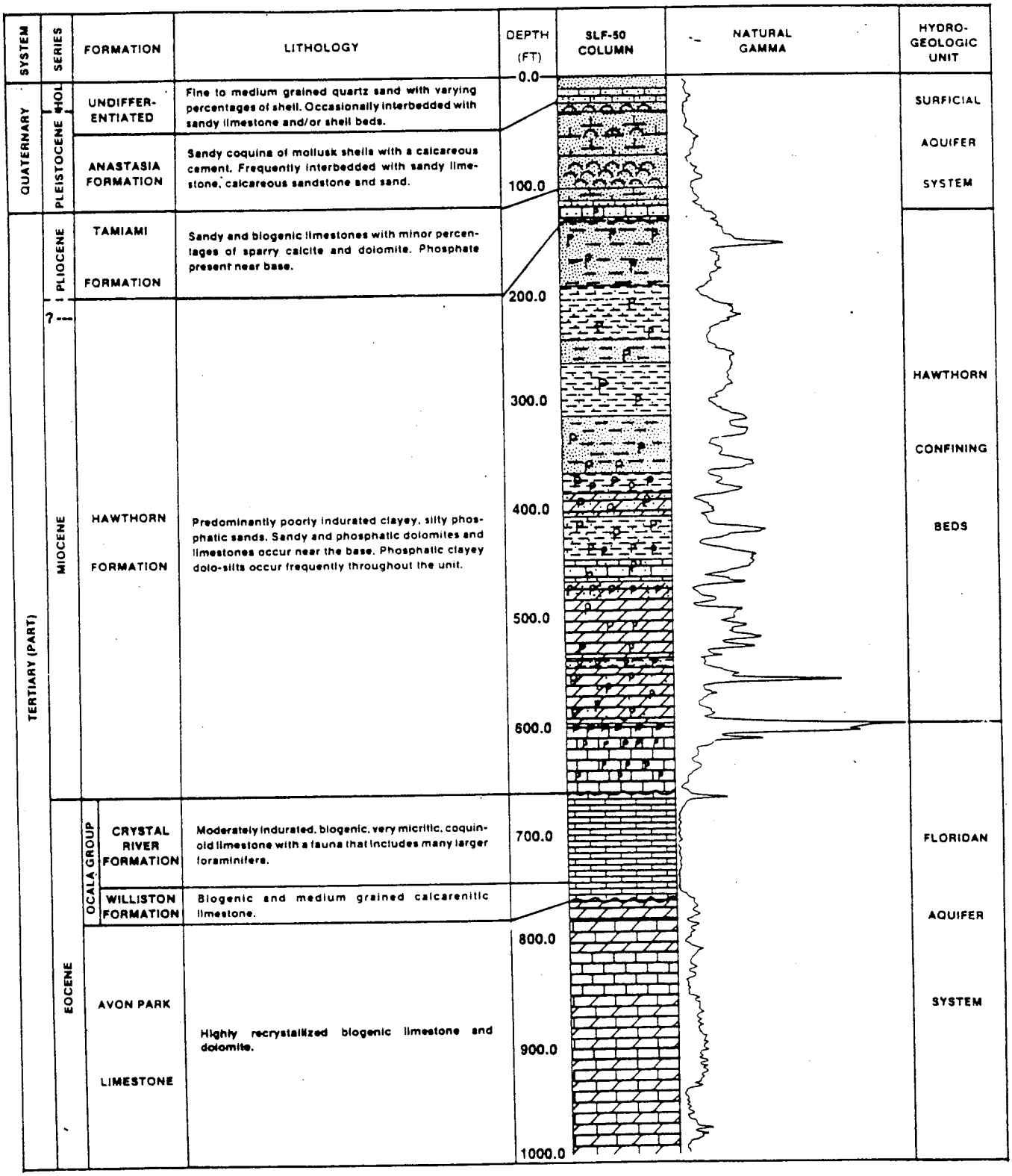
Submitted to Fulfill
Rule 17-28.330(2)(d):

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



Source: Armstrong, et al., 1985.

FIGURE 4.
Lithologic Columnar Section and Gamma-Ray Log for Core AG-106 (after Anonymous, 1975a).



Source: Wedderburn and Knapp, 1983.

FIGURE 3.

Stratigraphy, Lithology, and Hydrogeology of Exploratory Well SLF-50.

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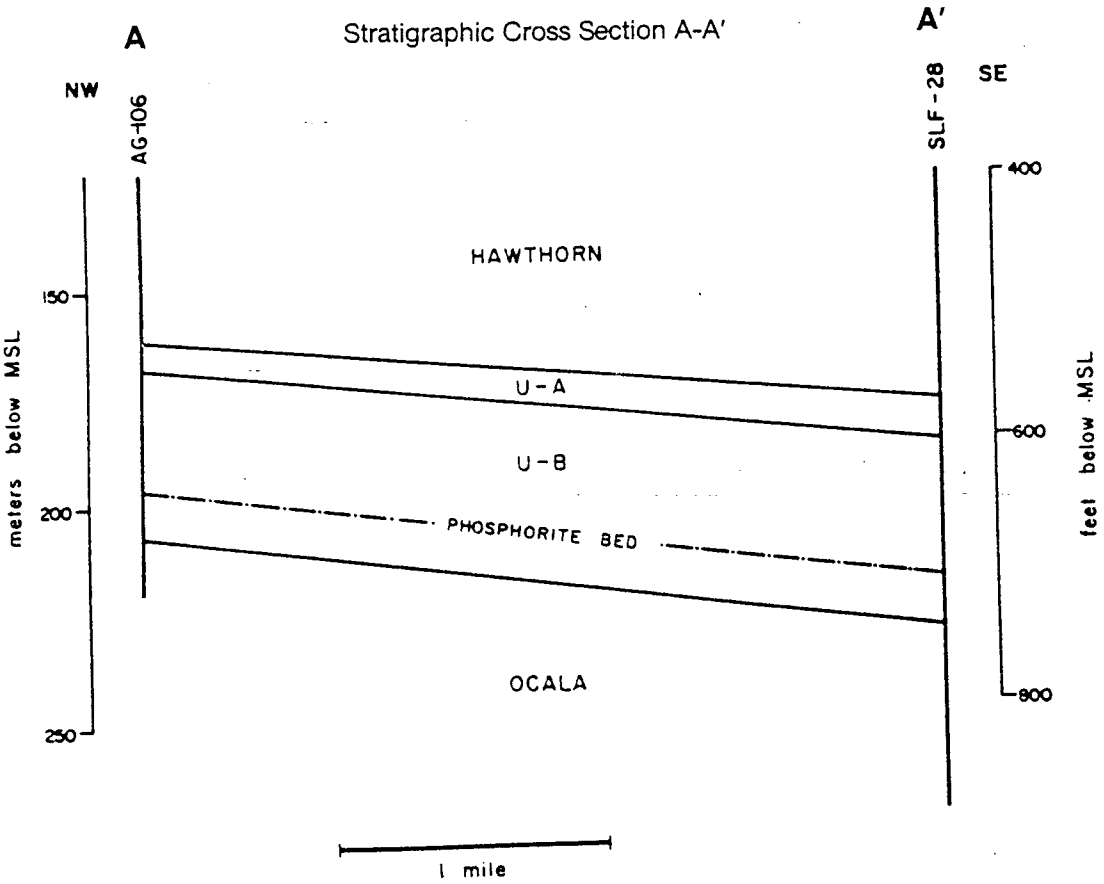

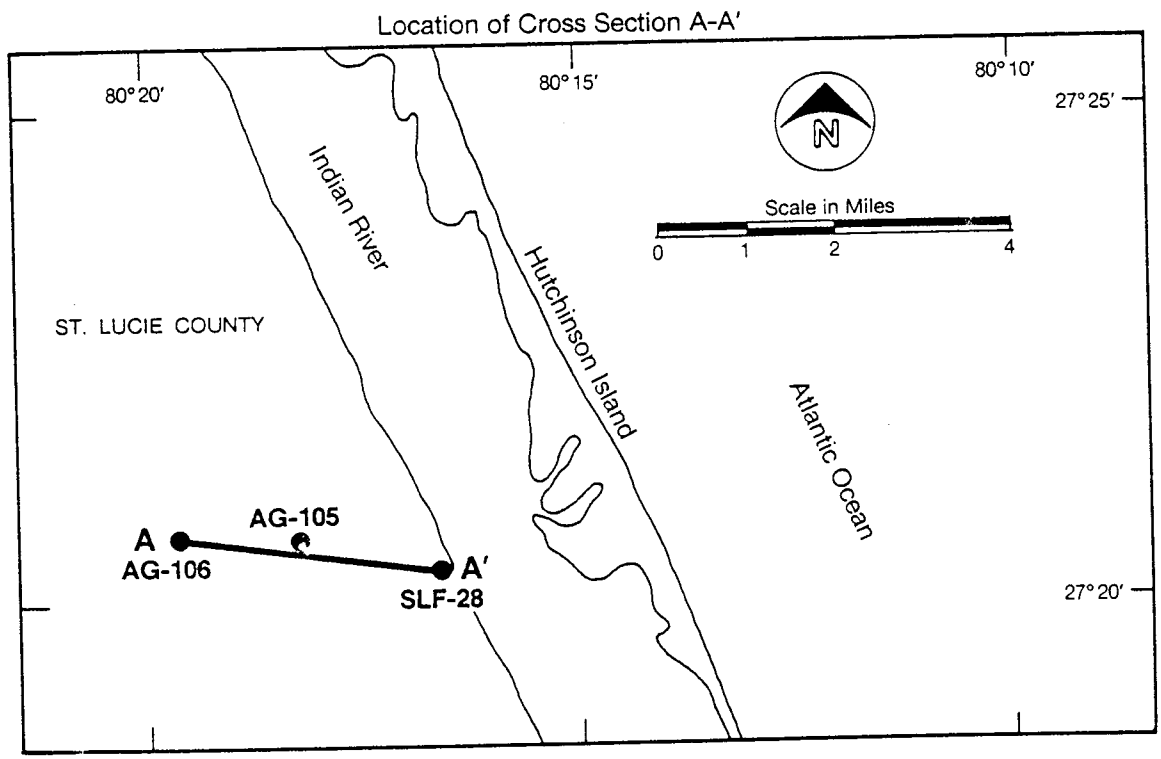

Source: Armstrong, et al., 1985.

FIGURE 5.
Map of Study Area Showing Well Locations and Cross Section Lines.

CH2MHILL

Section 5
REGIONAL GEOLOGIC MAPS AND CROSS SECTIONS

Submitted to Fulfill
Rule 17-28.330(2)(e):

Generalized maps and cross sections illustrating the regional geologic setting.

Section 5
REGIONAL GEOLOGIC MAPS AND CROSS SECTIONS

Puri and Winston (1974) produced several cross sections in southeast Florida as part of their study. One of the Amerada Cowles Magazine wells is used in Section CD, which is reproduced here as Figure 6. That figure and Figures 2-5 and 2-6 of the Engineering Report show the regional extent and thickness of the geologic formations. Figure 2-6 shows the base of the USDW's on a regional basis.

Puri, H.S. and G.O. Winston, 1974. Geologic Framework of the High Transmissivity Zones in South Florida. Florida Geological Survey Special Publication No. 20, 101 pp.

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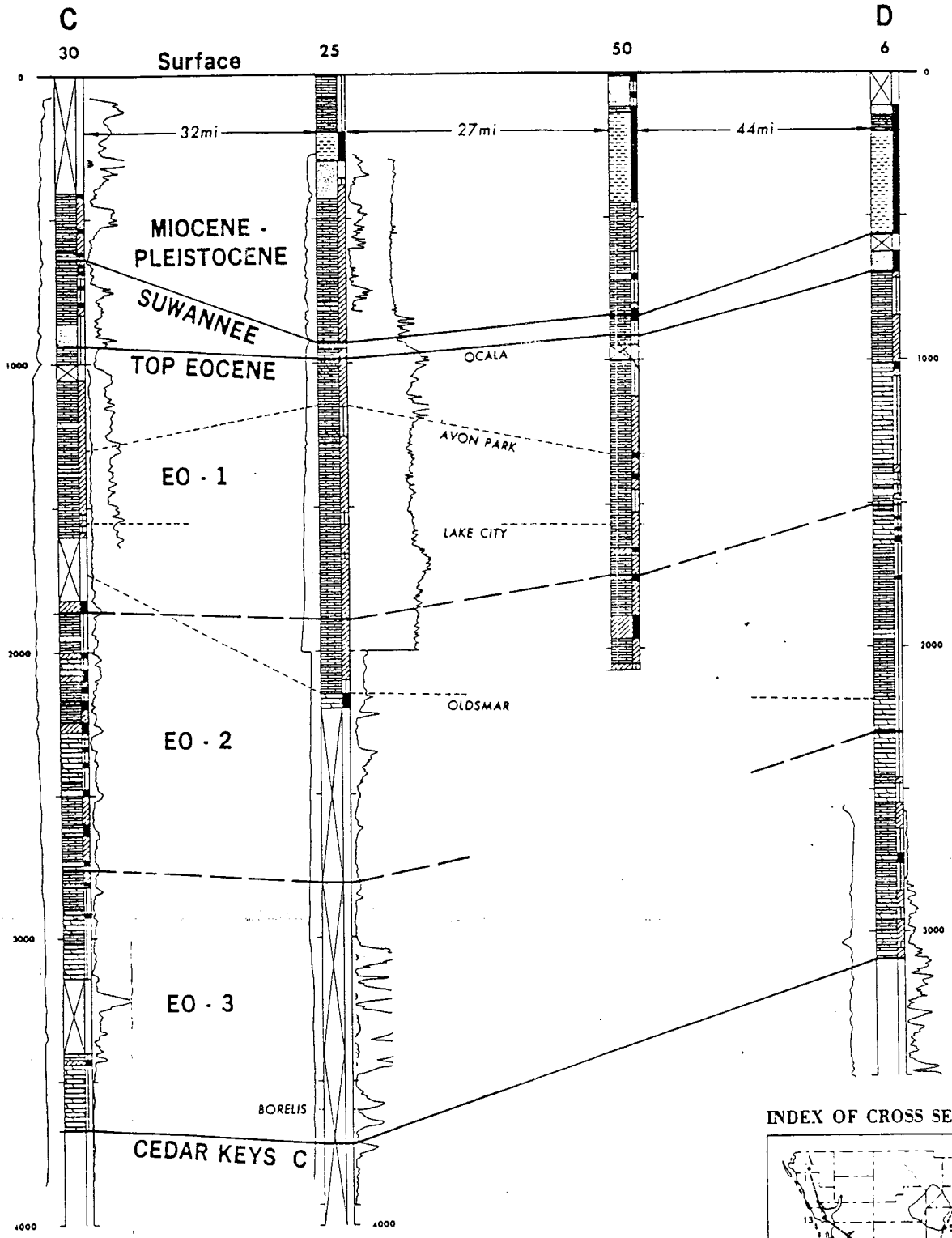
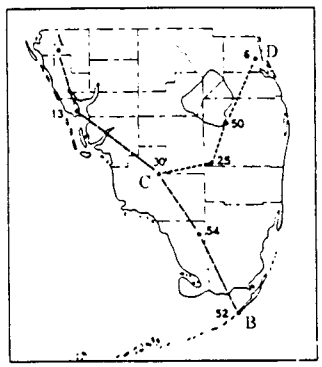


INDEX OF CROSS SECTIONS



CROSS SECTION

C - D

Florida

DATUM - SURFACE

HORIZONTAL SCALE - NONE

VERTICAL SCALE

0

500 FT

- Anhydrite
- Dolostone
- Limestone
- Sandstone
- Shale
- Missing Sample
- Impermeable
- High Permeability
- Low Permeability

Source: From Florida Bureau of Geology Special Publication No. 20

FIGURE 6.
Geologic Cross Section of Southeast Florida.

ATTACHMENT B

Documents deliberately omitted.

ATTACHMENT C

Section 3
HYDRAULIC TESTING

Several testing methods were used to characterize the confining and injection zones. The testing program developed for this site consisted of rock core analyses through the confining zone, a short duration well development, and a 16-hour step injection test. Two limitations existed on the testing: the storage capacity of the lined pond and the producing capacity of the monitor well.

INJECTION WELL ROCK CORES

Coring was conducted to characterize the confining beds above the injection zone. Five coring operations were made while drilling the 12-1/4-inch pilot hole. Table 3-1 summarizes the coring program, and provides a lithologic description of the cores.

Cores were taken from 2,100 to 2,634 feet, with recovery varying from 8 feet to over the full 10 feet. All cores were drilled using a 10-foot core barrel and a tungsten carbide-tipped core bit.

Portions of the cores at least 6 inches in length were selected and sent to Ardaman and Associates, Inc. for determination of the vertical and horizontal coefficient of permeability and porosity. The results of the vertical and horizontal permeability, and the porosity, from the core samples are shown in Table 3-2. Appendix B contains the actual laboratory reports.

Table 3-1
SUMMARY OF LITHOLOGIC CORE INTERVALS AND DESCRIPTIONS

Interval Cored (ft)	Recovery (ft)	Interval Sent to Lab	Lithology
2100-2110	10	2101-2101.8 2108.2-2109	Limestone, micritic-skeletal, white to very pale orange, coarsely micrograined to very fine, chalky, moderately well-cemented, interparticle porosity.
2245-2255	8	2249-2250 2253.5-2254	Dolomite, moderate yellowish brown, very fine to fine subhedral crystals, moderate to good alteration, well-cemented, slightly sucrosic, moldic and intercrystalline porosity; chert nodules.
2425-2435	10	2425-2426.2 2430-2431	Limestone, skeletal-pellet-micritic, very pale orange, coarsely micrograined to fine, granular appearance, chalky, poorly cemented, slightly glauconitic, interparticle porosity.
2445-2455	10+	2449-2450 2451-2451.75	Limestone, skeletal-pellet-micritic, white to very pale orange, coarsely micrograined to fine, poorly cemented, chalky, chert in lower 5 feet replacing Dictyoconus sp., interparticle porosity.
2624-2634	9.5	2628-2629 2632.5-2633.2	Limestone, micritic-pellet-skeletal, very pale orange, micrograined to very fine, very well cemented, granular appearance, interparticle porosity.

Table 3-2
CORE ANALYSIS SUMMARY
GDU NORTH PORT ST. LUCIE INJECTION WELL

Depth (ft)	Orientation (Horizontal or Vertical)	Coefficient of Permeability (cm/sec)	Porosity (Gs=2.70) (%)	Dry Density (pcf)
2101.0-2101.8	V	4.5×10^{-5}	35	109.2
2101.0-2101.8	H	5.4×10^{-5}	35	108.7
2108.2-2109.0	V	4.4×10^{-5}	32	114.6
2108.2-2109.0	H	3.3×10^{-5}	31	115.7
2249.0-2250.0	V	3.5×10^{-7}	13	147.0
2249.0-2250.0	H	1.4×10^{-7}	9	152.8
2253.5-2254.0	V	2.8×10^{-3}	37	105.8
2253.5-2254.0	H	1.2×10^{-3}	32	114.5
2425.0-2426.2	V	6.7×10^{-4}	35	109.5
2425.0-2426.2	H	5.7×10^{-4}	35	109.1
2430.0-2431.0	V	1.6×10^{-5}	34	111.6
2430.0-2431.0	H	3.4×10^{-4}	36	108.5
2449.0-2450.0	V	3.5×10^{-6}	35	109.8
2449.0-2450.0	H	8.9×10^{-5}	38	104.0
2451.0-2451.8	V	2.3×10^{-5}	31	116.5
2451.0-2451.8	H	1.1×10^{-5}	30	117.2
2628.0-2629.0	V	4.1×10^{-5}	25	125.7
2628.0-2629.0	H	1.9×10^{-4}	30	117.6
2632.5-2633.0	V	5.0×10^{-4}	31	116.3
2632.5-2633.0	H	1.5×10^{-4}	32	115.1

Note: Core analyses performed by Ardaman and Associates, Orlando, Florida.

Further evidence supporting the confining nature of the cored intervals is found by comparing the fluid velocity, caliper, and natural gamma ray logs of the pilot hole. Within the 1,650- to 2,300-foot interval above the 2,300 to 2,400-foot flow zone, a sharp reduction in fluid velocity, an overgauge-sized hole, and a low intensity natural gamma ray count (indicating a clean limestone) all indicate confinement.

The upper Oldsmar Limestone, whose top occurs at 2,400 feet, is the lowermost confining sequence above the injection zone. Confinement from 2,400 to 2,890 feet is indicated by the same pattern of a sharp reduction in fluid velocity, an oversized hole, and a low natural gamma ray count. Straight-line overgauge traces on the caliper log may be due to the impregnated chert noted in the cores taken from this interval. This confining sequence persists until approximately 2,890 feet, when the top of the "Boulder Zone" portion of the Oldsmar Formation is encountered.

INJECTION TEST OF 12-INCH CASING

After completing the injection well to a total depth of 3,324 feet, the well was developed for 2 hours at approximately 2,000 gpm, and the monitor well was drilled to a depth of 1,418 feet. A 16-hour step rate injection test was run to evaluate the hydraulic characteristics of the injection well and to finalize the injection pump design.

Brackish water from the monitoring well was used for the injection test. Chloride values of monitor well fluid from the 1,400-foot depth were approximately 1,065 to 1,315 mg/l (Appendix D). The monitor well was cased to 950 feet with a 16-inch casing, and open with a 15-inch hole to 1,418 feet for the test.

A vertical turbine pump was installed in the monitor well and discharged into a 12-inch pipe connected to the injection well. A Flow Research Corporation Series 1,000 flow meter, an inline propeller type with a totalizer, measured the flowrate. A Helicoid 10-inch pressure gauge placed between the flowmeter and the wellhead, reading from 0-100 psi, measured the injection pressure.

The test was originally designed to be 16 hours in duration, with step rates between 500 and 2,800 gpm. The injection test began on July 25, 1987, but due to several interruptions, was not completed until July 28, 1987. The total duration of the test was 17 hours, with the last 12 hours continuing uninterrupted. A second 1 hour injection test was run on July 30, 1987. The major reason the injection test had to be interrupted was that inadequate diesel motors and pump bowls were initially available. Once pumps and motors that could sustain the 2,800 gpm rate were supplied, the test proceeded without interruption.

After stepping up the injection rates from 700, 1,000, 1,400, and 2,000 gpm, the test was run at 2,940 gpm for 12 hours, reaching a maximum head of 121 feet (52.5 psi) of water after 30 minutes of pumping. Using a Hazen-Williams friction coefficient of 140, an average value for good, clean seamless steel pipe, the friction loss in the 12-inch casing is 51.8 feet (22.4 psi) of water. After the test, a static head of 50.8 feet (22 psi) of water was measured. The hydraulic loss (friction plus static) thus accounts for 103 feet of the 121 feet of head, which indicates that 18 feet or 7.8 psi of injection pressure is due to the formation.

After 12 hours of injecting at 2,940 gpm, the test was terminated. A second, 1 hour injection test was run on July 30, 1987. Both tests are summarized in Table 3-3 and the data from the tests are found in Appendix C.

Table 3-3
STEP INJECTION TEST SUMMARY-COMPLETED INJECTION WELL[a]

Injection Rate (gpm)	Duration (hours)	Maximum Injection Head (feet above pad)
0	--	50.8 Static
700	0.5	57.5
1,000	9.25	65.7
1,400	0.5	71.5
2,000	0.5	80.7
2,940	12	121.1
2,800	1	113

[a]Injection testing occurred from July 23-30, 1987.

ATTACHMENT D

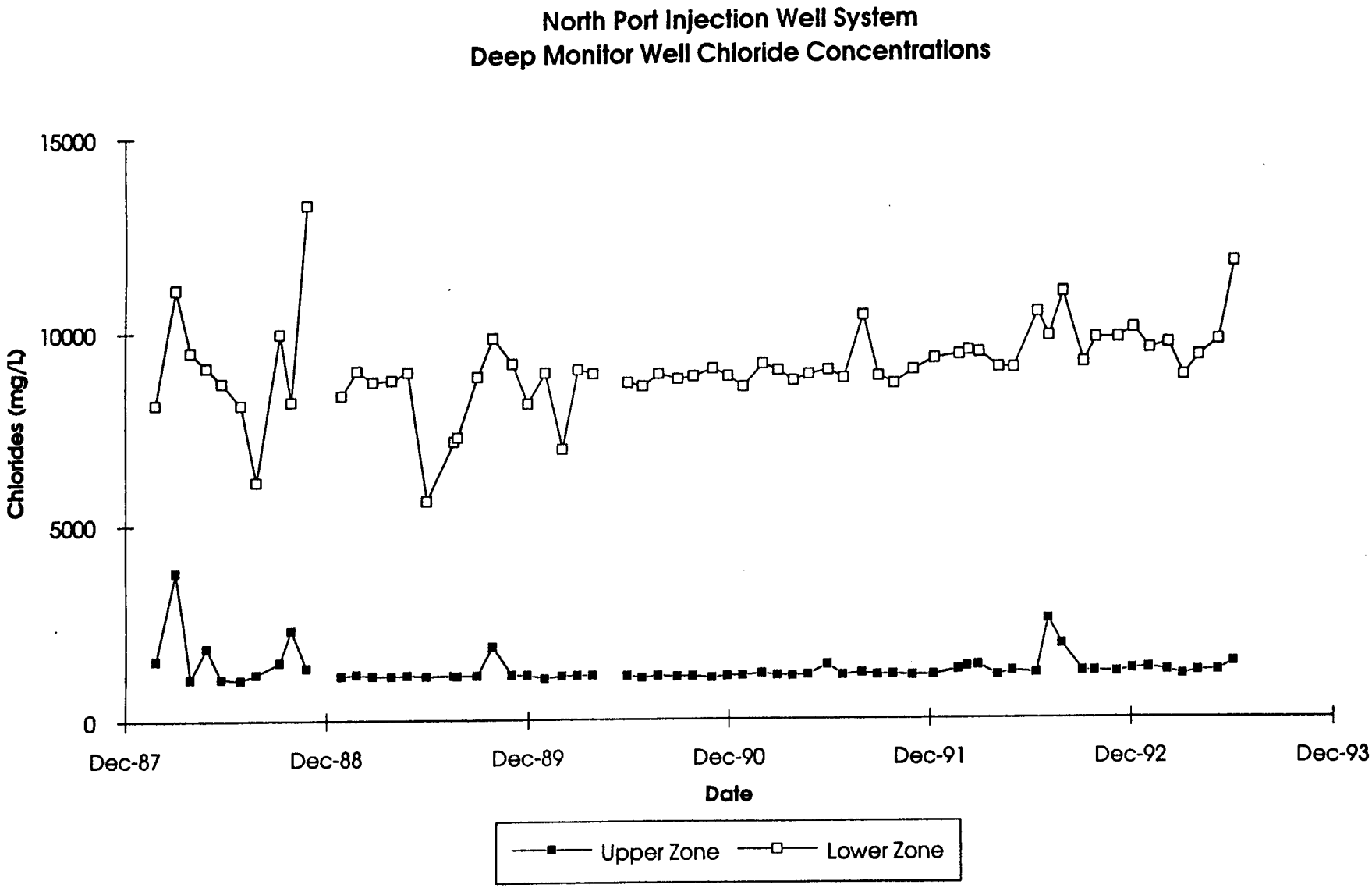

North Port Injection Well System
Deep Monitor Well Chloride Concentrations
Chlorides (mg/L)
15000
10000
5000
0
Dec-87
Dec-88
Dec-89
Dec-90
Dec-91
Dec-92
Dec-93
Date
Upper Zone
Lower Zone

FIGURE 10

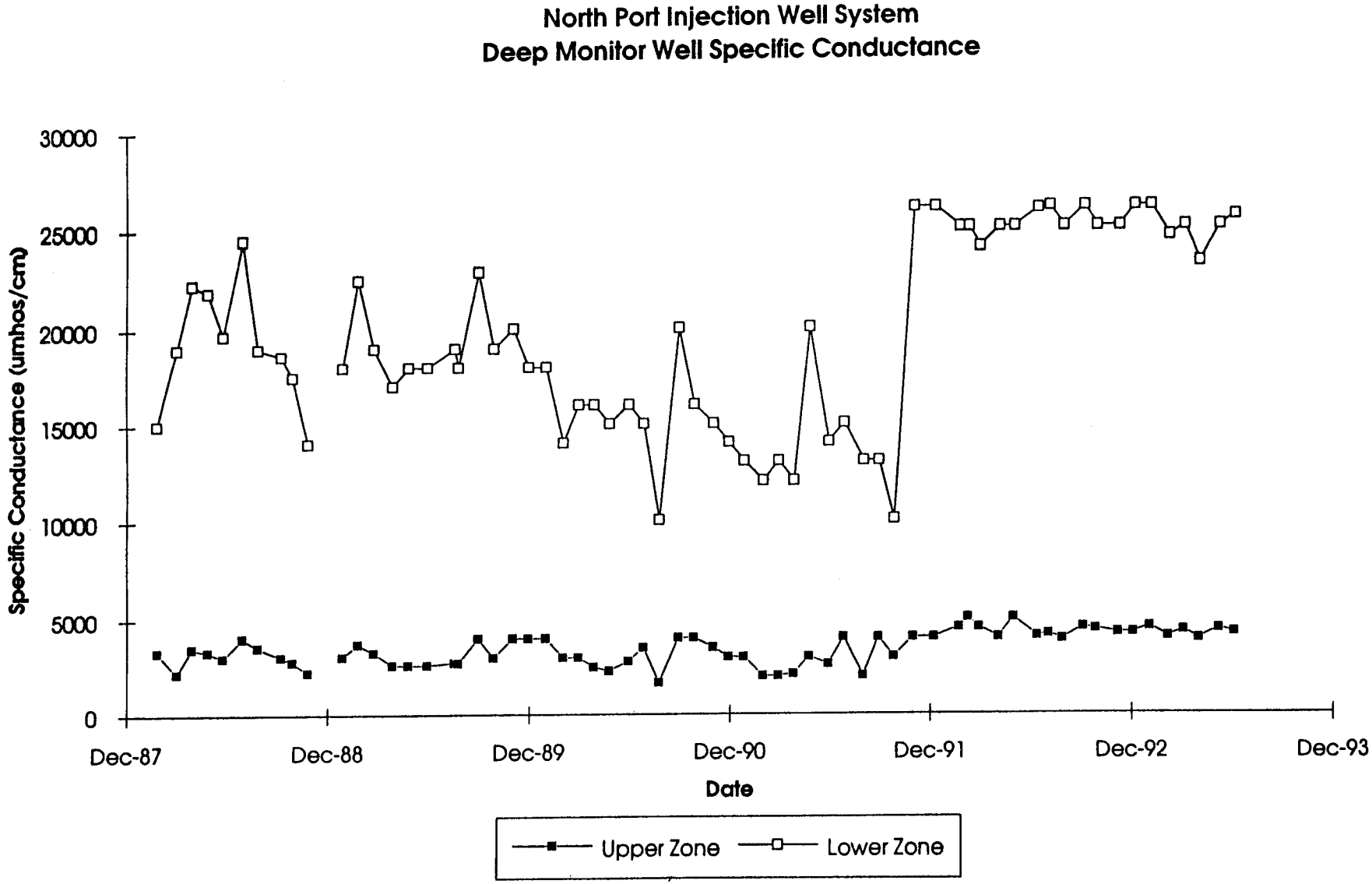

North Port Injection Well System
Deep Monitor Well Specific Conductance
Specific Conductance (umhos/cm)
30000
25000
20000
15000
10000
5000
0
Dec-87
Dec-88
Dec-89
Dec-90
Dec-91
Dec-92
Dec-93
Date
Upper Zone
Lower Zone

FIGURE 11

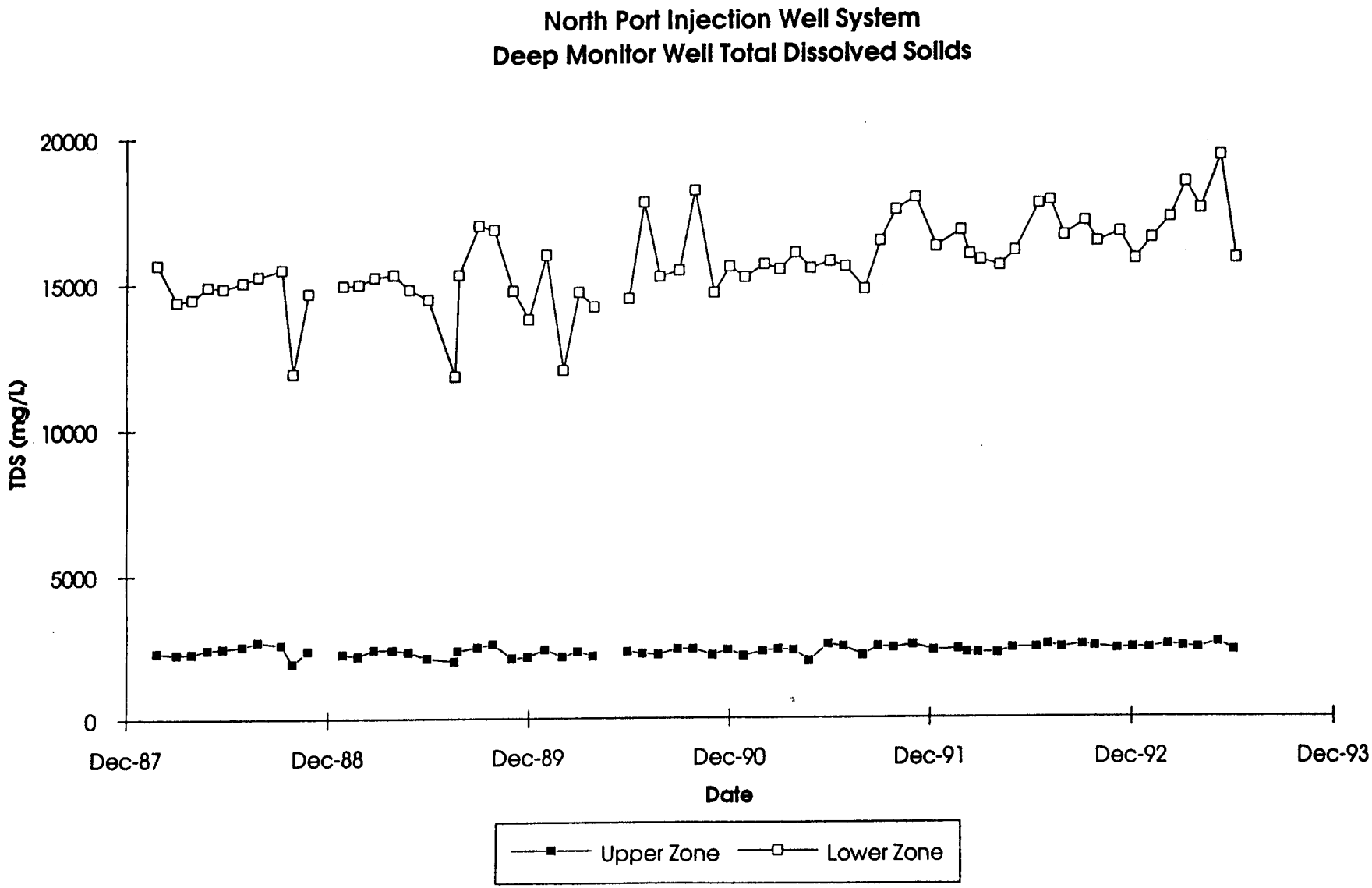

North Port Injection Well System
Deep Monitor Well Total Dissolved Solids
20000
15000
10000
5000
0
TDS (mg/L)
Dec-87
Dec-88
Dec-89
Dec-90
Dec-91
Dec-92
Dec-93
Date
Upper Zone
Lower Zone

FIGURE 12

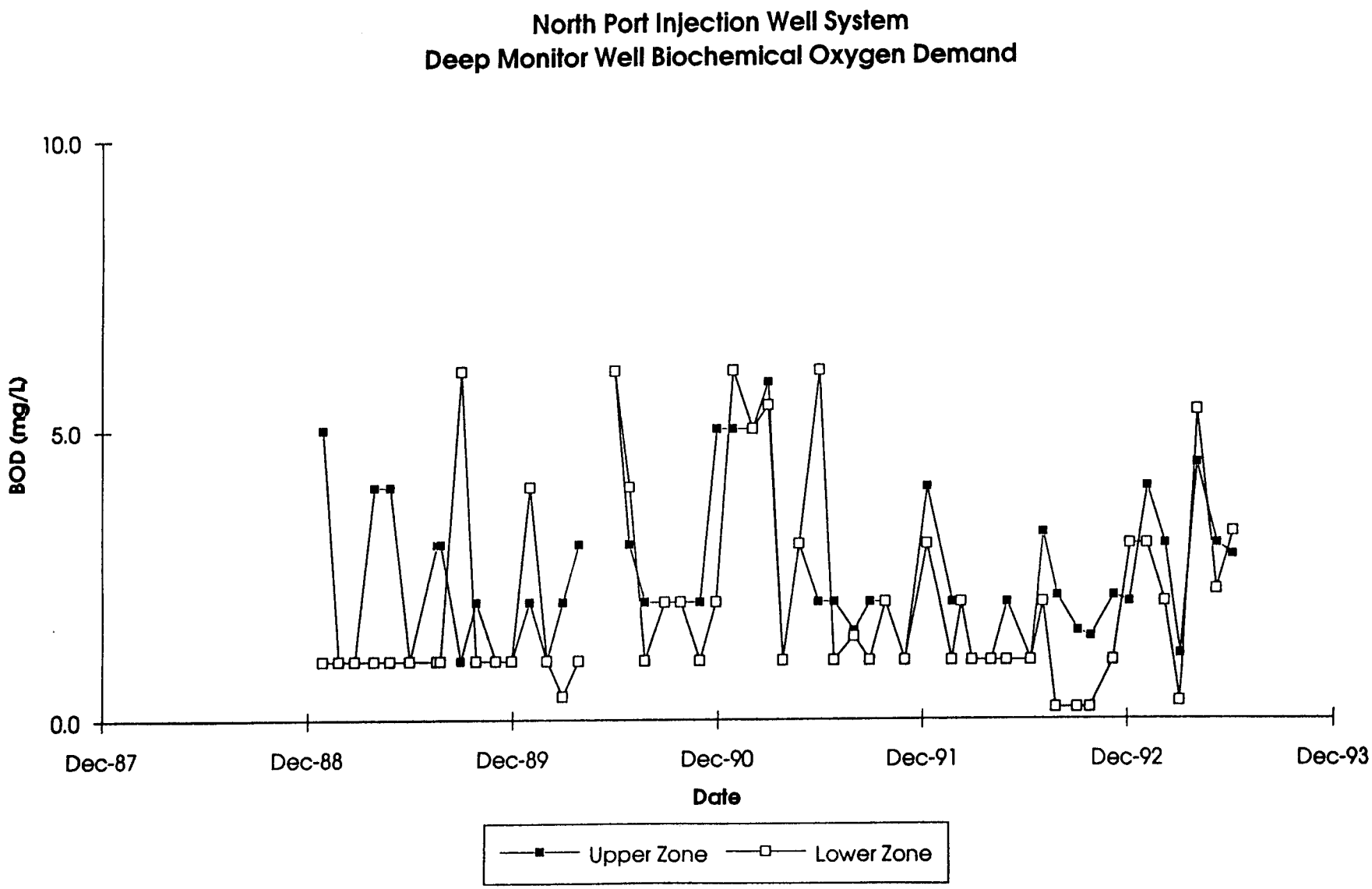

North Port Injection Well System
Deep Monitor Well Biochemical Oxygen Demand
10.0
5.0
0.0
BOD (mg/L)
Dec-87
Dec-88
Dec-89
Dec-90
Dec-91
Dec-92
Dec-93
Date
Upper Zone
Lower Zone

FIGURE 13

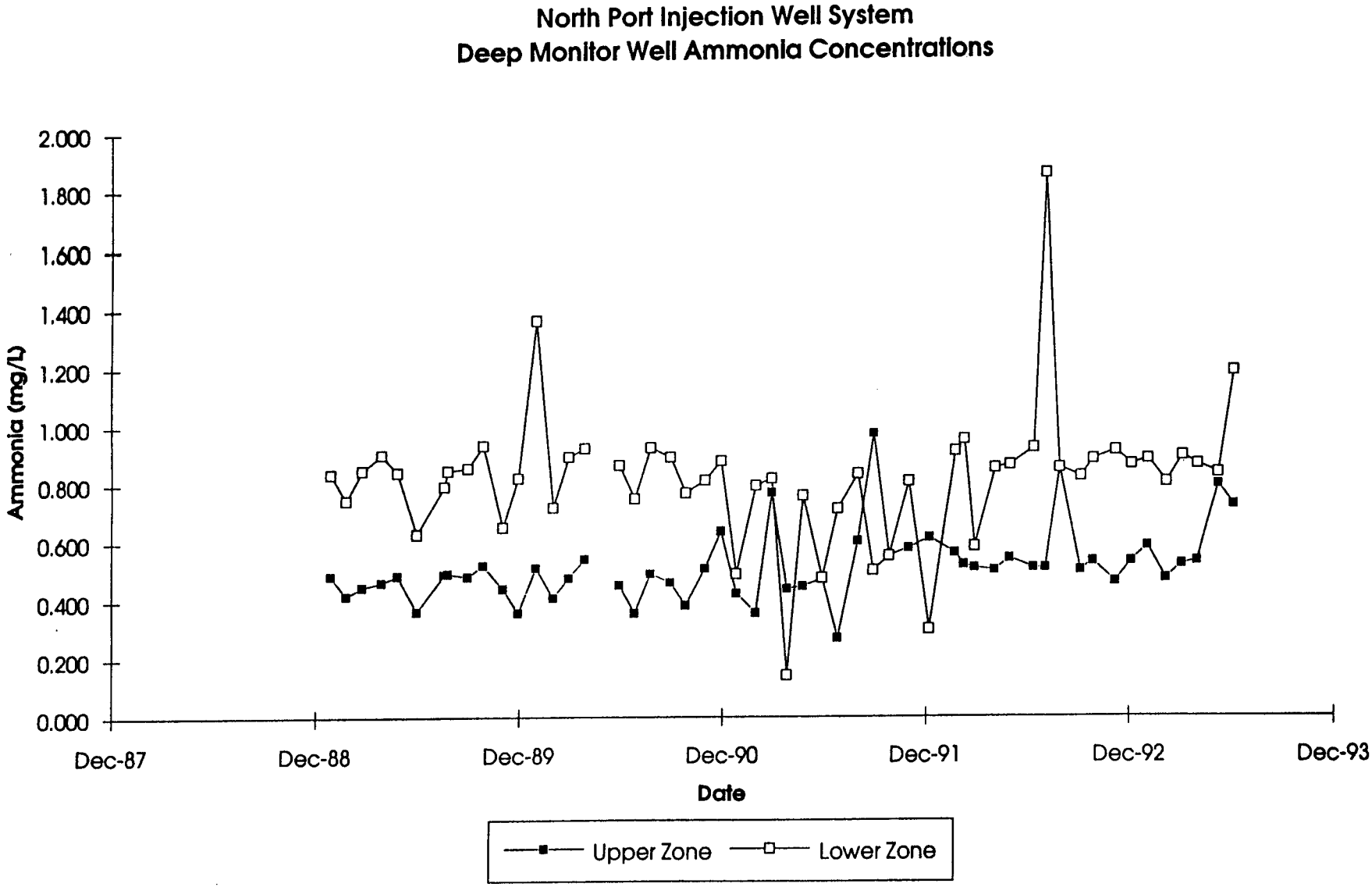

North Port Injection Well System
Deep Monitor Well Ammonia Concentrations
Ammonia (mg/L)
2.000
1.800
1.600
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
Dec-87
Dec-88
Dec-89
Dec-90
Dec-91
Dec-92
Dec-93
Date
Upper Zone
Lower Zone

FIGURE 14

ATTACHMENT E

SE15807.12

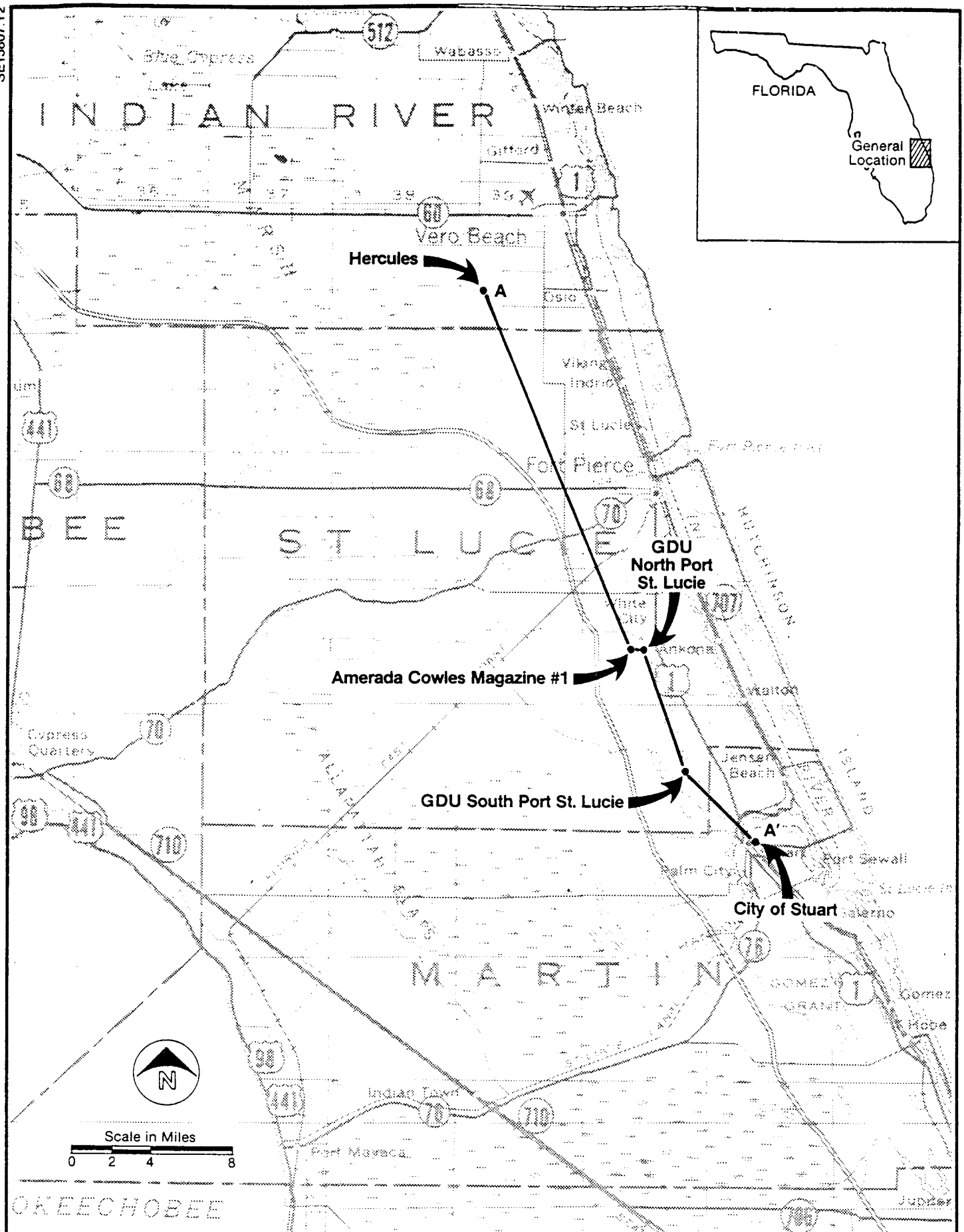
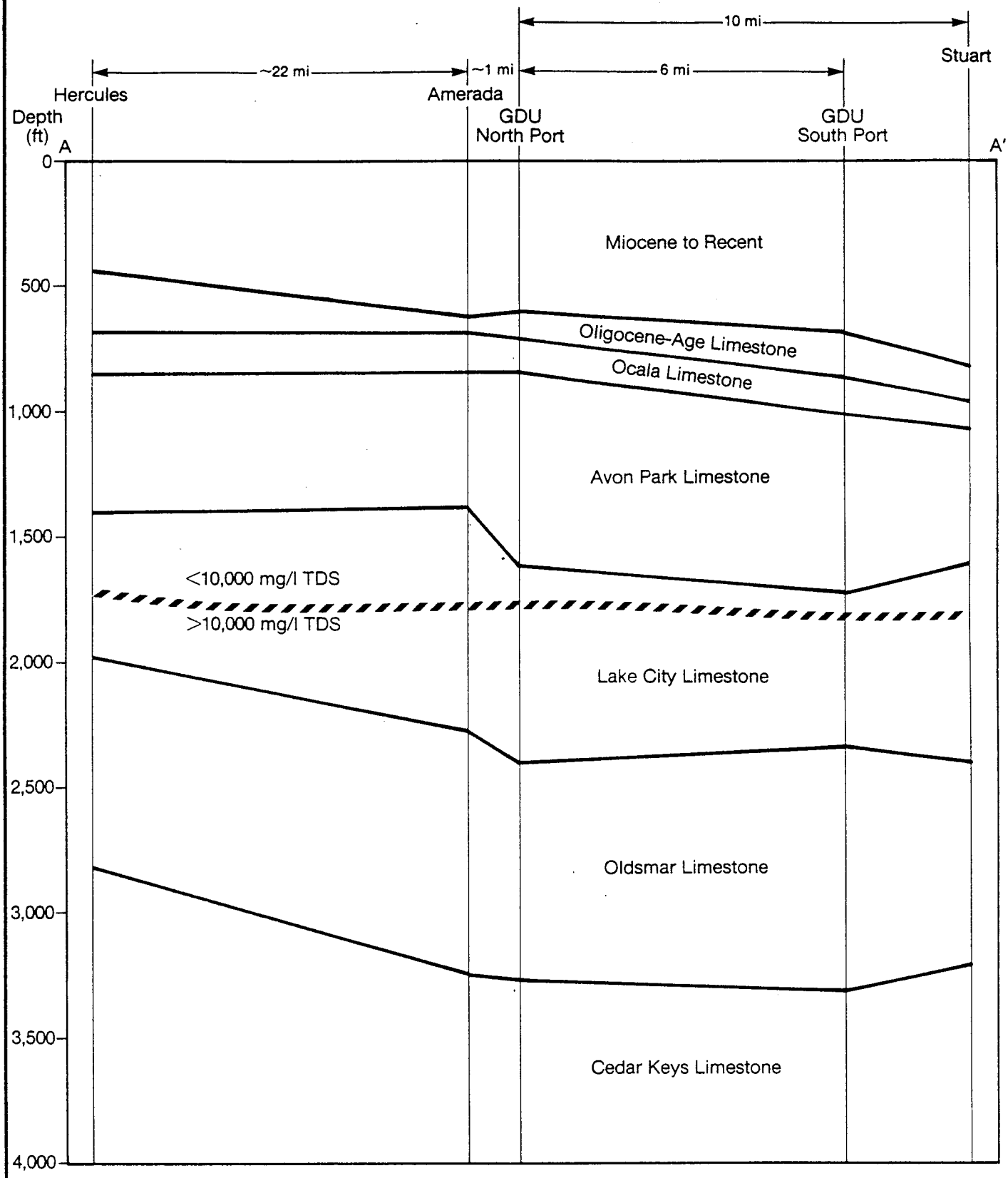


FIGURE 2-4.
GDU North Port St. Lucie WWTP—Location of Geologic Cross-Section.

SE15807.T2



Source: Florida Geologic Survey and CH2M HILL Files.

FIGURE 2-5.
GDU North Port St. Lucie WWTP—Generalized North-South Geologic Section from Indian River to Martin County.

ATTACHMENT F

SE15807.T2

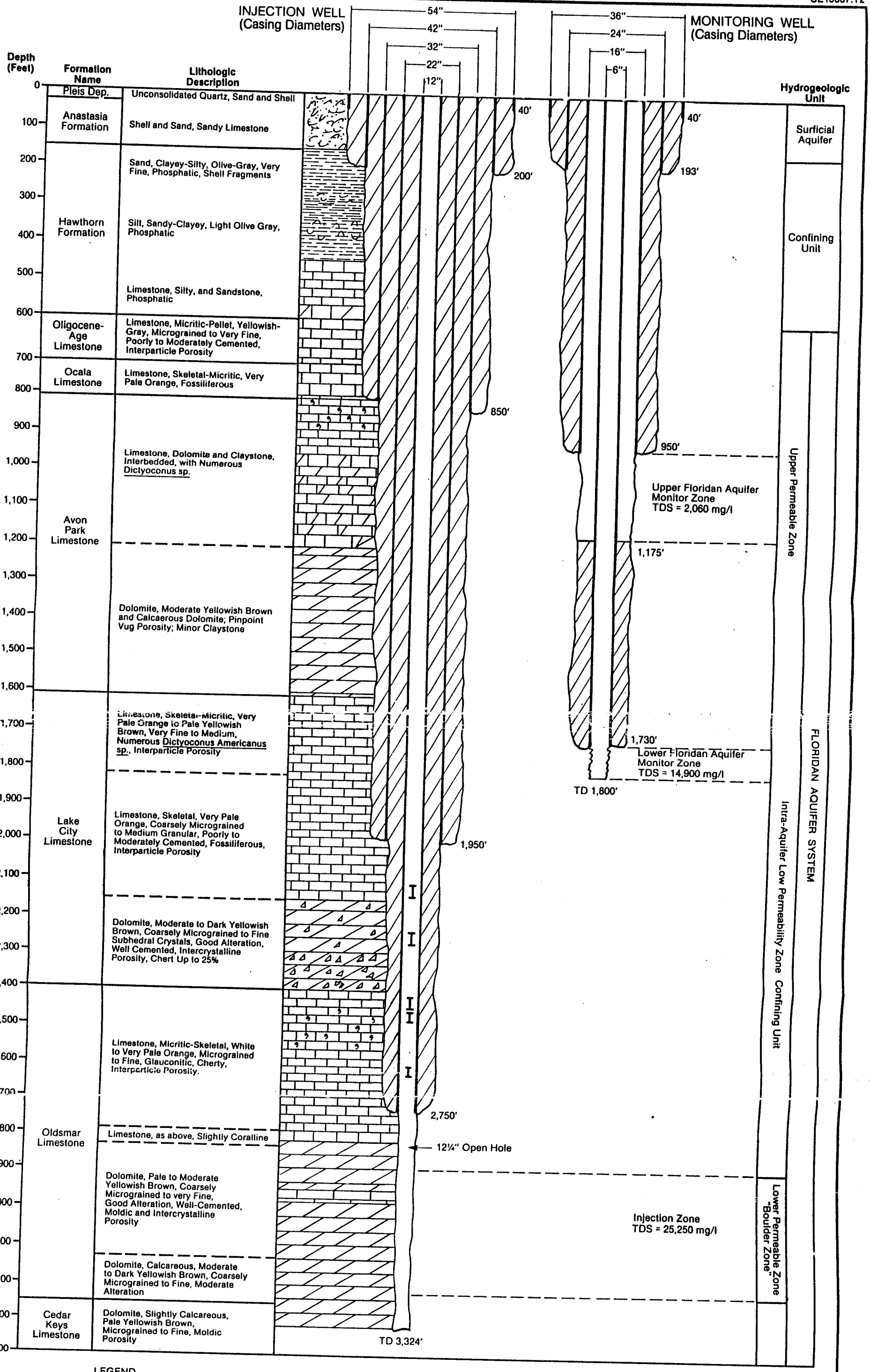


FIGURE 2-3.
GDU North Port St. Lucie WWTP—Summary of Well Construction and Hydrogeologic Data.

SE15807.T2

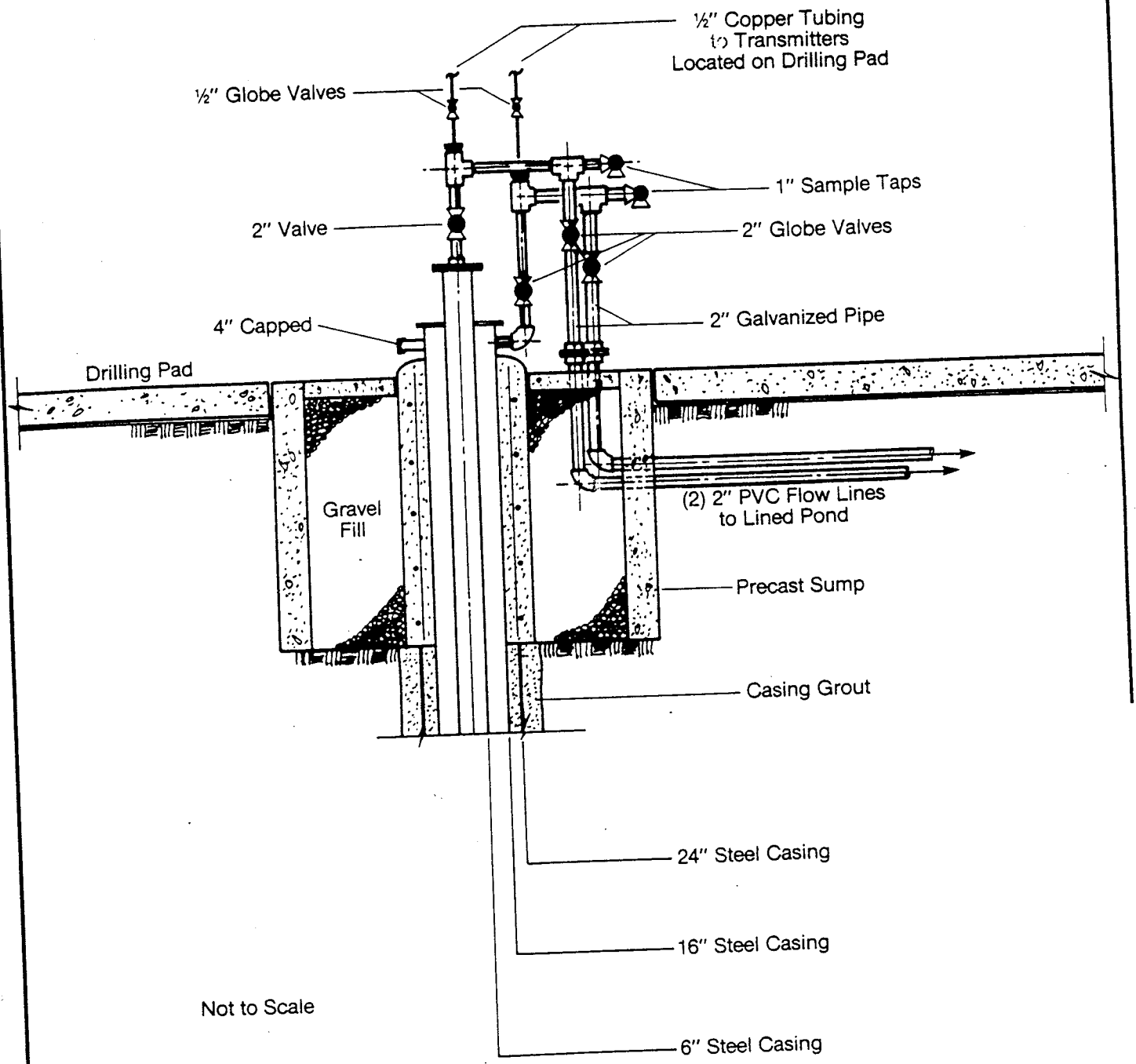


FIGURE 2-7.
GDU North Port St. Lucie WWTP—Monitor Wellhead Detail.

SE15807.T2

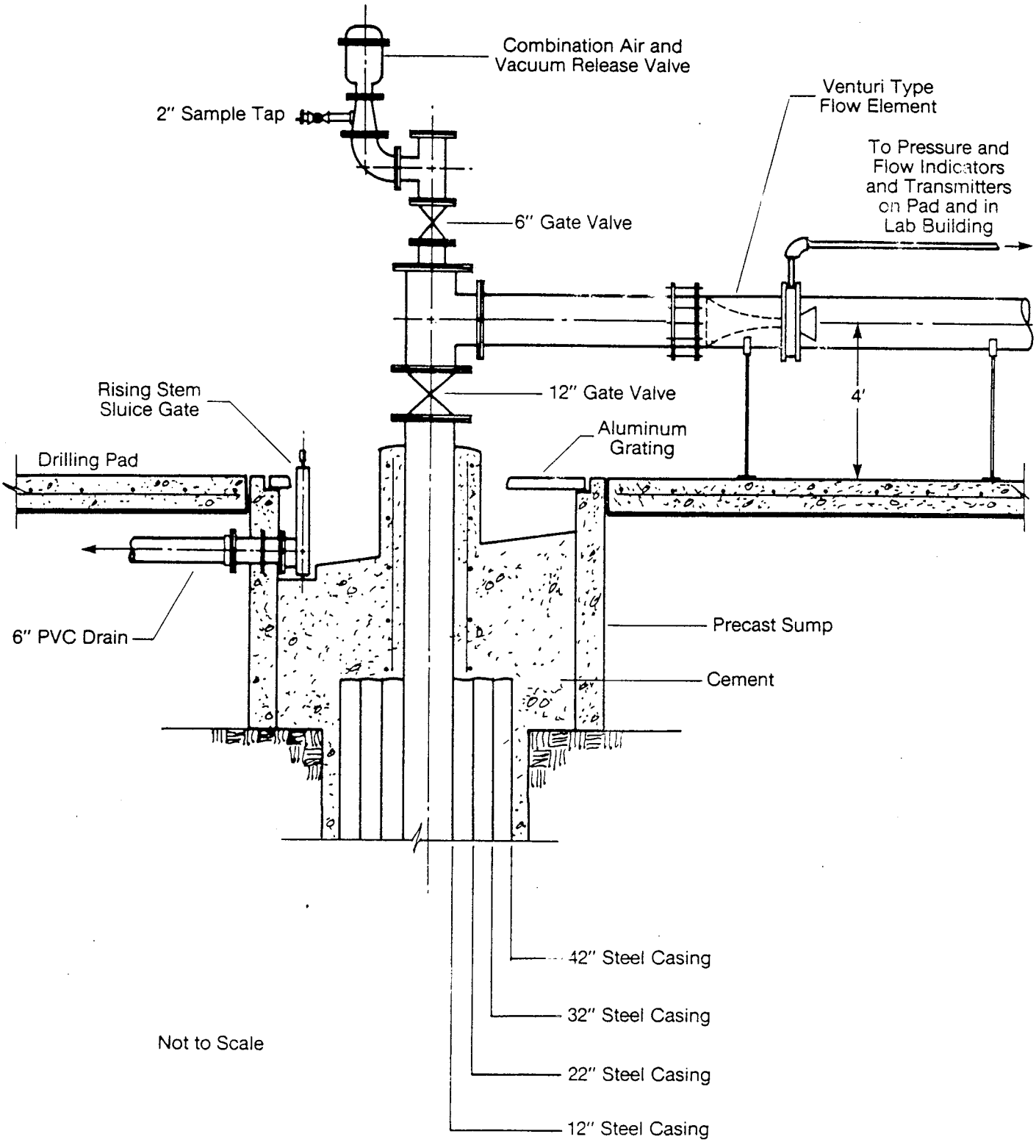


FIGURE 2-4.
GDU North Port St. Lucie WWTP—Injection Wellhead Detail.

CH2MHILL

ATTACHMENT G

TEST RESULTS

None of the tests conducted produced any results that are indicative of a leak in the casing or a pathway for upward migration of injected effluent. The pressure test on the North Port injection well satisfied the 5 percent criterion. The video survey did not reveal any structural defects in the casing.

OPERATIONAL DATA REVIEW

Data for the period of record for the North Port injection well, from issuance of the Operating Permit until July 1993 was reviewed. These data include injection well flows and wellhead pressures, specific injectivity, and dual-zone monitor well water quality data.

The monthly operating reports were reviewed for a representative value for daily flow rate and associated wellhead pressure. The value for flow was determined by selecting the daily flow value, which most closely represented the monthly average daily flow, for each month. A corresponding wellhead pressure was selected for this value from the day on which the flow occurred. Specific injectivity values as referenced on the monthly operating reports were plotted over time and versus flow.

The monthly water quality analysis values for chloride concentration, specific conductance, TDS, BOD, ammonia and fecal coliform sent to FDEP on a regular basis throughout the period of record also were reviewed. All the selected values were plotted on graphs. Summaries of the plotted data are presented in Appendix E. The following represents an interpretation of the collected data.

Average Flow Rate and Injection Pressure

The plot representing the average flow rates and wellhead pressures is represented as Figure 7. The average flow rate over the period of record has remained fairly constant, with only two significantly higher months, one in October 1988 and a second in January 1993 due to large rainfall during these months. From early 1988 until the end of 1991, the trend in average flow rates appeared to increase steadily, then a significant drop in average flow rate was observed. During 1992 flow rates increased steadily again until the end of the year. Throughout 1993 the average flow rate has been decreasing. The pressures corresponding to the average flow rates have basically reflected the trends observed in the flow rates, as expected.

Specific Injectivity

A specific injectivity test of the North Port Injection Well was conducted on July 30, 1993, following the brushing of the interior surface of the injection well casing. The Northport plant personnel executed the test in a manner consistent with past specific injectivity measurement procedures, so that comparisons could be made between the historic specific injectivity values of the well and those measured after the casing was brushed. Ideally, the specific injectivity should increase as a result of the brushing of well casing.

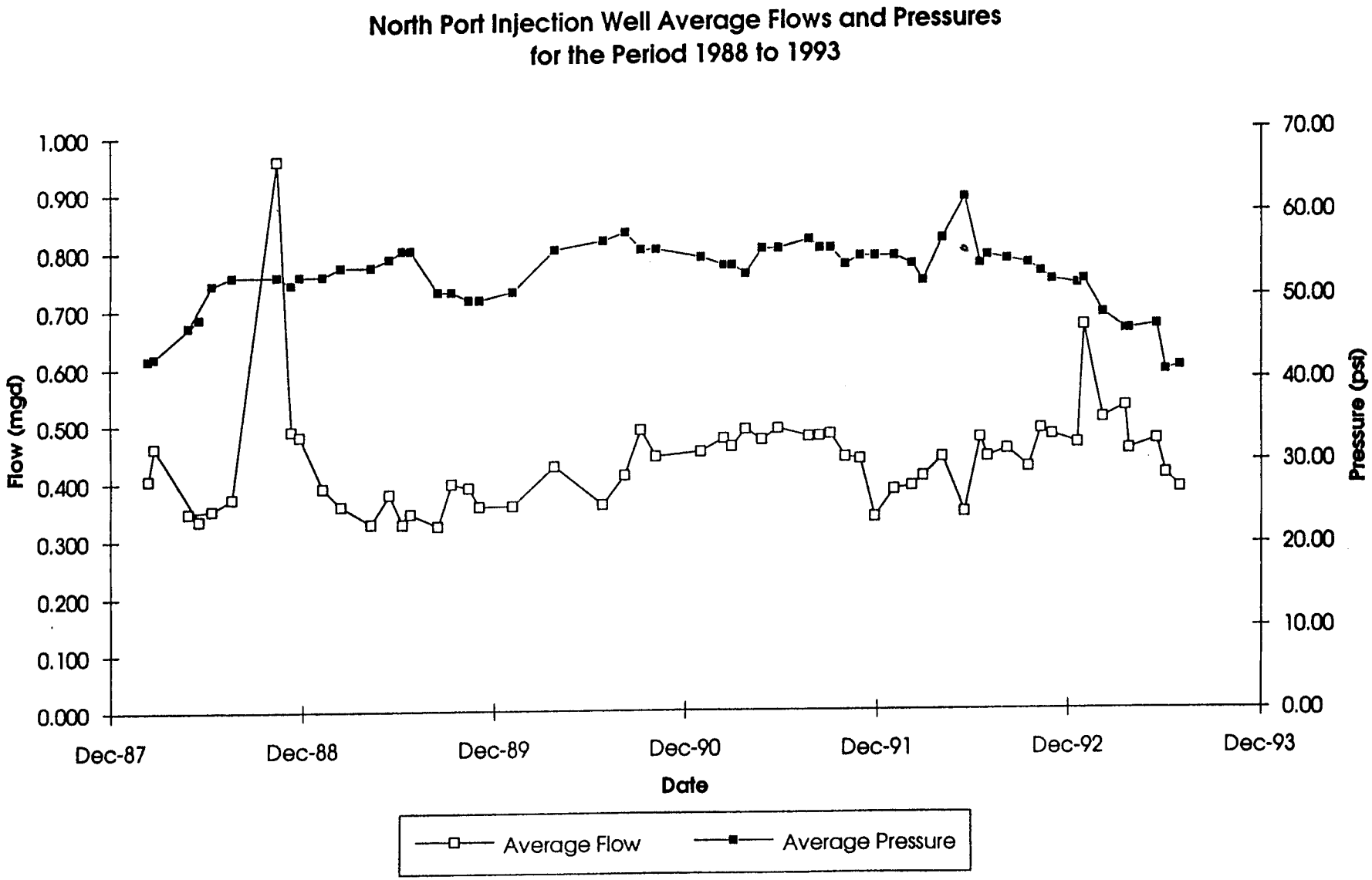

North Port Injection Well Average Flows and Pressures
for the Period 1988 to 1993
Flow (mgd)
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
Pressure (psi)
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Dec-87
Dec-88
Dec-89
Dec-90
Dec-91
Dec-92
Dec-93
Date
Average Flow
Average Pressure

FIGURE 7

Two separate flow ranges were used for the tests; a low range at 1,050 gpm, and a high range at 2,150 gpm. The specific injectivities were 156 gpm/psi for the low flow range and 127 gpm/psi for the high flow range. The decrease in the specific injectivity between the two tests is expected, as friction losses increase with increasing flow velocity. As can be seen in Figure 8, these values do not reflect a marked increase in the specific injectivity in relation to recent data, but do fall in the typical range of values for injectivities measured since June 1992.

As observed in Figure 9, specific injectivities have been steadily increasing since June 1992. This increase has been significant, resulting in specific injectivity values greater than those measured when the well was first placed on line. In the North Port well, which appeared to be relatively clean both on the casing surface and in the formation, brushing has not had a significant effect on improving specific injectivities. The reasons for the marked improvement in well efficiency over the past 14 months is not yet known, however, there is a theory. Approximately 14 months ago, chlorination of the effluent in the lined pond began. Doses of chlorine at the head of the lined pond have been high, approximately 100 pounds of chlorine per 1/2 mgd of effluent. Operators report, however, that chorine residuals are not present just before the effluent goes into the well. It is thought that vigorous chlorination of the effluent in the pond, almost eliminating algae growth in the pond, has assisted in keeping the well and formation free from build-up of materials in the well that would lower well efficiency. Changes in daily suspended solids values from the pond water also support this theory.

Dual Zone Monitor Well Water Quality Data

Graphs showing upper and lower monitor zone chloride concentration, conductance, TDS, BOD, and ammonia appear in this report as Figures 10, 11, 12, 13, and 14, respectively. No fecal coliforms have been detected in the upper and lower monitor zone samples throughout the period of record, so a graph of these data was not constructed.

Chloride (Figure 10). There appears to be no discernible trend in chloride concentration in the upper monitor zone. There is a very slight increasing trend in chloride concentration in the lower monitor zone, however. This trend would not appear to be significant in terms of mechanical integrity, because a leak from the injection zone to the lower monitor zone probably would result in a decrease in chloride concentration, rather than the reverse. However, slow upward movement of saline water from the injection zone might indicate upward movement of the injected fresh water. No other evidence currently suggests that upward movement of freshwater from the injection is occurring, however.

Specific Conductance (Figure 11). Conductance in samples collected from both upper and lower zones show a slight increase over the last year and a half of record, since December 1991. An especially sharp increase in specific conductance occurred in December 1991. The reason for this might be the acquisition of a new conductance probe by St. Lucie County in late October 1991. Prior to that, widely fluctuating values in the lower zone seemed to indicate an overall decreasing trend. These trends, by comparison with other measured parameters would seem uninterpretable in terms of actual changes in the water quality of the actual monitor zones, so might have indicated a problem with the measuring device.

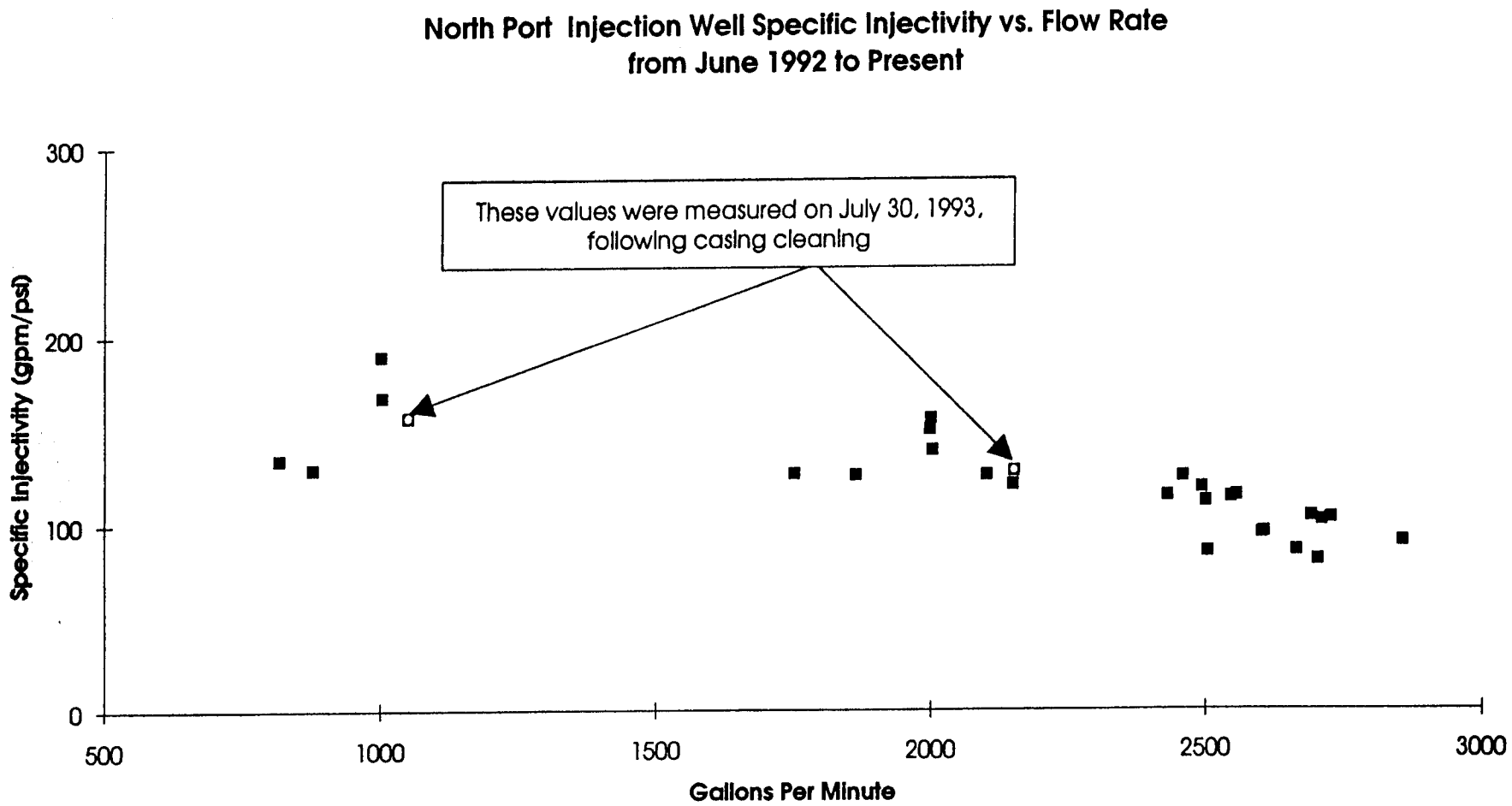

North Port Injection Well Specific Injectivity vs. Flow Rate
from June 1992 to Present
These values were measured on July 30, 1993,
following casing cleaning
Specific Injectivity (gpm/psi)
300
200
100
0
500
1000
1500
2000
2500
3000
Gallons Per Minute

FIGURE 8

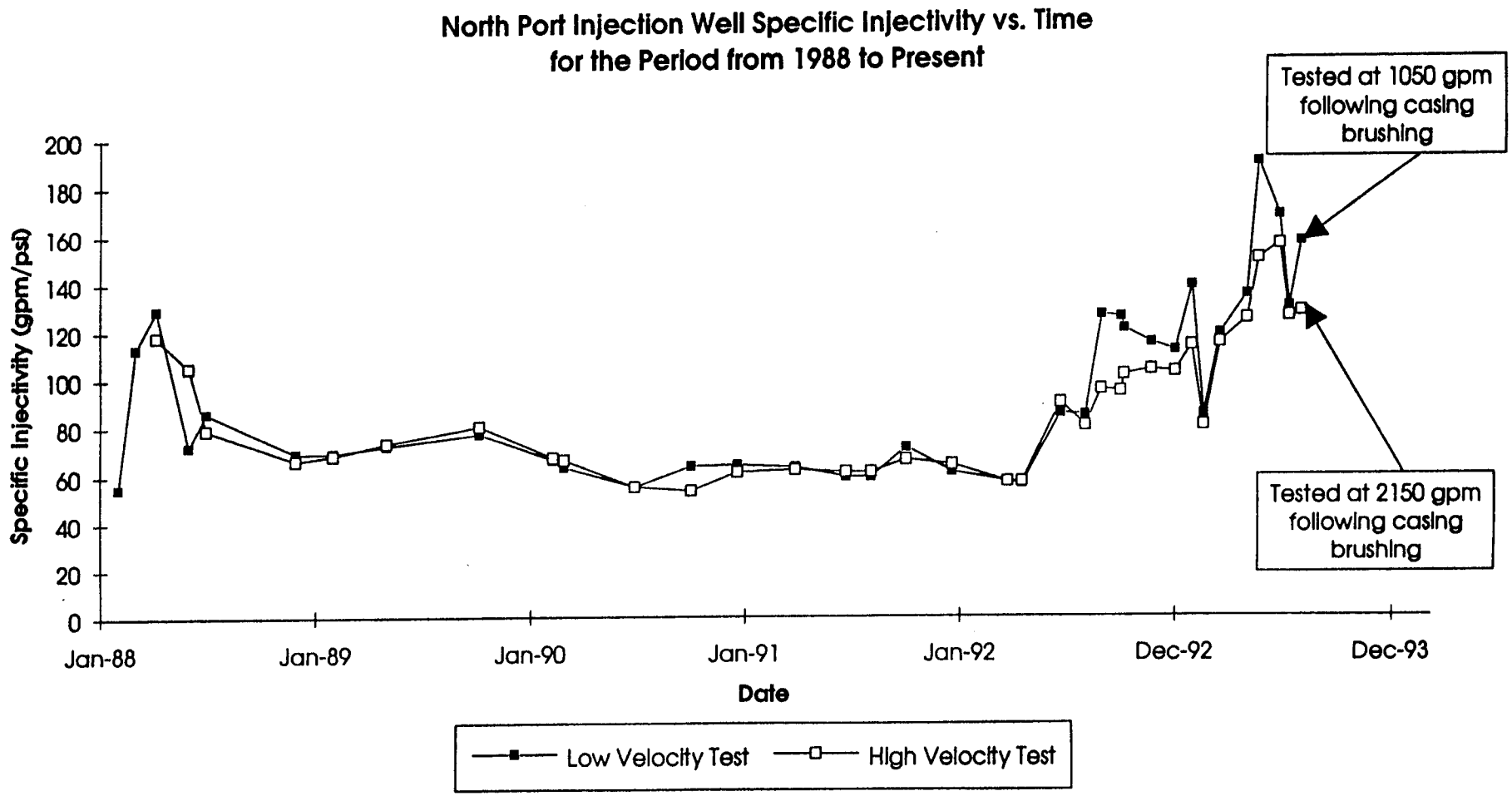
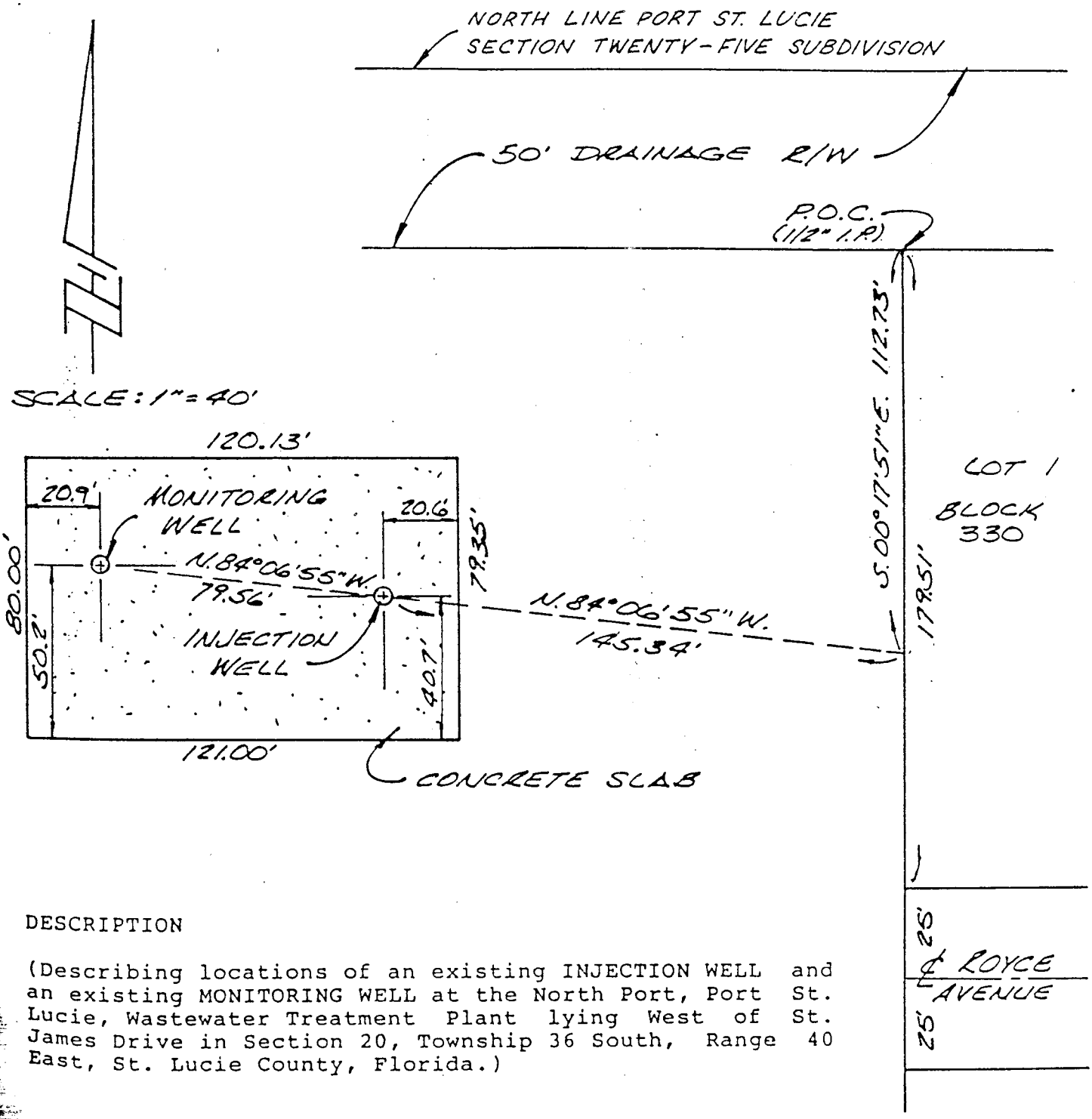

North Port Injection Well Specific Injectivity vs. Time
for the Period from 1988 to Present
Tested at 1050 gpm following casing brushing
Tested at 2150 gpm following casing brushing
Specific Injectivity (gpm/psi)
200
180
160
140
120
100
80
60
40
20
0
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Dec-92
Dec-93
Date
Low Velocity Test
High Velocity Test

FIGURE 9

ATTACHMENT H

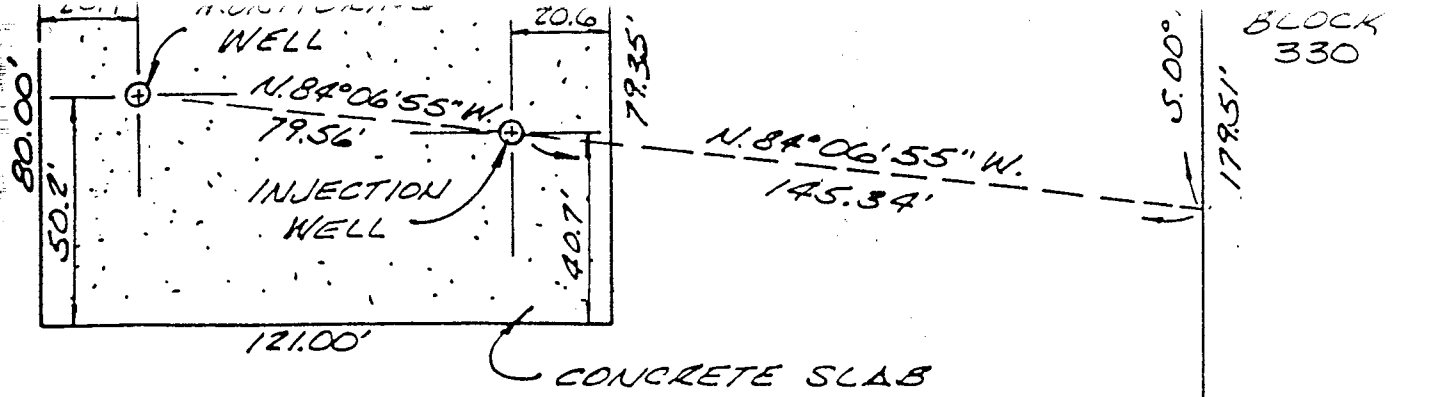


DESCRIPTION

(Describing locations of an existing INJECTION WELL and an existing MONITORING WELL at the North Port, Port St. Lucie, Wastewater Treatment Plant lying West of St. James Drive in Section 20, Township 36 South, Range 40 East, St. Lucie County, Florida.)

COMMENCING at a point (P.O.C.) being the Northwest corner of Lot 1 in Block 330 of subdivision entitled, PORT ST. LUCIE SECTION TWENTY FIVE, as recorded in Plat Book 13 at pages 32, 32A through 32I of the Public Records of St. Lucie County, Florida, run thence S 00° 17'51" E along the West line of said Lot 1, 112.73 feet; thence run N 84° 06'55"" W, 145.34 feet to the center of the aforementioned INJECTION WELL; thence continue N 84° 06'55" W, 79.56 feet to the center of the aforementioned MONITORING WELL and the end of this description.

Description prepared by CULBERTSON AND TERPENING.



DESCRIPTION

(Describing locations of an existing INJECTION WELL and an existing MONITORING WELL at the North Port, Port St. Lucie, Wastewater Treatment Plant lying West of St. James Drive in Section 20, Township 36 South, Range 40 East, St. Lucie County, Florida.)

COMMENCING at a point (P.O.C.) being the Northwest corner of Lot 1 in Block 330 of subdivision entitled, PORT ST. LUCIE SECTION TWENTY FIVE, as recorded in Plat Book 13 at pages 32, 32A through 32I of the Public Records of St. Lucie County, Florida, run thence S 00° 17'51" E along the West line of said Lot 1, 112.73 feet; thence run N 84° 06'55"" W, 145.34 feet to the center of the aforementioned INJECTION WELL; thence continue N 84° 06'55" W, 79.56 feet to the center of the aforementioned MONITORING WELL and the end of this description.

Description prepared by CULPEPPER AND TERPENING. (L8820)

I HEREBY CERTIFY THAT THE MAP OF SURVEY OF THE HEREON DESCRIBED PROPERTY IS TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF AS SURVEYED IN THE FIELD UNDER MY DIRECTION ON APRIL 7 TH. 1988 I FURTHER CERTIFY THAT THIS SURVEY MEETS THE MINIMUM TECHNICAL STANDARDS SET FORTH IN RULE 21HH-6 ADOPTED BY THE FLORIDA BOARD OF LAND SURVEYORS, PURSUANT TO FLORIDA STATUTE 472.027. THERE ARE NO ABOVE GROUND ENCROACHMENTS OTHER THAN THOSE SHOWN HEREON.

DATED THIS 8 TH DAY OF APRIL 1988.

BY: _____

E. BRETT CULPEPPER
FLORIDA CERTIFICATE NO. 3333

NOT VALID UNLESS SEALED WITH AN EMBOSSED SEAL

CULPEPPER & TERPENING, INC.

CONSULTING ENGINEERS & LAND SURVEYORS
FORT PIERCE, FLORIDA

FIELD BY:	DRAWN BY:	SCALE:	FILE NO.:
R.L.	D.F.	1" = 40'	8820

ATTACHMENT I

BOARD OF COUNTY COMMISSIONERS

ST. LUCIE COUNTY FLORIDA

UTILITY SERVICES DEPARTMENT

ST. LUCIE COUNTY UTILITY SERVICES DEPARTMENT

M E M O R A N D U M

To: Dan Sneed, Facility Operations Director

From: Carl Norton, Chief Operator NPWWTP

Date: November 4, 1993

Subject: Revisions - Injection Well O&M Manual

As requested, in response to DEP's request for information, through Montgomery Watson, the following revisions have been made to the O&M manual for the injection well. Enclosed are revised pages, tables, and figures to update the O&M manuals of all concerned. Also enclosed is a highlighted copy with notes showing where the revisions were made.

If there are any questions, or we can be of any further assistance please feel free to give us a call.

901 S.E. Prineville Street • Port St. Lucie, FL 34983 • Tel: (407) 878-2233 • Fax #: (407) 340-0479

Table 3-1
MONITORING DATA FOR THE INJECTION SYSTEM

Parameter	Equipment or Procedure	Data to be Submitted to FDEP
Injection Flow Rate	24-hour circular chart recorder & totalizer in laboratory	7A. Total daily & monthly flow; monthly maximum & minimum flow
Injection Pressure (psig)	24-hour circular chart recorder in laboratory	Daily minimum & maximum pressure; monthly minimum, maximum & average pressure 7B
Water Elevation in the Lower Monitoring Zone - 1,730-1,800 ft (ft of water)	24-hour circular chart recorder in laboratory	Daily minimum & maximum level; monthly minimum, maximum & average level 7C
Water Elevation in the Upper Monitoring Zone - 950-1,175 ft (feet of water)	24-hour circular chart recorder in laboratory	Daily minimum & maximum level; monthly minimum, maximum & average levels
Injection Well Capacity	Southeast District U. I. C. Protocol	Southeast U.I.C. Injectivity Testing Summary Sheet
Water Quality of the Two Monitoring Zones	Sample after flowing a minimun of 3 casing volumes from both zones	Upper & Lower Zones (Monthly) Specific conductance, chloride, fecal coliform, total dissolved solids, total phosphorous & sulfate. Consult DEP operating permit. Additional parameters may be required. 7D

revision 11-93
gnR196A/018a

NORTH PORT WWTP
GMS #5156P03278
TEST SITE ID #00005
Operating Permit #DO-56-148752
Injection Well Permit #UO-56-148337

SOUTHEAST DISTRICT
UNDERGROUND INJECTION CONTROL
INJECTIVITY TESTING SUMMARY SHEET

Injection Well No.:
DATE OF TEST:
FDER PERMIT No.:

Signature of Lead Operator

Were Wellhead Valves Exercised _____YES _____NO

TIME

	START	SHUT-IN PRESSURE
	MINS AFTER SHUT-IN	CALIBRATED PRESSURE GAUGE AT WELL HEAD (PSI)
	10	
	20	
	30	

COLUMN: 1	2	3	4	5		6	7	8	9	10
TIME	INJECTION WELL SHUT-IN PRESSURE AFTER 30 MINUTES (PSI)	PUMP NUMBER(S) ON-LINE	INJECTION RATE (gpm) and (mgd)	Injection Pressure after 10 minutes of pumping		PRESSURE DIFFERENTIAL (Col 5 - Col 2)	INJECTIVITY INDEX (Col 4 divide by Col 7)	UPPER MONITOR ZONE IN FEET OF HEAD ABOVE NGVD (FEET)	LOWER MONITOR ZONE IN FEET OF HEAD ABOVE NGVD (FEET)
				CALIBRATED GAUGE AT INJECTION WELLHEAD (PSI)	PRESSURE RECORDER (PSI)	FROM CALIBRATED PRESSURE GAUGE AT INJECTION WELLHEAD (PSI)	FROM CALIBRATED PRESSURE GAUGE AT INJECTION WELLHEAD (PSI)		

NOTES

1. INJECTIVITY INDEX (GPM/PSI) = INJECTION RATE (GPM) (COLUMN 4) / (INJECTION PRESSURE (PSI) (COLUMN 5) - SHUT-IN PRESSURE (PSI) (COLUMN 2))

2. FOR MORE INFORMATION REGARDING EXECUTION OF THIS TEST CONSULT THE INJECTIVITY TESTING PROTOCOL.

3. TO CONVERT PRESSURE READING (PSI) AT THE WELLHEAD FOR THE UPPER MONITOR ZONE TO FEET OF HEAD ABOVE NGVD, MULTIPLY (PSI) BY 2.31 AND ADD 23.97 FEET

4. DIGITAL READOUT AT WELLHEAD FOR LOWER MONITOR ZONE IS IN FEET OF HEAD ABOVE NGVD

FIGURE 3-1

The Plant's Operation Manager or designee should make the notification to F.D.E.P..

MONITORING DATA COLLECTION AND REPORTING

Injection system monitoring data are collected to provide a record of system performance and a guide to the operator locating and solving operating problems. This record represents the only direct indication of the injection system performance and server to substantiate decisions and recommendations. It also provides information the F.D.E.P. requires as stipulated in the operating permit. The data provide necessary information for planning future system expansions.

Table 3-1 lists the monitoring data to be collected from the injection system.

MONITORING DATA MONTHLY REPORT

The data for the Monitoring Data Monthly Report are to be compiled on a daily basis using the injection flowmeter recorder chart, the injection well pressure recorder chart, and the two annular monitoring zone recorder charts. The injection well reports will be sent to the following addresses no later than the 15th of the next month.

F.D.E.P.'s UNDERGROUND INJECTION CONTROL PROGRAM
PO. BOX 15425, WEST PALM BEACH FLA. 33416 7 F

F.D.E.P.'s UNDERGROUND INJECTION CONTROL PROGRAM
2600 BLAIR STONE ROAD, TALLAHASSEE, FLA. 32399-2400

MONITORING WELL WATER QUALITY REPORT

Every month, water quality samples are to be collected from the two monitoring zones in the monitoring well. These samples are compared to the pre-injection water quality in order to detect any changes caused by potential migration of

7E

6. After completing the injectivity test a fall off test will be run.

At the completion of the test, return the pump controls to the AUTO position and reopen all valves used to throttle the flow.

Record all information on the approved SOUTHEAST DISTRICT UNDERGROUND INJECTION CONTROL INJECTIVITY TESTING SUMMARY SHEET, as shown in Figure 3-1.

Table 3-1
MONITORING DATA FOR THE INJECTION SYSTEM

Parameter	Equipment or Procedure	Data to be Submitted to FDEP
Injection Flow Rate	24-hour circular chart recorder & totalizer in laboratory	Total daily & monthly flow; monthly maximum & minimum flow
Injection Pressure (psig)	24-hour circular chart recorder in laboratory	Daily minimum & maximum pressure; monthly minimum, maximum & average pressure
Water Elevation in the Lower Monitoring Zone - 1,730-1,800 ft (ft of water)	24-hour circular chart recorder in laboratory	Daily minimum & maximum level; monthly minimum, maximum & average level
Water Elevation in the Upper Monitoring Zone - 950-1,175 ft (feet of water)	24-hour circular chart recorder in laboratory	Daily minimum & maximum level; monthly minimum, maximum & average levels
Injection Well Capacity	Southeast District U. I. C. Protocol	Southeast U.I.C. Injectivity Testing Summary Sheet
Water Quality of the Two Monitoring Zones	Sample after flowing a minimum of 3 casing volumes from both zones	Upper & Lower Zones (Monthly) Specific conductance, chloride, fecal coliform, total dissolved solids, total phosphorous & sulfate. Consult DEP operating permit. Additional parameters may be required.

The Plant's Operation Manager or designee should make the notification to F.D.E.P..

MONITORING DATA COLLECTION AND REPORTING

Injection system monitoring data are collected to provide a record of system performance and a guide to the operator locating and solving operating problems. This record represents the only direct indication of the injection system performance and server to substantiate decisions and recommendations. It also provides information the F.D.E.P. requires as stipulated in the operating permit. The data provide necessary information for planning future system expansions.

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The data for the Monitoring Data Monthly Report are to be compiled on a daily basis using the injection flowmeter recorder chart, the injection well pressure recorder chart, and the two annular monitoring zone recorder charts. The injection well reports will be sent to the following addresses no later than the 15th of the next month.

F.D.E.P.'s UNDERGROUND INJECTION CONTROL PROGRAM
PO. BOX 15425, WEST PALM BEACH FLA. 33416

F.D.E.P.'s UNDERGROUND INJECTION CONTROL PROGRAM
2600 BLAIR STONE ROAD, TALLAHASSEE, FLA. 32399-2400

MONITORING WELL WATER QUALITY REPORT

Every month, water quality samples are to be collected from the two monitoring zones in the monitoring well. These samples are compared to the pre-injection water quality in order to detect any changes caused by potential migration of

6. After completing the injectivity test a fall off test will be run.

At the completion of the test, return the pump controls to the AUTO position and reopen all valves used to throttle the flow.

Record all information on the approved SOUTHEAST DISTRICT UNDERGROUND INJECTION CONTROL INJECTIVITY TESTING SUMMARY SHEET, as shown in Figure 3-1.

ATTACHMENT J

PLUGGING AND ABANDONMENT PLAN FOR INJECTION WELL IW-1 AND DUAL ZONE MONITOR WELL NORTH PORT ST. LUCIE COUNTY INJECTION WELL SYSTEM (NOVEMBER 5, 1993)

This Plugging and Abandonment Plan outlines the procedures and costs for plugging and abandoning Injection Well IW-1 and one dual zone monitor well located at the North Port St. Lucie Wastewater Treatment Plant. In the event that the injection well system has to be abandoned, the injection zones must be effectively plugged and sealed. This would prevent the upward migration of fluid from the injection zone and/or an interchange of formation waters between aquifers.

This plan describes a procedure for filling the open hole (injection zone) with coarse aggregate or concrete with coarse aggregate; plugging the injection well and the lower zone of the monitoring well using bridge plugs; and the sealing of the upper annular monitor zone using gravel and cement. In this procedure, the open hole is filled with coarse aggregate and a bridge plug is set at the bottom of the casing in the injection well and in the final tubing of the monitor well. The casing and tubing are then plugged with cement above the bridge plug. The upper monitor zone annulus is filled with gravel in the open borehole, and cemented to land surface.

The following is a description of: (1) the bridge plug method of abandonment for the injection well and the lower zone of the monitor well; and (2) modifications to the plan that apply to the open annulus section (upper monitor zone) of the monitor well, where a bridge plug cannot be set. The cost calculations allow for the purchase of all the materials necessary for these tasks, and represent an approximate cost for the plugging and abandonment of the injection well and the dual zone monitor well, including 10 percent contingency and 15 percent estimated associated engineering cost.

A. To plug the injection well and the lower zone of the monitor well by the bridge plug method, the proposed plan is as follows:

1. Mobilize a drill rig, "kill" the well by filling the casing with 9.0 pounds per gallon (ppg) drilling mud, and remove the valve assembly and appurtenances from the wellhead.

2. Fill the open hole portion of the well between the bottom of the casing and the bottom of the well with coarse aggregate or concrete with coarse aggregate. The fill will be emplaced with a tremie pipe. The volume estimated for filling the open hole of the injection well is approximately 940 cubic feet and includes a 100 percent loss to cavities. The volume estimated for filling the open hole of the monitor well is approximately 14.5 cubic feet and includes a 50 percent loss to the formation.

3. Set a bridge plug, consisting of a short section of threaded pipe with a bottom plug and a hydraulically operated packer, at the bottom of the injection well casing and in the lower zone of the monitor well. This bridge plug will be lowered to the bottom of the casing by a drill string consisting of threaded pipe, a "J" disconnect and an on/off tool followed by enough drill pipe to set the bridge plug.

4. Expand the bridge plug and set it by pumping water or other fluid under pressure to the mechanical packer. The drill string will then be backed off, disconnecting at the "J" disconnect. A slurry of neat cement will be pumped in stages into the hole through a tremie pipe to the bridge plug assembly. The quantity of cement pumped should be equivalent to the volume of slurry required to fill the casing 20 to 25 feet above the top of the bridge plug.

5. The cement should be allowed to set for 24 hours and then tagged with a wire line to determine if sufficient fill up has been achieved.

6. The remainder of the casing will then be filled with neat cement.

The method described above could be used to plug the injection well and the lower zone (deep zone) section of the monitor well. However, the open annulus section in the upper, or shallow, zone of the monitor well cannot be filled using this method. It will be necessary to plug the upper zone by filling the open hole portion of the well with gravel, tagging and pumping cement to land surface in stages.

B. To plug the upper zone of the monitor well by the gravel and cement method, the proposed plan is as follows:

1. Mobilize a drill rig, "kill" the well by filling the casing with 9.0 ppg drilling mud, and remove the valve assembly and appurtenances from the wellhead.

2. Add a volume of gravel to the well equal to the volume of the open hole section of the well. Fill the open formation with gravel to approximately 10 feet above the bottom of the casing.

3. Verify the depth to gravel tagging with a wire line.

4. Pump a slurry of neat cement into the well through a tremie pipe to the top of the gravel and fill the annulus of the casing with cement slurry in stages to land surface.

PLUGGING AND ABANDONMENT PLAN
FOR INJECTION WELL IW-1 AND DUAL ZONE MONITOR WELL
NORTH PORT ST. LUCIE COUNTY INJECTION WELL SYSTEM

COST ESTIMATE

INJECTION WELLS		
1.	Mobilize the drill rig and "kill" the well	$ 25,000
2.	Fill the open hole with 940 cubic feet of coarse aggregate at $8 per cubic foot	7,520
3.	Purchase and install bridge plug and place 4,230 cubic feet of neat cement at $15 per cubic foot	71,450
	Injection Well TOTAL COST	$ 103,970
	10 Percent Contingency - Injection Well	10,400
	15 Percent Engineering Fees - Injection Well	15,600
	TOTAL ESTIMATED COST - INJECTION WELL	$ 129,970
DUAL ZONE MONITOR WELL		
Lower Zone		
1.	Mobilize the drill rig and "kill" the well	$ 20,000
2.	Fill the open hole with 15 cubic feet of coarse aggregate at $8 per cubic foot	120
3.	Purchase and install bridge plug and place 285 cubic feet of neat cement at $15 per cubic feet	9,925
Upper Zone		
4.	Fill the open annular space with 215 cubic feet of gravel at $8 per cubic foot	1,720
5.	Place 940 cubic feet of neat cement at $15 per cubic foot	14,100
	Monitor Well TOTAL COST	$ 45,865
	10 Percent Contingency - Monitor Well	4,590
	15 Percent Engineering Fees - Monitor Well	6,880
	TOTAL ESTIMATED COST - MONITOR WELL	$ 57,335
TOTAL ESTIMATED COST FOR INJECTION WELL AND MONITOR WELL		$ 187,305

This cost estimate does not include testing or monitoring prior to abandonment and assumes that the abandonment of each well will be conducted independently.