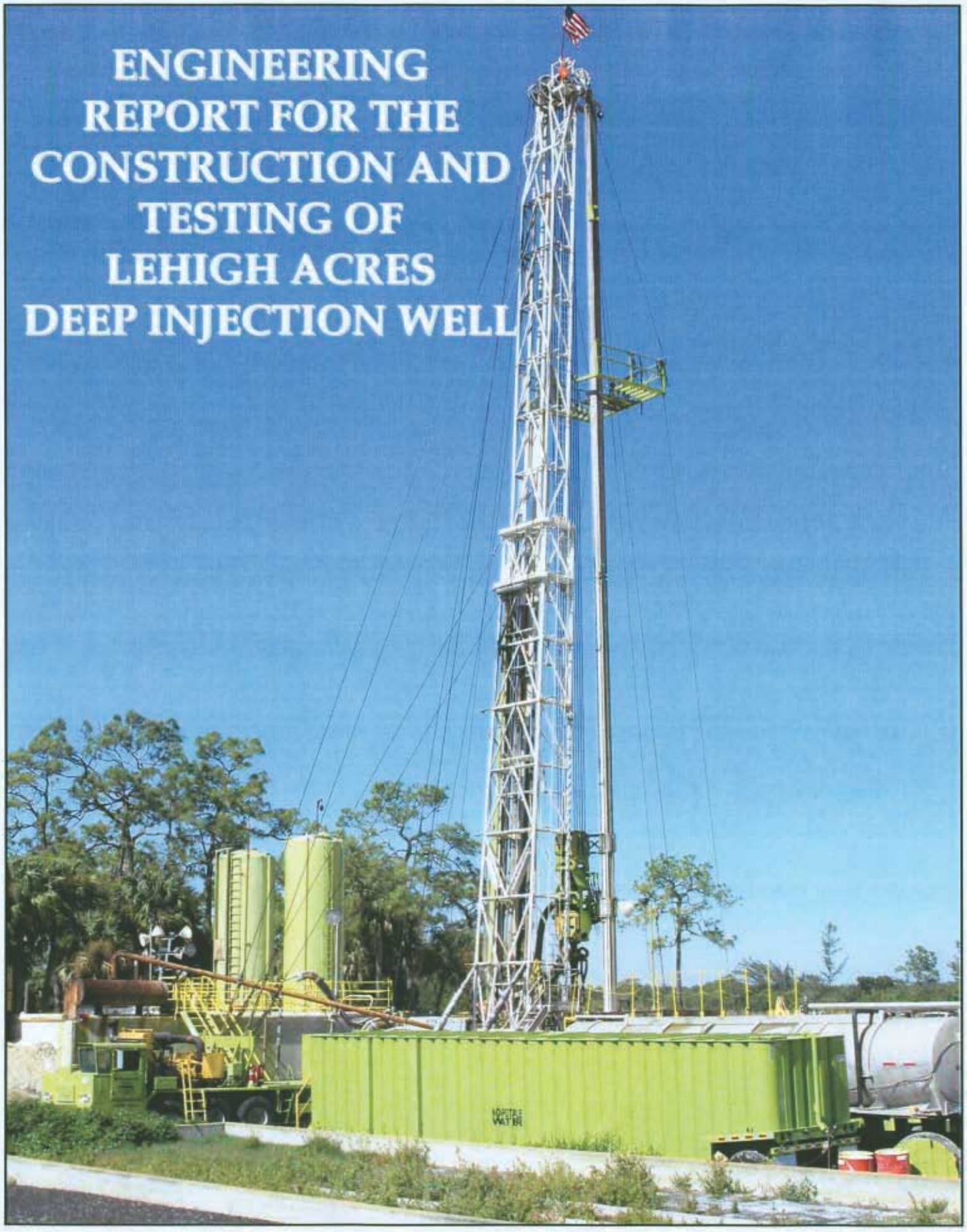
ENGINEERING REPORT FOR THE CONSTRUCTION AND TESTING OF LEHIGH ACRES DEEP INJECTION WELL



FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
CLASS I INJECTION WELL

TEST WELL CONSTRUCTION PERMIT

No. 48064-078-UC

Report
Volume 1

PREPARED FOR

FLORIDA GOVERNMENT UTILITY AUTHORITY
LEHIGH ACRES, FLORIDA

PREPARED BY

5300 West Cypress Street
Tampa, Fl 33607

JUNE 2008

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FLORIDA DEPARTMENT OF
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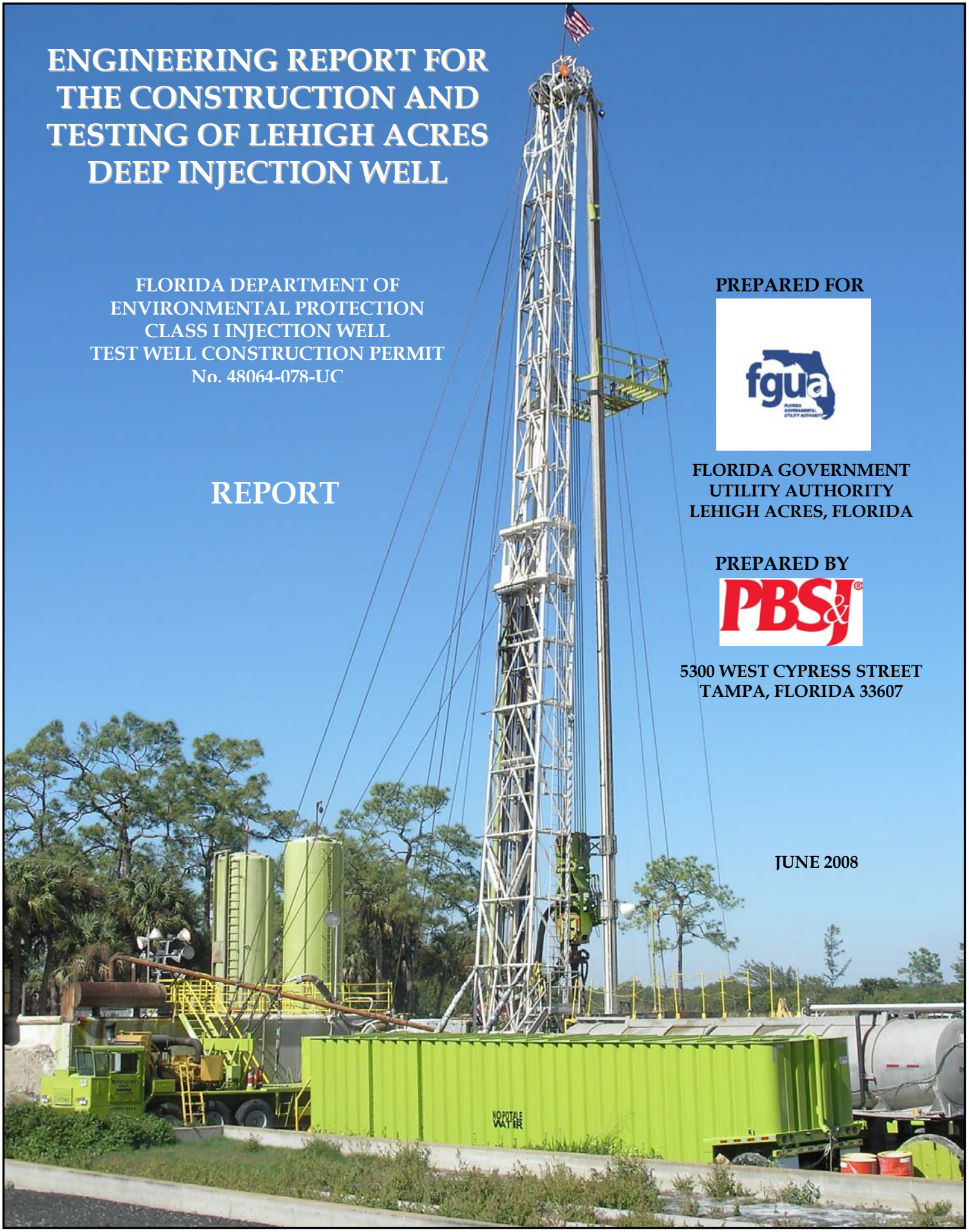
REPORT



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FLORIDA GOVERNMENT
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LEHIGH ACRES, FLORIDA

PREPARED BY

5300 WEST CYPRESS STREET
TAMPA, FLORIDA 33607

JUNE 2008

PBS&J

An employee-owned company

July 16, 2008

Mr. Art Dacre
Florida Governmental Utility Authority
280 Wekiva Springs Rd
Protegrity Plaza II Suite # 2000
Longwood FL - 32779

RE: Lehigh Acres Deep Injection Well
Well Construction Summary Final Report; Project LE 020

Dear Art:

We are pleased to transmit eight (8) final copies of the Lehigh Acres Well Construction Summary Report. Four copies are included for FGUA records, with two copies for David Rhodes (FDEP-Ft. Myers), and one copy each to Joe Haberfeld (FDEP-Tallahassee) and Steve Anderson (SFWMD-West Palm). Due to the intention of FGUA to initiate temporary disposal of excess reclaimed water at the newly constructed deep injection well as soon as it is permittable, we would recommend that FGUA forward the final copies of the report at your earliest convenience. FDEP will need to complete a review of the report prior to granting authorization for commencing injection activities.

If you have further questions, please contact this office.

Respectfully,

Thomas Farkas, P.G.
Project Manager

Enclosures: Final Summary Report (8 copies)

cc: Mike Micheau, letter only
Brad McMahen, letter only

Professional Geologist Certification

The hydrogeological evaluations and interpretations contained in the "Engineering Report for the Construction and Testing of Lehigh Acres Deep Injection Well" for FGUA dated June 2008, were prepared by, or reviewed by, a Registered Professional Geologist in the State of Florida.

Thomas A. Farkas, P.G.
Professional Geologist #2074

7/15/08
Date

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1.0 Introduction

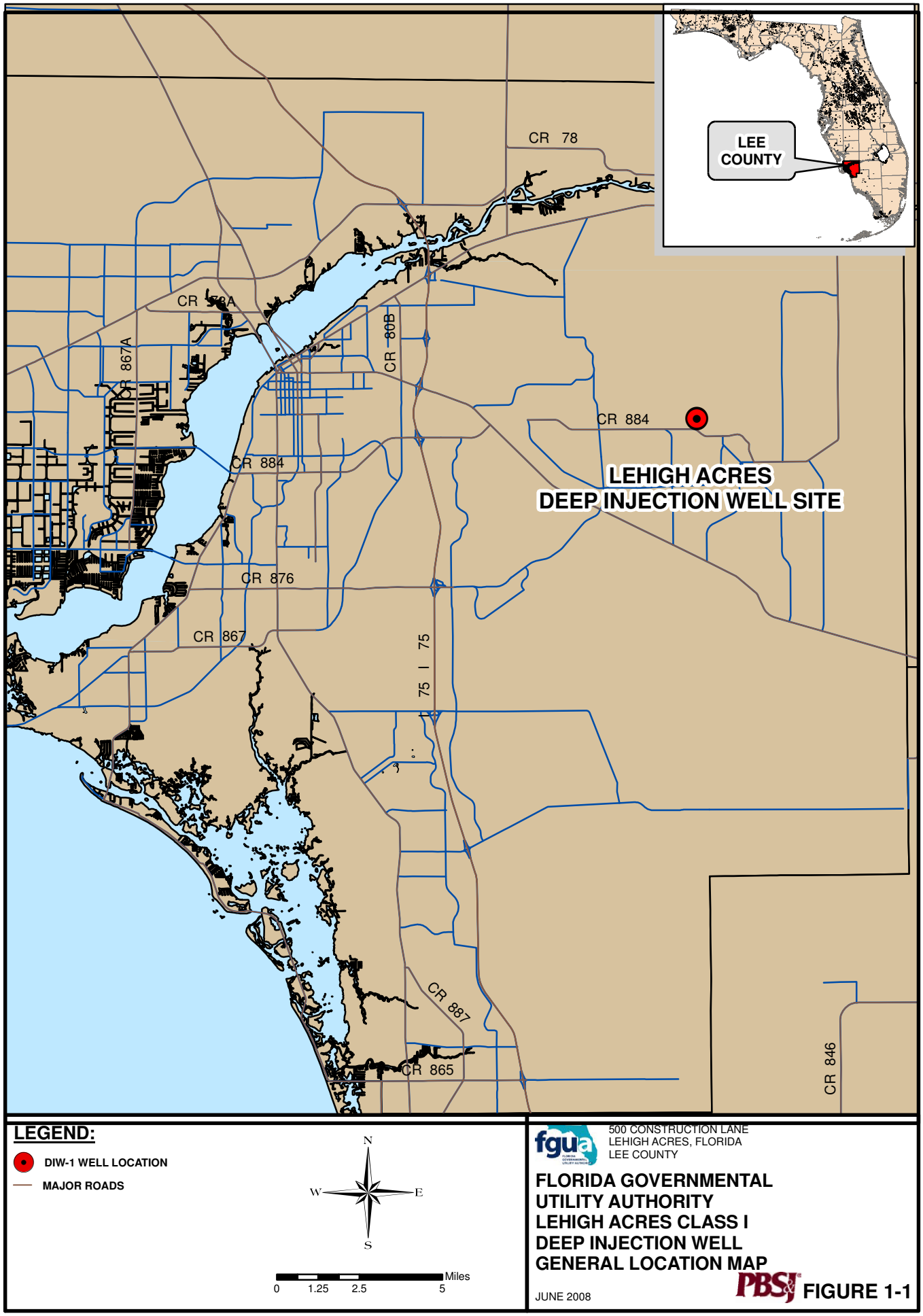
1.1. Project Background

Lehigh Acres Class I Deep Injection Well (DIW-1) is located at the Lehigh Acres Wastewater Treatment Plant in eastern Lee County within the Florida Governmental Utility Authority (FGUA) Lehigh Acres Utility System as shown in **Figures 1-1** through **1-3**. DIW-1 is a Class I municipal injection well designed and constructed to dispose of non-hazardous, secondary treated effluent, which has received high-level disinfection from the Lehigh Acres Wastewater Treatment Plant (WWTP).

FGUA sought construction of DIW-1 to provide additional wet-weather disposal capacity of the excess treated wastewater (reclaimed water) from the Lehigh Acres WWTP. The facility is currently permitted to treat an annual average daily flow (AADF) of 2.5 million gallons per day (MGD) with an annual average daily reuse/disposal capacity of 2.35 MGD. Per the Florida Department of Environmental Protection (FDEP) wastewater facility permit (FLA014565), the permitted treatment capacity is limited to 2.35 MGD AADF until additional disposal capacity is available. The treated effluent is primarily disposed of via the on-site rapid infiltration basin system that consists of evaporation/percolation ponds with a permitted capacity of 1.48 MGD. The remaining effluent is utilized for irrigation of the Lehigh Acres North and Mirror Lakes golf courses. The FGUA is planning to expand the treatment capacity of the facility by an additional 1.00 MGD, resulting in a capacity of 3.50 MGD. Expansion of the WWTP will result in the need of additional permitted wet-weather wastewater disposal capacity, which DIW-1 would provide when it becomes operational. DIW-1 is designated as a Class I municipal well, and is designed to eventually accommodate a disposal capacity up to 18.6 MGD at a maximum injection rate of 12,900 gallons per minute (gpm).

Design and permitting of DIW-1 was initiated by FGUA in 2005 with the assistance of PBS&J, the Engineer of Record. The FDEP issued the injection well construction permit (FDEP Permit No. 48064-078-UC) to FGUA on February 23, 2007. The FDEP permit includes permit conditions for upper and lower zone monitoring wells in addition to four shallow water table monitoring wells. A copy of the FDEP well construction permit is presented in **Appendix A**.

Technical specifications and contract documents were prepared and let for bid by FGUA (Bid No. LE 020) on January 17, and opened on February 19. Youngquist Brothers, Inc. (YBI) of Ft. Myers, Florida was selected as the lowest responsive bidder for the construction and testing of the DIW-1. Following verification of the bid submittal and execution of the contract documents, a notice-to-proceed was issued to YBI on April 24, 2007. Site preparation work including construction of a site access road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REVIEWED BY: 22033
LEE COUNTY
CR 78
CR 78A
CR 867A
CR 867
CR 80B
CR 884
CR 884
LEHIGH ACRES
DEEP INJECTION WELL SITE
CR 876
CR 867
I 75
I 75
CR 887
CR 865
CR 846
LEGEND:
DIW-1 WELL LOCATION
MAJOR ROADS
N
W
E
S
0
1.25
2.5
5
Miles
500 CONSTRUCTION LANE
LEHIGH ACRES, FLORIDA
LEE COUNTY
FLORIDA GOVERNMENTAL
UTILITY AUTHORITY
LEHIGH ACRES CLASS I
DEEP INJECTION WELL
GENERAL LOCATION MAP
JUNE 2008
FIGURE 1-1
F:\COMMON\Hydrogeological Program\FIGURES\MXD\071200_90\LOCATION_1-1.MXD

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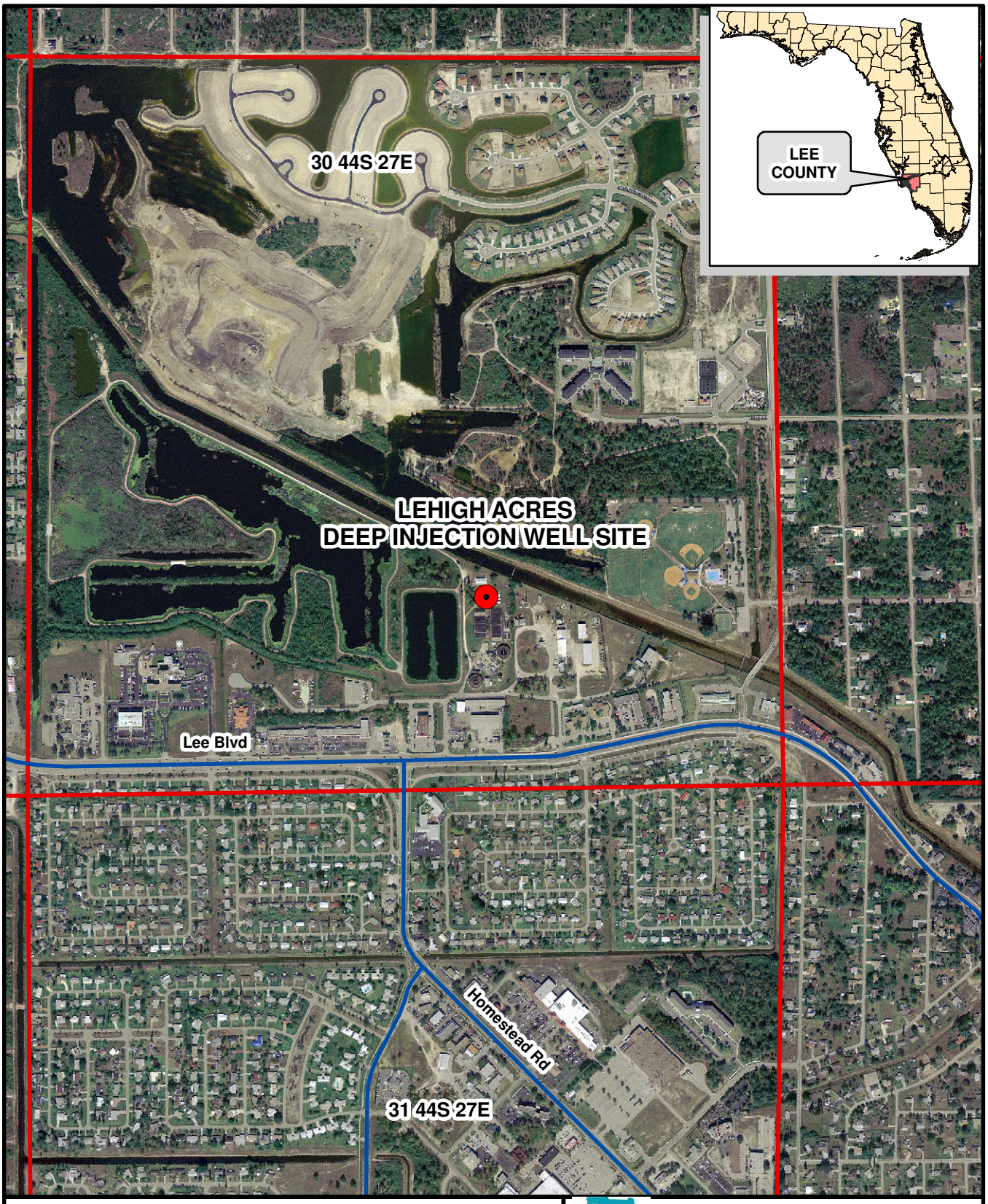


F:\COMMON\Hydrogeological Program\FIGURES\MXD\071200_90\LOCATION_1-2.MXD

LEGEND:

- DIW-1 WELL LOCATION
- SECTION TOWNSHIP RANGE
- LOCAL ROADS

N
W E
S

0 500 1,000 Feet

500 CONSTRUCTION LANE
LEHIGH ACRES, FLORIDA
LEE COUNTY

FLORIDA GOVERNMENTAL UTILITY AUTHORITY LEHIGH ACRES CLASS I DEEP INJECTION WELL SITE LOCATION MAP

SCALE: AS SHOWN
JUNE 2008

PBSJ

FIGURE 1-2

CREATED BY: 22601
REVIEWED BY: 22033

LEGEND:

- DEEP INJECTION WELL LOCATION
- UPPER & LOWER ZONE MONITORING WELL LOCATIONS
- PLUGGED & ABANDONED LOWER ZONE MONITORING WELL LOCATION
- PAD SHALLOW MONITORING WELLS

N
W E
S

0 50 100 200 Feet

500 CONSTRUCTION LANE
LEHIGH ACRES, FLORIDA
LEE COUNTY

FLORIDA GOVERNMENTAL UTILITY AUTHORITY LEHIGH ACRES CLASS I DEEP INJECTION WELL SITE LAYOUT

SCALE: AS SHOWN
JUNE 2008

PBSJ

FIGURE 1-3

F:\COMMON\Hydrogeological Program\FIGURES\MXD\071200_90\LOCATION_1-3.MXD

began in May. Drilling equipment was initially mobilized to the site on May 18. PBS&J provided inspection services during all construction and testing activities of the DIW-1 system.

1.2. Site Description

DIW-1 is located at the Lehigh Acres WWTP in the eastern portion of Lee County in Lehigh Acres, Florida (**Figures 1-1** and **1-2**). Access to DIW-1 is off of Construction Lane approximately 300 feet north of the intersection of Lee Boulevard and Homestead Road North **(Figure 1-3)**. Topography at the site is low and flat, with elevations averaging approximately 20 feet above National Geodetic Vertical Datum (NGVD). The DIW-1 site is located on reclaimed strip mining land. The injection well site is bordered on the north by Able Canal and vegetation, on the south by Lehigh Acres WWTP followed by commercial and residential development, to the east by a commercial trucking facility, and on the west by the access road, and the facility percolation ponds.

The injection well and the upper zone monitor well is located on a 40 foot wide by 60 foot long concrete containment pad, which is curbed and sloped toward the injection well and sump system. The lower zone monitoring well is located approximately 50 feet east of the injection well and is surrounded by a 6 by 6 foot concrete pad. Four pad monitor wells were constructed (prior to drilling) near each corner of the drilling pad to monitor the potential impacts of construction activities on the water table aquifer. **Figures 1-3** and **1-4** illustrate the general site layout.

1.3. Purpose and Scope

The purpose of this report is to present a description of the well construction activities and the hydrogeologic testing program completed during the construction of DIW-1, the upper zone monitor well (UZMW-1) and the lower zone monitor well (LZMW-1B). A summary of the findings and appropriate recommendations are presented at the end of this report. The report is prepared in compliance with FDEP requirements contained in Chapter 62-528 of the Florida Administrative Code (F.A.C.) and the FDEP well construction permit.

Well construction information provided in this report includes a description of drilling procedures, the type and quantity of materials used to complete the injection and monitor wells, and the chronology of major construction and testing events. A chronology of critical decisions made requiring Technical Advisory Committee (TAC) concurrence is also provided. Unless otherwise specified, all depths given in this report refer to feet below land surface.

Hydrogeologic testing data presented in this report includes the results of formation sampling, drilling and packer test water quality analyses, rock core descriptions and

SITE LAYOUT – CONSTRUCTION COMPLETED

Figure 1-4

analyses, geophysical logging, packer hydraulic tests, short-term injection testing, and mechanical integrity testing (MIT). A description of the data and methods used in the identification of the base of the Underground Source of Drinking Water (USDW) and water quality at the project location and an analysis of the hydraulic characteristics of confining units overlying the injection zone.

The well head piping, valving and pumping system along with the electrical controls has not yet been constructed to date. The final design for this system is complete and FGUA is in the bid process of selecting a general contractor to complete this construction of the injection well system which is expected to occur by the end of 2008. Following completion of all construction activities, As-Built records will be provided to FDEP along with an Operation & Maintenance (O&M) manual describing the injection well system start- up and proposed operational testing program

1.4. Acknowledgements

The successful completion of the Lehigh Acres injection and monitoring well system was the result of close cooperation by numerous agencies and people. The FDEP Technical Advisory Committee provided valuable agency support and technical assistance throughout the project. Key TAC individuals include:

Mr. David Rhodes, P.G., FDEP/Ft. Myers, TAC Chairperson
Mr. Joe Haberfeld, P.G., FDEP/Tallahassee
Mr. Steve Anderson, P.G., SFWMD/West Palm Beach
Mr. Ron Reese, USGS/Miami

FGUA personnel were also helpful in providing guidance and logistical support towards the successful completion of the project. Key FGUA individuals include:

Mr. Tarek M. Fahmy PE CGC Director of Operations
Mr. David Huff
Mr. Mike Quigley
Mr. Tim Rapp
Mr. John Mervin

2.0 Well Construction

This section describes the construction and mechanical integrity testing history of the pad monitoring wells, SMW-1 through SMW-4, LZMW-1B, UZMW-1, and the DIW-1 at the Lehigh Acres site. For each of these wells, a detailed description is provided for the well drilling methodology used, casing installation and cementing procedures, and the quantity of materials used in all the wells. Hydrogeological data collected during construction of the wells are presented and discussed in **Section 3.0** of this report.

Pad Wells SMW-1 through SMW-4 were constructed prior to the initiation of construction activities of the injection well system. LZMW-1B was constructed and tested first to confirm and provide additional design criteria for the injection well. The UZMW-1 was constructed following completion of the LZMW-1B. DIW-1 construction followed the construction of the UZMW-1. During well construction activities, TAC members were provided weekly summary reports. The weekly TAC construction summary reports, daily construction activity logs, and well completion reports generated during the course of this project are included in **Appendix B, C,** and **D** respectively.

2.1. Drilling Operation Methodology

The two monitor wells of the injection well system were drilled with a Schram T130 truck-mounted rotary drilling rig (**Figure 2-1).** The drilling rig incorporated a top-head drive rotary system with a drill floor located approximately 3.5 feet above the top of the steel containment pad **(Figure 2-2)**. The drill rods were approximately 30 feet in length with a 7-inch outside diameter **(Figure 2-3)**. An Ingersoll Rand model 650 top head drive rotary drilling rig was utilized in the construction of the deep injection well **(Figure 2-4)**. The drill rods utilized consisted of two, 40-foot drill rods for an approximate length of 80 feet. Various drill bit sizes were used during well construction ranging in diameter from 12.25 inches to 56 inches (**Figure 2-5** and **2-6).**

The drilling operations for the LZMW-1B well consisted initially of mud rotary drilling techniques followed by reverse-air drilling methods, whereas, mud rotary drilling techniques were utilized to drill the entire UZMW-1. The mud drilling technique was primarily used to drill through sand and unconsolidated or poorly consolidated deposits that generally are unstable and produce little water. These deposits have a tendency to collapse into the borehole. The drilling mud stabilizes the hole and removes the drill cuttings during drilling operations. Reverse-air drilling techniques are used primarily to drill in competent, generally water-bearing, rock. Water produced by the formation serves as the drilling fluid. Reverse-air drilling techniques allow for the collection of formation water samples during drilling operations.

Figure 2-1

MONITOR WELL DRILLING RIG

Figure 2-2

MONITOR WELL DRILLING RIG

Figure 2-3

MONITOR WELL
SITE LAYOUT

DIW-1 DRILLING RIG

Figure 2-4

DRILLING BITS

Figure 2-5

Figure 2-6

DRILLING BIT

Both drilling techniques were used at the site under a closed circulation system (no discharge). This closed system was necessary since the deep aquifers that were penetrated are under sufficient pressure (artesian) that they can flow at the land surface. The water in these aquifers is brackish to saline water and would contaminate the water table aquifer at the site. The FDEP construction permit 48064-078-UC specifically prohibits any discharge during the drilling operation.

2.1.1. Mud Drilling Method

The mud drilling operations at the site used bentonite-drilling mud with approved additives as the drilling fluid. The drilling mud was mixed in an approximately 20,000 gallon mud slurry tank that connected to a 90,000 gallon steel tank which was located on a temporary secondary steel pad constructed southwest of the drill rig area. This fluid was pumped through a 4-inch steel mud line to the drill rig and ultimately down the drill rods, exiting out the drilling bit. The viscous drilling fluid suspends the cuttings and circulates back up the borehole to land surface where the drilling fluid was routed through a 6-inch steel return line back to the mud tank onto vibrating screens, known as a "shale shakers," suspended over the mud tank (**Figure 2-7)**. The screen separates the cuttings from the drilling fluid and directs the cuttings to a large storage tank. The drilling fluids were collected in the mud tank and re-circulated back down the drill rod. Cuttings were removed from the storage tank with a track hoe and disposed of along with excess drilling fluids at the Youngquist Brothers Inc. Aggregate Limestone Quarry disposal site.

2.1.2. Reverse-Air Drilling Method

Reverse-air drilling uses water as the drilling fluid. Steel tubing is suspended down inside the 6-inch I.D. drill rod assembly and connected to a high capacity diesel-powered air compressor. The bottom of the 2 3/8-inch steel airline was generally set to a depth between 60 and 90 feet above the drilling bit. Compressed air is piped down the tubing and aerates the water inside the drill pipe above the end of the tubing. This aeration causes a pressure differential, which in turn causes upward flow of the water inside the drill pipe. The drill rod in effect becomes an airlift pump. Water and cuttings at the bottom of the borehole and at the drill bit face are drawn into the drilling bit and conveyed up the drill rod to the surface. The water and cuttings from the drill rod are then routed to the storage tank system. The cuttings are separated by a desander and shale shaker and are conveyed to the storage tank. The separated water flows into the storage tank where it is pumped back into the well through a port on the wellhead.

Artesian conditions in the well required use of a blowout and flow preventer on the wellhead to prevent potential salt water discharge at land surface (**Figure 2-8)**. When operations require that the drill rod be removed or when the well had to be accessed for

MUD SYSTEM &
SHALE SHAKERS

Figure 2-7

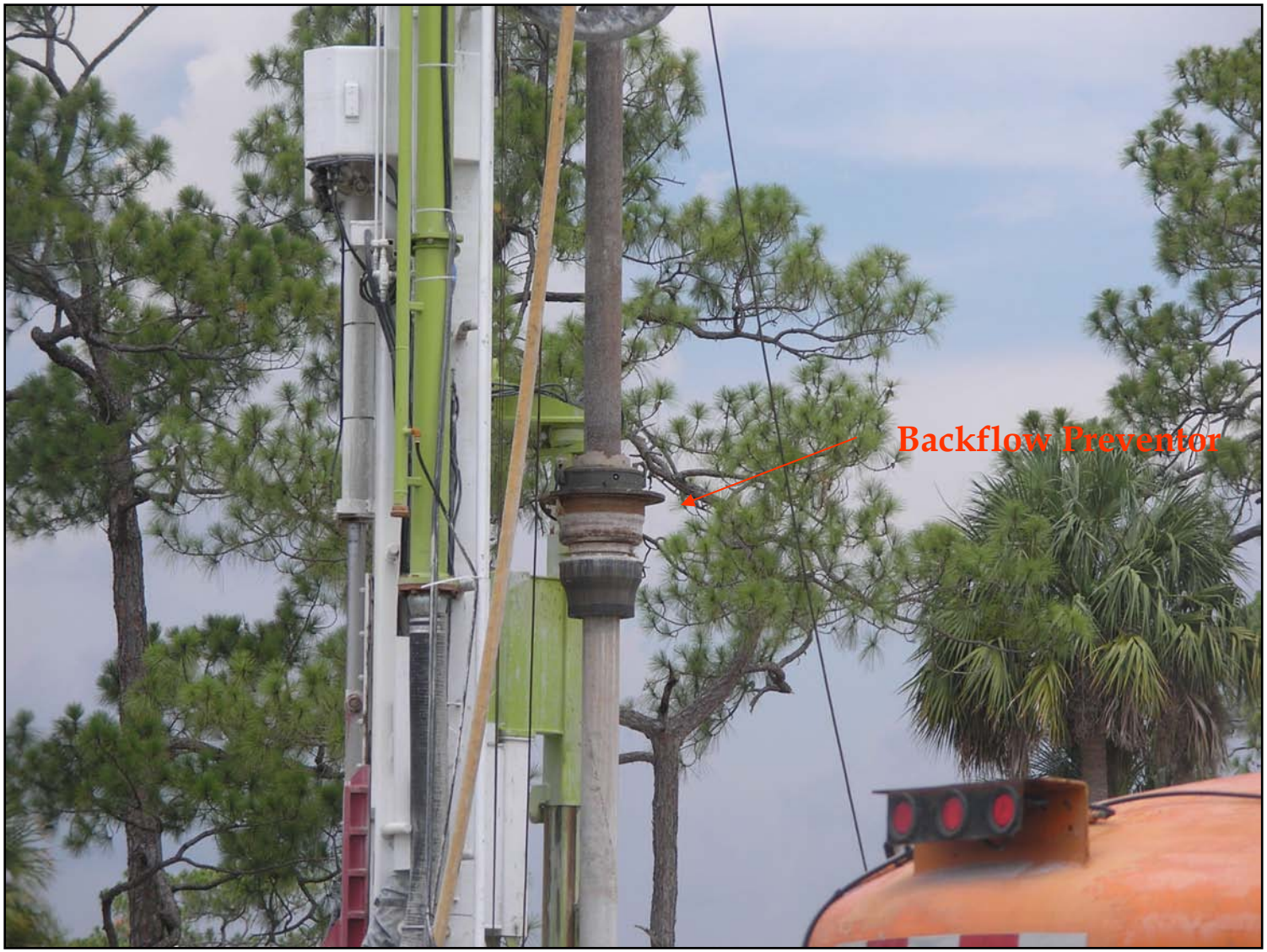


Figure 2-8

BACKFLOW PREVENTOR

testing or casing installation, a mud wafer solution was pumped into the top of the well to offset formation pressure and suppress water levels in the well to below top of the casing.

2.2. Pad Monitor Well Construction

On May 17, 2007, prior to the start of any drilling activities, monitor wells SMW-1 through SMW-4 were installed around the perimeter of the temporary drilling pad (**Figures 2-9** and **2-10**). The shallow wells were used to monitor the water quality (conductivity, chloride, dissolved oxygen, pH, temperature and turbidity) of the Surficial Aquifer during drilling operations of the deep injection well system.

YBI drilled these wells using a small truck mounted rotary drilling rig. All of the monitor wells were installed by mud rotary drilling techniques using a nominal 6-inch diameter drill bit. Each well was drilled to a total depth of approximately 20 feet; after which, 10 feet of a 2-inch diameter blank Schedule 40 PVC casing with a 10-foot PVC screen (0.01-inch slot size) were installed to the total depth. The annulus was backfilled with 20/30 graded silica sand to a depth of approximately 8 feet. The remainder of the annulus was filled with Type II neat cement grout to land surface. Each completed well was developed in preparation for water quality sampling prior to and during injection well construction activities and equipped with a PVC locking cap. Completion reports for all the permitted wells are contained in **Appendix D**.

2.3. Lower Zone Monitor Well Construction

LZMW-1A

Construction began on LZMW-1A on June 29, 2007, which was located approximately 50 feet east of UZMW-1. Pilot hole drilling was conducted utilizing a 12.25 inch mud rotary bit. The pilot hole was advanced to approximately 1,180 ft bls on July 3, the borehole was reamed to a diameter of 23 inches to 1,150 ft bls, between July 4, and July 5. A 16 inch steel casing was installed and seated at 1,150 ft bls between July 6 and 7. The 12.25 inch pilot hole was continued to a depth of approximately 1,680 feet when the contractor encountered mechanical failure of the drilling rod, resulting in drill rod separation on July 12. In conjunction with the drill rod separation, the last 36-foot section foot the 16 inch casing separated and fell down the pilot hole, becoming lodged at approximately 1,230 feet bls. The broken casing string allowed sand from the upper zones to intrude into the borehole effectively locking in the broken drill string and bit. Numerous "fishing" attempts were made by YBI, but proved unsuccessful. A meeting was called at the site on June 25 to discuss the construction options of the contractor, FGUA, FDEP and PBSJ. An agreement was reached by all parties present to plug and abandon LZMW-1A. LZMW-1A was plugged with 12% bentonite additive cement from

SHALLOW MONITOR WELL DRILLING RIG

Figure 2-9

PAD MONITOR WELL

Figure 2-10

approximately 1,680 feet bls to land surface, with a full cement return witnessed at land surface on July 28 (**Figure 2-11**). YBI then remobilized the drilling rig and began construction of LZMW-1B. All data collected during the early stages of LZMW-1A construction is compiled in **Appendix T**.

LZMW-1B

Construction of LZMW-1B commenced on August 3, 2007 and was completed on September 6. A chronology of the significant monitor well construction and testing activities is presented in **Table 2-1**.

The pilot hole for the well was drilled to a total depth of approximately 1,907 feet with the monitoring zone interval completed between approximately 1,796 feet and 1,907 feet. Casing sizes of the well varied and included the following: a 26-inch pit casing, a 16-inch intermediate casing (**Figure 2-12**) and a 6-inch final casing. Copies of the mill certificates for all the casings used in the construction of the LZMW-1B are presented in **Appendix E**.

2.3.1. Drilling and Casing Installation

2.3.1.1. Pit Casing

The start of drilling operations coincided with the installation of the pit casing for the LZMW-1B on August 3. Consisting of a 26-inch diameter, 0.375-inch wall steel casing, the pit casing was installed to a depth of approximately 64 feet into competent rock and cemented into place by pressure grouting **(Figure 2-13)**. The primary function of the pit casing is to stabilize the borehole near the surface until the 16-inch intermediate casing can be installed.

2.3.1.2. LZMW-1B Intermediate Casing (16-Inch)

Between August 4 and 6, a 12.25-inch diameter pilot hole was advanced to a depth of approximately 1,150 feet using mud rotary drilling methods. Formation samples were collected at 10-foot intervals during pilot-hole drilling, examined on-site by PBS&J geologists, and used to prepare the lithologic log for the well. Based on the driller's reports, borehole flow was encountered below a depth of approximately 700 feet. Geophysical logs, including caliper, gamma ray, borehole compensated (BHC) sonic and dual induction, were conducted in the pilot hole to a depth of approximately 1,150 feet and were interpreted to determine the top of the Suwannee Limestone (estimated at approximately 650 feet). Based on the results of the geophysical evaluation, an approximate casing setting depth of 1,150 feet was determined for the 16-inch

ABANDONED WELL - LZMW-1A

Figure 2-11

TABLE 2-1
CHRONOLOGY OF SIGNIFICANT LZMW-1B
CONSTRUCTION AND TESTING ACTIVITIES

DATE	ACTIVITY
7/31/07	Mobilization to the lower zone monitoring well (LZMW-1B) site begins.
8/3/07	Began drilling 34-inch pilot hole for pit casing
8/4/07	Pilot hole drilled to 64 feet below land surface (bls); 26-inch pit casing installed and grouted with 49 barrels of 100% neat cement; began drilling pilot hole with 12.25-inch tricone bit.
8/5/07	Pilot hole drilling continued
8/6/07	Pilot hole drilling continued to depth of 1,150 ft bls; geophysical logging of the bore hole was conducted and included: XY caliper / gamma ray, sonic and dual induction.
8/7/07	Begin reaming the pilot hole to 24 inches in diameter.
8/8/07	Reaming continues
8/9/07	Reaming concluded to 1,150 feet bls.
8/11/07	Geophysical logging conducted on the reamed hole: XY caliper/ gamma; 16 inch casing installed to 1,150 feet bls; casing grouted to land surface in one stage using 8 % additive.
8/12/07	Prepared the rig to reverse-air drill
8/13/07	Begin pilot hole drilling with reverse-air at 1,150 feet bls.
8/14/07	Continue pilot hole drilling; conduct specific capacity tests every 60 feet; rig is shut down for repairs.
8/15/07	Resumed pilot hole drilling
8/16/07	Continued pilot hole drilling; attained total depth of 1,907 feet bls; conducted full suite of geophysical logs, which included the following: XY caliper/ gamma ray, dual induction, borehole compensated (BHC) sonic with log derived total dissolved solids (TDS), temperature and flow logs, fluid conductivity, televiewer log. The dynamic logs conducted included a flow log, temperature and fluid conductivity.
8/17/07	Continued geophysical logging described above; installed off bottom packer for first packer test.
8/18/07	Conduct Packer test 1
8/19/07	Conduct Packer test 2
8/20/07	Conduct Packer test 3
8/21/07	Conduct Packer test 4

TABLE 2-1
CHRONOLOGY OF SIGNIFICANT LZMW-1B
CONSTRUCTION AND TESTING ACTIVITIES

DATE	ACTIVITY
8/25/07	Water quality results of the packer tests are submitted with lithology logs to FDEP for casing depth and monitor interval approval.
8/29/07	FDEP grants approval of monitoring interval and casing setting depth.
8/30/07	Begin reaming the bore hole to 14 inches to a depth of 1,788 feet bls.
8/31/07	Continue reaming
9/1/07	Reaming concluded: install disposable packer and casing.
9/2/07	Pour first and second grout stages to secure casing seat: each stage is 4 barrels of 100% neat cement.
9/3/07	Tag resulting from 1st and 2nd grout stages is 1,718 ft bls; third stage is poured consisting of 39 barrels of neat cement, then 98 barrels of 6%; the resulting tag was 1,263 feet bls; the fourth stage was poured and consisted of 85 barrels of 6% gel additive.
9/4/07	Monthly site meeting; Fifth stage of cement poured consisting of 110 barrels of 6% gel additive.
9/5/07	Temperature log and cement bond log were conducted on the hole; Temperature tag is 188 feet bls; Sixth cement stage conducted consisting of 31 barrels of neat cement; full return of cement at land surface.
9/7/07	Casing pressure test passed at 50 psi with +0.25 psi.
9/10/07	Begin demobilization of the drilling rig.
9/26/07	Development of monitoring interval
9/27/07	Development concluded; background WQ samples collected by Sanders Laboratory Inc .

16″ INTERMEDIATE CASING

Figure 2-12

STEEL CASING INSTALLATION

Figure 2-13

intermediate casing. A complete discussion of all geophysical surveys completed on the LZMW-1B is presented in **Section 3.6.1**.

The 12.25-inch pilot hole was reamed to 24 inches in diameter to an approximate depth of 1,150 feet using mud rotary drilling techniques between August 7 and 9. The borehole was prepared for casing installation by circulating with mud until the mud returns were relatively free from cuttings. Prior to the installation of the 16-inch intermediate casing, several "wiper trips" were made by rotating the bit in and out of the borehole to ensure the borehole was clear of obstructions.

Borehole deviation surveys, using a sure-shot tool, were collected in both the pilot hole and the reamed hole at 90-foot intervals throughout the entire length of the well. A summary of the deviation surveys collected on the pilot hole are presented in **Table 2-2** while the summary of reamed hole deviation surveys are presented in **Table 2-3**. All of the deviation surveys were within the allowable deviation of 1 degree over the tested interval of 90 feet.

The intermediate casing of the LZMW-1B consisted of nominal 42-foot sections of 0.5-inch wall, 16-inch steel casing, which were butt-welded together as they were installed into the reamed borehole (**Figures 2-14)**. Steel strap centralizers were placed at 5, 20 and 40 feet from the bottom of the casing and every 100 feet thereafter. The casing was installed to a total depth of approximately 1,150 feet without encountering any obstructions on August 11.

All cementing operations were completed by YBI. YBI cemented the 16-inch intermediate casing in one pressure grout stage consisting of 462 barrels of Type II neat cement. A return of cement at surface was observed during the pressure grouting activity.

The cemented 16-inch casing was allowed to cure for a period of approximately 18 hours prior to resuming drilling activities. The total volume of cement pumped slightly exceeded the theoretical cement volume of 450 barrels, which was estimated for the annulus of the intermediate casing. The difference in cement quantity could be attributed to losses to the formation. Cementing information from all of the grouting stages during construction of the LZMW-1B is presented in **Table 2-4**.

2.3.1.3. LZMW-1B Final Casing (6-Inch)

Following the installation of the 16-inch intermediate casing, the drilling technique was switched to reverse-air-drilling. During the course of drilling the pilot hole, hydraulic testing was completed to characterize the hydrogeologic framework, provide information required by the TAC (identification of USDW) for the final casing depths, and identification of the targeted monitoring zone. The hydrogeologic data gathered

PBS&J

Florida Governmental Utility Authority
Lehigh Acres WWTP Class I Deep Injection Well
Lower Zone Monitoring Well Pilot Hole Deviation Survey

TABLE 2-2
LZMW-1B PILOT HOLE DEVIATION SURVEY

Date	Depth (ft)	Deviation (degrees)
8/6/2007	141	0.50
8/6/2007	231	< 0.75
8/6/2007	321	< 0.75
8/6/2007	411	< 0.25
8/6/2007	501	0.50
8/6/2007	591	< 0.75
8/6/2007	681	0.75
8/6/2007	771	< 0.50
8/6/2007	861	< 0.75
8/6/2007	951	0.50
8/6/2007	1041	0.75
8/6/2007	1131	0.75
8/16/2007	1267	< 0.25
8/16/2007	1327	< 0.2.5
8/16/2007	1417	0.50
8/16/2007	1507	0.50
8/16/2007	1597	< 0.75
8/16/2007	1687	< 0.25
8/16/2007	1777	< 0.50
8/16/2007	1867	0.75

Florida Governmental Utility Authority
Lehigh Acres WWTP Class I Deep Injection Well
Lower Zone Monitoring Well Ream Hole Deviation Survey

TABLE 2-3
LZMW-1B REAM HOLE DEVIATION SURVEY

Date	Depth (ft)	Deviation (degrees)
8/7/2007	115	0.50
8/7/2007	205	< 0.75
8/7/2007	295	0.75
8/7/2007	385	0.50
8/7/2007	475	< 0.75
8/8/2007	565	0.75
8/8/2007	655	0.75
8/8/2007	745	0.75
8/8/2007	835	0.50
8/8/2007	925	< 0.50
8/8/2007	1015	0.25
8/9/2007	1105	< 0.25
8/30/2007	1237	0.50
8/30/2007	1327	0.50
8/30/2007	1417	0.50
8/30/2007	1507	0.50
8/30/2007	1597	0.25
8/30/2007	1687	0.75
8/30/2007	1777	0.75
8/30/2007	1867	0.75

WELDING DURING CASING INSTALLATION

Figure 2-14

TABLE 2-4
SCHEDULE OF GROUT PLACEMENT FOR LZMW-1B

Date	Stage No.	Interval Filled (feet)	Linear Fill (feet)	Volume Pumped (sacks)	Volume Pumped (barrels)	Theoretical Volume (sacks)	Theoretical Volume (barrels)	Method of Emplacement	Additives to Cement
26" Pit Casing									
8/4/2007	1	64-58	6	219	49	12	3	pressure grout	neat
8/4/2007	2	58-0	58			151	34	tremmie pipe	neat
Totals			**64**	**219**	**49**	**163**	**37**		
16" Intermediate Casing									
8/11/2007	1A	1150-0	1150	1760	395	2007	450	pressure grout	neat
8/11/2007	1B			299	67			pressure grout	8%
Totals			**1150**	**2059**	**462**	**2007**	**450**		
6" Final Casing									
9/2/2007	1	1796-1772	24	18	4	13	3	tremmie pipe	neat
9/2/2007	2	1772-1718	54	45	10	49	11	tremmie pipe	neat
9/3/2007	3	1718-1263	455	609	137	543	122	tremmie pipe	neat (switching to 6%)
9/3/2007	4	1263-781	482	379	85	334	75	tremmie pipe	6%
9/4/2007	5	781-188	593	110	25	410	92	tremmie pipe	6%
9/5/2007	6	188-0	188	31	7	163	37	tremmie pipe	neat
Totals			**1796**	**1192**	**267**	**1512**	**339**		

during drilling of the pilot hole are presented and discussed in later sections of this report.

After installation of the intermediate casing on August 11, the 12.25-inch pilot hole was completed to an approximate depth of 1,907 feet on August 16. Water quality sampling, packer test evaluations, and geophysical data gathered during drilling indicated that the USDW occurs at a depth of approximately 1,700 feet. A detailed discussion of the identification of the base of the USDW is presented in **Section 3.** The information supporting the identification of the base of the USDW and a final casing depth of 1,788 feet were forwarded to FDEP for their review on August 24. FDEP concurred with PBS&J's recommendations and approved the 6-inch final casing setting depth of approximately 1,788 feet on August 29.

The pilot hole was then reamed to a nominal 14 inches to a depth of approximately 1,788 feet between August 30 and September 1. The final casing of the LZMW-1B consisted of nominal 30 foot sections of 6-inch diameter Fiberglass Reinforced Plastic (FRP) casing with threaded joints, which were prepared for installation by applying Tephlon tape to the threads which were then sealed with an alcohol based sealant as they were installed in the reamed borehole (**Figures 2-15** and **2-16)**. Centralizers at 90-degree orientation were placed at 5, 20 and 40 feet from the bottom of the casing and every 100 feet thereafter. The casing was installed to a depth of approximately 1,788 feet utilizing computer programmed tongs, without encountering any obstructions. A "California" Packer assembly was utilized to seal the casing off from the open interval below, which consisted of a 6-foot aluminum packer assembly with a rubber expander, capable of expanding to 17 inches in diameter (**Figure 2-17**). Preceding the installation of the casing, the "California" Packer threads were prepared with Tephlon tape and an alcohol based sealant to ensure a tight seal between the packer and the bottom of the first casing string. Following the installation of the casing, the packer was expanded with potable water to seat the casing, thus isolating the casing annulus from the open interval. An aluminum pressure valve located at the bottom of the packer assembly allowed the packer to stay expanded with the inner casing pressurized throughout the grouting process. After all grouting procedures were concluded the packer was pressurized with additional water to the fail point of the pressure valve, causing it to open (per instrument design), resulting in the monitoring interval connecting to the casing above.

Cementing of the 6-inch final casing was completed in six tremmie grout stages **(Figure 2-18)**. The fist tremmie grout stage initiated on September 2, consisted of 4 barrels of 100% neat Portland cement. The resulting top of cement as indicated on the temperature log was approximately 1,772 feet correlating with a tremmie pipe hard tag of 1,782 feet. The second cement stage, delivered via tremmie method, pumped 10 barrels of 100% neat cement. After the second cementing stage, the temperature log indicated a cement top tag of approximately 1,715 feet correlating with a hard tremmie tag of 1,715 feet. The third cement stage consisted of 137 barrels, starting with 100%

6″ FRP CASING

Figure 2-15

Figure 2-16

6 INCH FRP INSTALLATION

Figure 2-17

CALIFORNIA PACKER ASSEMBLY

GROUTING

Figure 2-18

neat cement then switching to add a 6% bentonite gel additive, resulting in a temperature log identified cement top tag of 1,263 feet and a hard tremmie pipe cement top tag of 1,298 feet. The fourth stage of the grouting procedure was comprised of 85 barrels of cement containing a 6% bentonite gel additive. The temperature log tag conducted on this stage indicated a cement top of approximately 781 feet correlating with a tremmie pipe cement top tag of 806 feet. The fifth stage consisted of 25 barrels of 6% bentonite gel additive cement; the temperature log indicated cement top of 188 feet with a tremmie pipe hard tag of 202 feet. The sixth and final stage poured on September 5, brought the cement to land surface and consisted of 7 barrels of 100% neat Type II cement. All cementing stages produced a fluid return observed at land surface with a full cement return witnessed on the final stage. The total volume of cement pumped was 267 barrels, which was slightly less than the theoretical cement volume of 339 barrels estimated for the annulus of the intermediate casing.

2.3.2. Monitoring Zone Development

The monitoring zone for the LZMW-1B was developed in conjunction with the development of UZMW-1, which occurred on September 27. LZMW-1B was developed at approximately 40 GPM. The total volume of water evacuated from the well was approximately 14,000 gallons, which is in excess of three well volumes. A four horsepower external centrifugal pump was utilized to develop the well. The discharge water at the end of well development appeared to be clear and free of any sediment or particulates.

At the beginning of the well development process, field measurements of the discharge water indicated a specific conductivity of 41,200 microsiemens per centimeter (µS/cm), and a temperature of 30.9 degrees Celsius. At the end of development, the discharge water contained a specific conductivity of 40,100 µS/cm, and a temperature of 30.6 degrees Celsius. The stabilization in conductivity of the development water after three well volumes (approximately 10,160 gallons of water) had been pumped from the monitoring zone confirmed that native background conditions had been reached. Personnel from Sanders Laboratories, Inc. were on-site to collect the background water sample analyses at the end of well development.

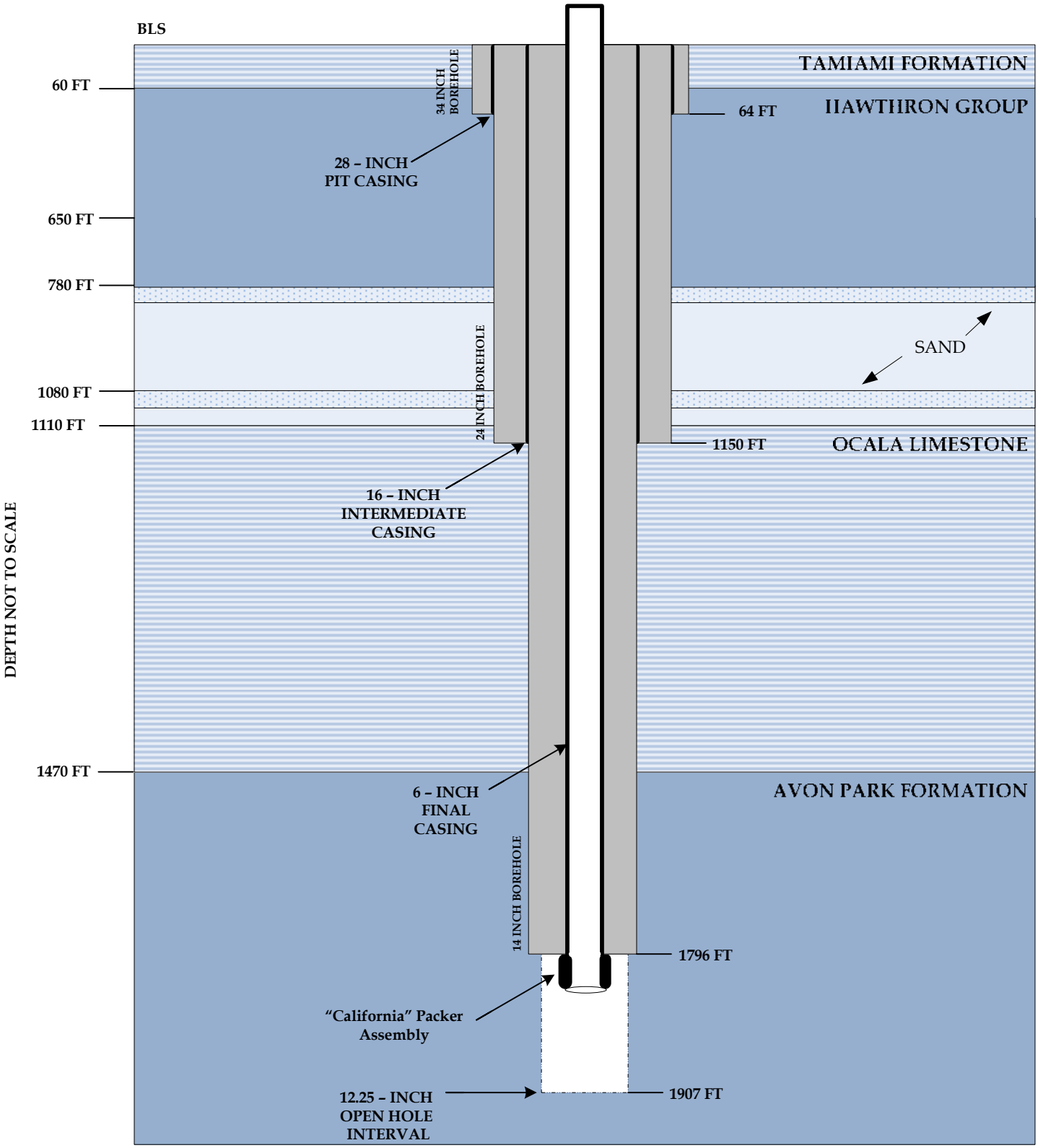
After development of the monitoring zone, the wellhead of the LZMW-1B was completed in April of 2008 (**Figure 2-19)**. Laboratory results from the background sample are presented in **Section 3.** An as-built drawing of the LZMW-1B in addition to the various geologic formations that were encountered during the drilling of the well is depicted in **Figure 2-20**.

LZMW-1B – Completed Well

Figure 2-19

FIGURE 2-20
LEHIGH ACRES DIW PROJECT

AS-BUILT DRAWING OF LZMW-1B
INCLUDING FORMATION CONTACTS



2.4. Upper Zone Monitor Well Construction

The UZMW-1 was the second well completed at the site. Although the construction of the UZMW-1 began on May 31, 2007, construction of the well was halted on June 19, due to sand intrusion. The well was initially planned and constructed through the installation of the intermediate casing as the LZMW-1, but on June 14, while drilling the pilot hole for the final 6 inch casing, utilizing reverse air drilling techniques, at a depth of 799 feet bls, a very fine silica sand was encountered near the top of the Suwannee Limestone. After repeated dredging attempts to surpass 800 feet bls were not successful, construction was suspended. A site meeting was conducted to propose a "flip-flop" of well construction sites. The current well would be renamed UZMW-1 and completed utilizing mud drilling techniques, which would allow for the pilot hole to progress though the sand layers, enabling for the final casing installation. The mud drilling required to completed UZMW-1 would prevent a large portion of the data collection process from being performed. The majority of hydrogeologic data would have to be collected during drilling of the new LZMW-1 utilizing reverse air techniques. All parties involved, FGUA, FDEP, YBI and PBS&J, were in agreement that this was the best course of action. On June 22, the drilling rig was demobilized temporarily from UZMW-1 to the new location for LZMW-1, approximately 50 feet east of the UZMW-1 well site. The construction of UZMW-1 was re-initiated on September 13, and was completed on September 25. A chronology of the significant monitor well construction and testing activities is presented in **Table 2-5**.

The pilot hole of the well was drilled to a total depth of approximately 1,578 feet with the monitoring zone interval completed between approximately 1,496 feet and 1,578 feet, which was selected to include a permeable interval above the base of the USDW at 1,700 feet bls. Casing sizes of the well varied and included the following: a 26-inch pit casing, a 16-inch intermediate casing, and a 6-inch final casing. Copies of the mill certificates for all the casings used in the construction of the UZMW-1 are presented in **Appendix E**.

2.4.1. Drilling and Casing Installation

2.4.1.1. UZMW-1 Pit Casing

The start of drilling operations coincided with the installation of the pit casing for the UZMW-1 on May 31. The 26-inch diameter, 0.375-inch wall steel casing was installed to a depth of approximately 110 feet into competent rock and cemented into place with neat cement.

TABLE 2-5
CHRONOLOGY OF SIGNIFICANT UZMW-1
CONSTRUCTION AND TESTING ACTIVITIES

DATE	ACTIVITY
5/29/07	YBI continues mobilization to the UZMW-1 site; pit casing commences.
5/31/07	Pit casing installed; total depth of 110 feet below land surface (bls) achieved, 26-inch casing installed to 110 feet bls.
6/2/07	Began pilot hole drilling with 12.25-inch bit to 215 feet bls.
6/3/07	Continue pilot hole drilling
6/4/07	Continue pilot hole drilling; attained total depth at 750 feet bls for 16-inch intermediate casing.
6/5/07	Geophysical logging of the pilot hole with caliper/gamma, sonic and dual induction to 750 feet bls; determined intermediate casing will seat at 680 feet bls.
6/6/07	Began reaming of the pilot hole to 20 inches in diameter.
6/7/07	Continue reaming
6/9/07	Geophysical logging including caliper/gamma logs; installation of 16-inch intermediate casing; first stage of cementing pressure grouted, 300 barrels.
6/10/07	Temperature log conducted on stage 1; tag depth to top of cement - 257 ft bls, second stage conducted 126 barrels, tremmie grout, full cement return at land surface.
6/11/07	Site was prepared for reverse-air drilling.
6/13/07	Began reverse-air drilling at 680 feet bls; conducted Specific Capacity tests and water quality sampling every 60 feet.
6/14/07	Continue drilling at 799 ft bls; encounter sand intrusion at 799 ft bls and begin dredging.
6/15/07	Continue drilling to 830 feet bls; sand continues to intrude, dredging continues at 800 feet bls.
6/16/07	Dredging continues at 780 feet bls
6/17/07	Dredging continues at 780 feet bls
6/18/07	Dredging continues at 770 feet bls
6/19/07	Dredging continues at 790 feet bls
6/20/07	Dredging stopped; work suspended until meetings about the future construction of UZMW-1 can be conducted.
6/22/07	Demobilize drilling off UZMW-1
9/12/07	Mobilize drilling onto UZMW-1

TABLE 2-5
CHRONOLOGY OF SIGNIFICANT UZMW-1
CONSTRUCTION AND TESTING ACTIVITIES

DATE	ACTIVITY
9/13/07	Continue mud drilling with a 12.25-inch bit at 830 feet bls.
9/14/07	Continue mud drilling to1,200 feet bls.
9/17/07	Drilled to total depth of 1,578 feet bls.
9/18/07	Conduct geophysical logging suite, including XY caliper, gamma ray, dual induction, sonic borehole compensated (BHC) with log derived total dissolved solids (TDS).
9/19/07	Ream the bore hole to 1,497 feet bls with a 14-inch bit; clean out the bore hole from 1,497-1,578 feet bls with a 12.25-inch bit.
9/20/07	Conduct geophysical logs in the reamed hole. Conducted XY caliper and gamma ray; install 6-inch fiberglass reinforced plastic (FRP) casing to 1,497 feet bls (including California packer at the bottom).
9/21/07	First grout stage: 4 barrels of 100 % neat cement; Second grout stage: 4 barrels of 100% neat cement; Tag from combined 1st and 2nd stages is 1,330 feet bls; Temperature log conducted, showing tag at 1,315 feet bls; Third grout stage poured, 45 barrels of 6% gel additive.
9/22/07	Temperature log conducted, tag at 1,072 ft bls; Stage 4 grout poured, 265 barrels at 6% gel additive.
9/23/07	Temperature log conducted, tagged at 270 feet bls
9/24/07	Fifth stage of grout poured: 44 barrels of 4% gel additive, full return at land surface
9/25/07	Casing pressure test conducted at 50 psi, passed at +5%; resulting water collected after the pressure is bled off, 6.5 gallons; cap on the packer is blown, casing is open to the interval; airlift development of the open interval begins.
9/26/07	Airlift development continues
9/27/07	Development concluded; Background water quality samples collected by Sanders Laboratory personnel.
9/28/07	Begin demobilization off UZMW-1

2.4.1.2. UZMW-1 Intermediate Casing (16-Inch)

Beginning on June 2, a 12.25-inch diameter pilot hole was advanced to an approximate depth of 750 feet by June 5, using mud-rotary drilling methods. Formation samples were collected every 10 feet during installation of the pit casing and continued during the drilling of the pilot hole. Based on lithologic data collected from the pilot hole, relatively competent rock was found to occur approximately between 660 and 680 feet. Geophysical evaluations conducted in the UZMW-1 pilot hole confirmed that competent rock occurred at 680 feet, which was selected as the casing setting depth. A complete discussion of all geophysical surveys completed on the UZMW-1 is presented in **Section 3.6.2**.

The 12.25-inch pilot hole was reamed to a nominal 24 inches in diameter to a depth of approximately 680 feet using mud-rotary drilling methods. The borehole was prepared for casing installation by circulating with mud until mud returns were free from cuttings. Several "wiper trips" were made by rotating the bit in and out of the borehole, prior to the installation of the 16-inch intermediate casing.

Borehole deviation surveys, using a "sure-shot tool," were collected in both the pilot hole and reamed hole at 90-foot intervals throughout the entire length of the well. A summary of the deviation surveys collected on the pilot hole are presented in **Table 2-6** while the reamed hole deviation surveys are summarized in **Table 2-7**. All of the deviation surveys were well within the allowable deviation of one degree over the tested interval of 90 feet.

The intermediate casing of the UZMW-1 consisted of sixteen, nominal 42-foot sections of 0.5-inch wall, 16-inch diameter steel casing, which were butt-welded together as they were installed into the reamed borehole on June 9. Steel strap centralizers were placed at 5, 20 and 40 feet from the bottom of the casing and every 100 feet thereafter. The casing was installed to a total depth of 680 feet without encountering any obstructions.

YBI cemented the 16-inch intermediate casing with one pressure grout stage and one tremmie grout stage consisting of pumping 95 barrels of neat cement. Using a temperature log, the cement top in the annulus was estimated at 252 feet below land surface approximately eight hours after grouting. A hard tag inside the annulus confirmed the cement top at a depth of approximately 257 feet. The second grout stage consisted of pumping 111 barrels of neat cement via the tremmie method with fluid and cement returns visible at land surface at the end of the stage.

The cemented 16-inch casing was allowed to cure for a period of approximately 18 hours prior to resuming drilling activities. The total volume of cement pumped was 207 barrels, which was comparable to the theoretical cement volume of 211 barrels estimated for the annulus of the intermediate casing. Cementing information from all of the grouting stages during construction of the UZMW-1 is presented in **Table 2-8**.

PBS&J

Florida Governmental Utility Authority
Lehigh Acres WWTP Class I Deep Injection Well
Upper Zone Monitoring Well Pilot Hole Deviation Survey

TABLE 2-6
UZMW-1 PILOT HOLE DEVIATION SURVEY

Date	Depth (ft)	Deviation (degrees)	Remarks
6/3/2007	202	< 1	
6/3/2007	292	< 1	
6/3/2007	382	< 1	
6/3/2007	472	< 1	
6/4/2007	562	1	Left indentation mark is on the 1° line.
6/4/2007	652	< 1	
6/4/2007	742	1	Left indentation mark is on the 1° line.
9/17/2007	770	< 1	
9/17/2007	860	< 1	
9/17/2007	950	< 1	
9/17/2007	1040	< 1	
9/17/2007	1130	< 1	
9/17/2007	1220	< 1	
9/17/2007	1310	< 1	
9/17/2007	1400	< 1	
9/17/2007	1490	< 1	

Florida Governmental Utility Authority
Lehigh Acres WWTP Class I Deep Injection Well
Upper Zone Monitoring Well Ream Hole Deviation Survey

TABLE 2-7
UZMW-1 REAM HOLE DEVIATION SURVEY

Date	Depth (ft)	Deviation (degrees)	Remarks
6/6/2007	185	< 1	
6/6/2007	275	1	Left indentation mark is on the 1° line.
6/7/2007	365	< 1	
6/7/2007	455	< 1	
6/7/2007	545	< 1	
6/7/2007	635	< 1	
9/19/2007	770	< 1	
9/19/2007	860	< 1	
9/19/2007	950	< 1	
9/19/2007	1040	< 1	
9/19/2007	1130	< 1	
9/19/2007	1220	< 1	
9/19/2007	1310	< 1	
9/19/2007	1400	< 1	
9/19/2007	1490	< 1	

PBS&J

Florida Governmental Utility Authority
Lehigh Acres WWTP Class I Deep Injection Well
Upper Zone Monitoring Well Grout Placement Schedule

TABLE 2-8
SCHEDULE OF GROUT PLACEMENT FOR UZMW-1

Date	Stage No.	Interval Filled (feet)	Linear Fill (feet)	Volume Pumped (sacks)	Volume Pumped (barrels)	Theoretical Volume (sacks)	Theoretical Volume (barrels)	Method of Emplacement	Additive to Cement
26" Pit Casing									
5/31/2007	1	110 - 0	110	352	79	261	59	pressure	0%
Total			**110**	**352**	**79**	**261**	**59**		
16" Intermediate Casing									
6/9/2007	1	680 - 257	423	424	95	586	131	pressure	0%
6/10/2007	2	257 - 0	257	497	111	356	80	tremmie	0%
Total			**680**	**921**	**207**	**942**	**211**		
6" Final Casing									
9/20/2007	1	1496-1384	82	17.8	4	18	4	tremmie	0%
9/21/2007	2	1384-1315	89	17.8	4	18	4	tremmie	0%
9/22/2007	3	1315-1072	243	200.5	45	485	109	tremmie	6%
9/22/2007	4	1072-270	802	1181.0	265	1024	230	tremmie	6%
9/24/2007	5	270-LS	270	196.0	44	200	45	tremmie	4%
Total			**1404**	**1613**	**362**	**1745**	**392**		

2.4.1.3. UZMW-1 Final Casing (6-Inch)

The final casing of the UZMW-1 consisted of forty-nine nominal 30 foot sections of FRP casing, which were joined together by threaded couplings that were taped and sealed. Centralizers at 90-degree orientation were placed at 5, 20 and 40 feet from the bottom of the casing and every 100 feet thereafter. The bottom of the casing was seated at a depth of approximately 1,496 feet. A "California" packer assembly was attached at the bottom of the final casing to facilitate the formation of a grout plug around the bottom of the casing that would prevent cement from entering the open borehole interval (approximate depth range of 1,496 to 1,578 feet) during the following grouting operations. The packer (10-inch diameter) consisted of a 6-foot aluminum assembly with an expandable rubber section. The packer was coupled to the FRP casing with an aluminum threaded adapter.

After the casing was lowered into place on September 20, two smaller cement stages, totaling 8 barrels of neat cement, were pumped to assure that the inflated section of the packer would retain the cement. A hard tag of the cement inside the annulus following the second stage was at approximately 1,315 feet. The remaining portion of the final casing (from approximately 1,315 feet to land surface) was tremmie grouted in three cement stages utilizing a total of 354 barrels of neat cement. The third cement stage consisted of 45 barrels of cement with a 6% bentonite gel additive, resulting in the cement top indicated on a temperature log at approximately 1,072 feet. A hard tag with a tremmie pipe at approximately 1,068 feet confirmed the temperature log. The fourth stage was comprised of barrels of cement containing a 6% bentonite gel additive. A temperature log indicated a cement top at 270 feet, which was confirmed with a hard tag of 275 feet. The fifth cement stage was comprised of 44 barrels of cement with a 4% bentonite gel additive. This last stage brought the cement to land surface as witnessed by PBS&J personnel.

2.4.1.4. Monitoring Zone Development

Development of the open borehole interval (approximately 1,496 to 1,578 feet below land surface) of the UZMW-1 was initiated following the completion of the casing installation and a casing pressure test on September 27. The open interval was developed via reverse-air for approximately six hours at an average rate between 40 and 60 gpm (total of 19,000 gallons of ground water discharge). The discharge water at the end of well development appeared to be clear and free of any sediment or particulates.

At the end of development, the discharge water contained a specific conductivity of 4,150 µS/cm, and the temperature was 29.9 degrees Celsius. The well was considered stabilized and development complete when the field water quality parameters of conductivity and temperature did not exhibit any appreciable change, the conductivity

values from the field samples collected in the last hour of development were 4,150, 4,170 and 4,150 uS/cm. Personnel from Sanders Laboratories, Inc. were on-site to collect the background water sample at the end of well development on September 27.

After development of the monitoring zone, the wellhead was completed (**Figure 2-21)**. Laboratory results from the background sample are presented in **Section 3**. **Figure 2-22** depicts an as-built drawing of the UZMW-1 in addition to the various geologic formations that were encountered during the drilling of the well.

2.5. Injection Well Construction

Construction of DIW-1 began on November 19, 2007 and was completed on April 17, 2008. A chronology of the significant injection well construction activities is presented in **Table 2-9**.

The injection well was drilled to a total depth of approximately 3,200 feet, completed on January 29. Hydrogeologic testing and data collected during the construction indicated that the injection zone was located between approximately 2,370 and 3,200 feet. Casing sizes of the injection well included a 54-inch pit casing, a 42-inch surface casing, a 34-inch intermediate casing, and a 24-inch final casing (**Figure 2-23)**. A copy of the mill certificates for all the casings are presented in **Appendix E**.

2.5.1. Drilling and Casing Installation

2.5.1.1. DIW-1 Pit Casing

The commencement of drilling operations coincided with the installation of the pit casing on November 20. The 54-inch diameter, 0.375-inch wall steel casing was set and installed to an approximate depth of 57 feet. The pit casing was cemented into competent rock using 59 barrels of neat cement. The primary function of the pit casing was to stabilize the top of the borehole allowing for pilot hole drilling and reaming operations facilitating the installation of the surface casing.

2.5.1.2. DIW-1 Surface Casing (42-Inch)

A 12.25-inch diameter mud-rotary drilled borehole was advanced to an approximate depth of 1,202 feet on November 24. The pilot hole was reamed with a 52.5 inch diameter reamer bit to a depth of 1,185 feet bls on December 3, in preparation for installation of the 42-inch surface casing. Deviation surveys were collected in the pilot hole and in the reamed borehole of the injection well at 90-foot intervals. **Table 2-10**

Figure 2-21

UZMW-1 – Completed Well

FIGURE 2-22
LEHIGH ACRES DIW PROJECT

AS-BUILT DRAWING OF UZMW-1
INCLUDING FORMATION CONTACTS

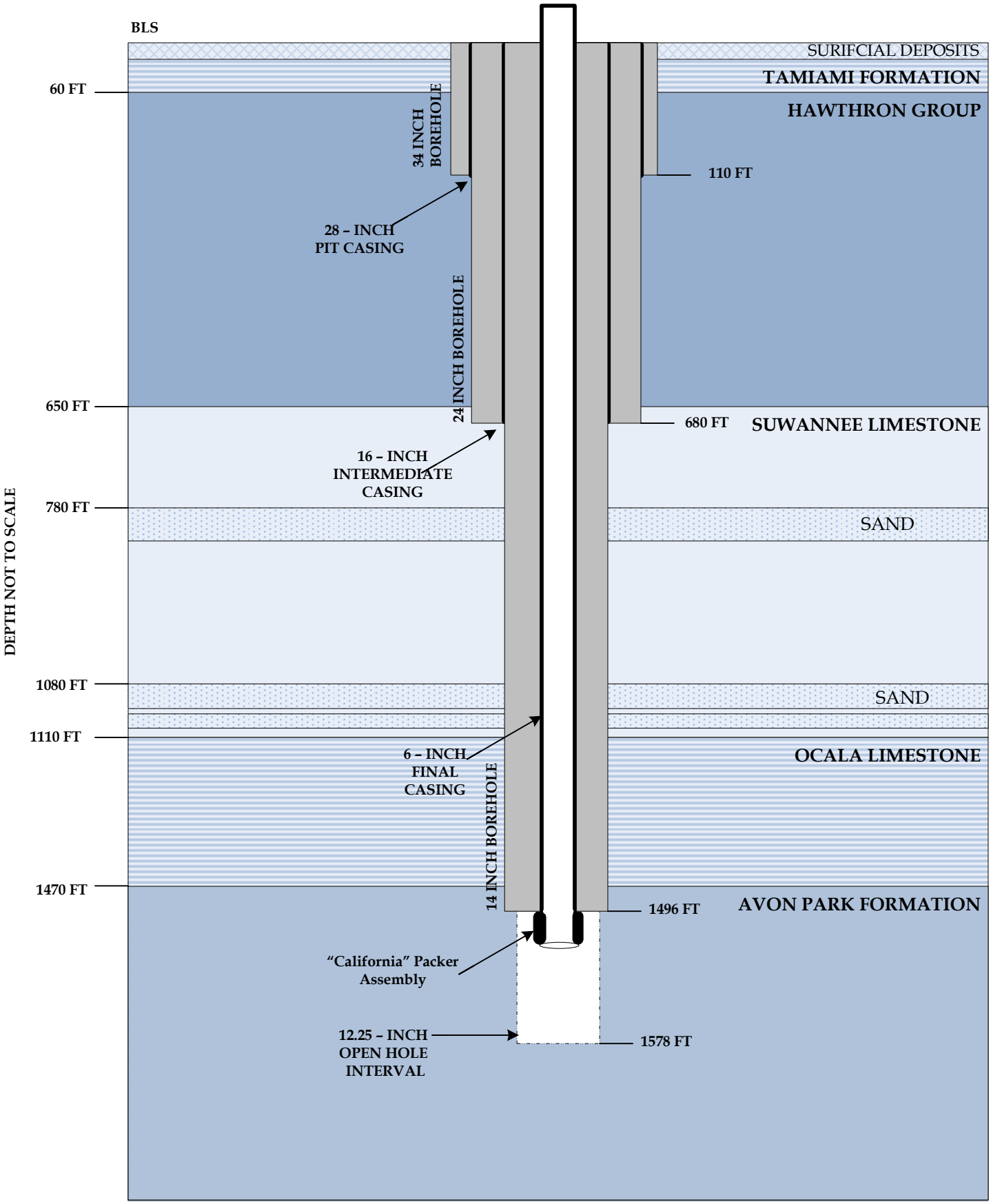


TABLE 2-9
CHRONOLOGY OF SIGNIFICANT DIW-1
CONSTRUCTION AND TESTING ACTIVITIES

DATE	ACTIVITY
5-NOV-07	Began mobilization of the rig to the Lehigh Acres DIW site.
19-NOV-07	Began drilling for the pit casing with a 58 inch bit, pit casing was set at 57 ft bls with 54 inch steel casing
20-NOV-07	54 inch casing grouted into place with barrels neat cement
21-NOV-07	Began drilling pilot hole with 12.25 inch bit
22-NOV-07	Site shut down for thanksgiving holiday
23-NOV-07	Continued pilot hole drilling at a depth of 500 ft bls
24-NOV-07	Continued pilot hole drilling at a depth of 1202 ft bls: conducted geophysical logging in preparation for casing setting at 1180 ft bls
25-NOV-07	Reamed the pilot hole to a depth of 1180 ft bls and diameter of 52.5 inches
26-NOV-07	Continued reaming the pilot hole at a depth of 100 ft bls
27-NOV-07	Continued reaming the pilot hole at a depth of 260 ft bls
28-NOV-07	Continued reaming the pilot hole at a depth of 470 ft bls
29-NOV-07	Continued reaming the pilot hole at a depth of 675 ft bls
30-NOV-07	Continued reaming the pilot hole at a depth of 760 ft bls
1-DEC-07	Continued reaming the pilot hole at a depth of 810 ft bls
2-DEC-07	Continued reaming the pilot hole at a depth of 1100 ft bls
3-DEC-07	Reaming completed at 1185 ft bls; Began wiper trips in the borehole
4-DEC-07	Continued wiper trips
5-DEC-07	Continued wiper trips
6-DEC-07	Wiper trips complete; geophysical logging for grout quantities conducted followed by 34 inch Intermediate casing install
7- DEC-07	Continue casing installation followed by STAGE 1 of cement grout, 350 barrels of 12% and 86 barrels of neat
8-DEC-07	Conduct temperature log of STAGE 1; 730 ft bls, continue cementing practices with STAGE 2, 317 barrels of 12% grout, Temp log on STAGE 2 is 328 ft bls; continue cementing with STAGE 3, 228 barrels of 12%
9-DEC-07	Conduct temperature log of STAGE 3, 100 ft bls; continue cementing up to land surface with STAGE 4 with 95 barrels of 4% cement; Rig switched to reverse air drilling

TABLE 2-9
CHRONOLOGY OF SIGNIFICANT DIW-1
CONSTRUCTION AND TESTING ACTIVITIES

DATE	ACTIVITY
13- DEC-07	Began reverse air drilling at 1185 ft bls, collect water quality samples every 60 ft bls
14-DEC-07	Continue pilot hole drilling to 1520 ftbls
15-DEC-07	Continue pilot hole drilling to TD for this part of the pilot at 1800 ft bls,
16- DEC-07	Pilot hole cleaned out with wiper trips; formation water quality collected; conduct pilot geophysical logs
17-DEC-07	Submittal for casing seating depth sent to DEP
18-DEC-07	DEP approves casing seating of 1800 ft bls
19-DEC-07	YBI begins cementing of the pilot hole; Begin reaming the pilot hole to 40 inches
20-DEC-07	Continue reaming activities
21-DEC-07	Continue reaming activities
22-DEC-07	Continue reaming activities
23-DEC-07	Continue reaming activities
24-DEC-07	Continue reaming activities
25-DEC-07	Site shut down for the holiday
26-DEC-07	Continue reaming activities
27-DEC-07	Continue reaming activities
28-DEC-07	Complete reaming activities at 1800 ft bls; conduct borehole geophysical logs, an obstruction is observed at the bottom of the well, YBI trips back in with the reamer bit to clean it out
29-DEC-07	Continue reaming activities
30-DEC-07	Continue reaming activities
31-DEC-07	Continue reaming activities
01-JAN-08	Begin 34 inch intermediate casing installation
02-JAN-08	Complete casing installation; Pressure grout in STAGE 1 of casing cementing, 308 barrels of 12% cement
03-JAN-08	Temp log shows cement top at 1257 ft bls; Cement STAGE 2, 100 barrels of 12% cement
04-JAN-08	Temp log for STAGE 2 shows cement top of 1134 ft bls; Cement STAGE 3,

TABLE 2-9
CHRONOLOGY OF SIGNIFICANT DIW-1
CONSTRUCTION AND TESTING ACTIVITIES

DATE	ACTIVITY
	157 barrels of 12% cement; Temp log for STAGE 3 shows cement top at 791 ft bls ; Cement STAGE 4
05-JAN-08	Temp log for STEGE 4 shows cement top at 565 ft bls; Cement STAGE 5, 156 barrels of 12%
06-JAN-08	Temp log for STAGE 5 shows cement top at 370 ft bls; conduct CBL log on the 34 inch intermediate casing; Cement STAGE 6 to land surface, 307 barrels of 12% cement
07-JAN-08	Trip in with drill bit and begin drilling on the cement plug
08-JAN-08	Continue pilot hole drilling with 12.25 inch bit at 1800 ft bls to a depth of 1930 ft bls
09-JAN-08	Continue pilot hole drilling to 1961ft bls, 1st core depth: core collected between 1961 ft – 1973 ft bls
10-JAN-08	Continue coreing activity; collect 10 ft of core sample; continue pilot drilling
11-JAN-08	Continue pilot hole drilling, depth achieved 2000ft bls, 2 coring depth; begin second core; recover 15 ft of core material
12-JAN-08	Continue pilot hole drilling to 2065 ft bls ; 3rd coring depth; begin 3rd core
13-JAN-08	Continue 3rd core; extract 15 ft of recovered material; resume pilot hole drilling to a depth of 2120ft bls
14-JAN-08	Continue pilot hole drilling to 2157 ft bls
15-JAN-08	Continue pilot hole drilling to 2161 ft bls; 4th core depth; begin 4th core
16-JAN-08	Continue 4th core; extract core sample; Continue pilot hole drilling to 2255 ft bls
17-JAN-08	Continue pilot hole drilling to a depth of 2323 ft bls; drill rod broke in the hole and was fished out
18-JAN-08	Maintenance and repairs on the rig
19-JAN-08	Continue pilot hole drilling to a depth of 2466 ft bls
20-JAN-08	Continue pilot hole drilling to a depth of 2677ft bls
21-JAN-08	Continue pilot hole drilling to a depth of 2753 ft bls
22-JAN-08	Continue pilot hole drilling to a depth of 2808 ft bls
23-JAN-08	Continue pilot hole drilling at a depth of 2820 ft bls; rig repairs and

TABLE 2-9
CHRONOLOGY OF SIGNIFICANT DIW-1
CONSTRUCTION AND TESTING ACTIVITIES

DATE	ACTIVITY
	maintenance
24-JAN-08	Continue pilot hole drilling at a depth of 2877 ft bls
25-JAN-08	Continue pilot hole drilling at a depth of 2996 ft bls
26-JAN-08	Continue pilot hole drilling at a depth of 3065 ft bls
27-JAN-08	Continue pilot hole drilling at a depth of 3090 ft bls
28-JAN-08	Continue pilot hole drilling at a depth of 3130 ft bls
29-JAN-08	Continue pilot hole drilling at a depth of 3200 ft bls; Total depth
01-FEB-08	Geophysical logging suite conducted on the pilot hole
03-FEB-08	Begin Packer testing; first interval is 1940-1970ft bls; conductivity 49,400 uS/cm, TDS 24,700 mg/L
04-FEB-08	Continue Packer Testing; second interval is 1885-1915 ft bls; conductivity 45,000 uS/cm, TDS 22,500 mg/L
05-FEB-08	Continue Packer Testing; third interval is 1990-2088 ft bls; conductivity 52,400 uS/cm, TDS 26,200
06-FEB-08	Continue Packer Testing; fourth interval is 2130-2230 ft bls; conductivity 53,900 uS/cm, TDS 26,900
07-FEB-08	Submittal sent to FDEP for purposed casing setting depth for 24 inch final casing at a depth of 2370 ft bls
08-FEB-08	FDEP responds in agreement with purposed casing setting depth; the site is prepared for reaming activities
11-FEB-08	The pilot hole was backfilled with 12% cement from 2370 to 1800 ft bls; Reaming activities began
12-FEB-08	Continue reaming activities
13-FEB-08	Continue reaming activities
14-FEB-08	Continue reaming activities
15-FEB-08	Continue reaming activities
16-FEB-08	Continue reaming activities
17-FEB-08	Continue reaming activities
18-FEB-08	Continue reaming activities
19-FEB-08	Continue reaming activities

TABLE 2-9
CHRONOLOGY OF SIGNIFICANT DIW-1
CONSTRUCTION AND TESTING ACTIVITIES

DATE	ACTIVITY
20-FEB-08	Continue reaming activities
21-FEB-08	Continue reaming activities
22-FEB-08	Continue reaming activities
23-FEB-08	Continue reaming activities
24-FEB-08	Continue reaming activities
25-FEB-08	Continue reaming activities
26-FEB-08	Continue reaming activities
27-FEB-08	Continue reaming activities
28-FEB-08	Continue reaming activities
01-MAR-08	Continue reaming activities
02-MAR-08	Continue reaming activities
03-MAR-08	Continue reaming activities
04-MAR-08	Continue reaming activities
05-MAR-08	Continue reaming activities
06-MAR-08	Continue reaming activities
07-MAR-08	Continue reaming activities
08-MAR-08	Reaming has reached total depth of 3205 ft bls
09-MAR-08	Begin 24 inch steel final casing installation
10-MAR-08	Final casing installed to 2370 ft bls
11-MAR-08	Begin Cementing of the 24 inch casing; cement STAGE A; 2 barrels of neat cement
12-MAR-08	Cement STAGE B and C; 2 barrels each of neat cement; Cement STAGE 1, 17 barrels of neat cement
13-MAR-08	Temperature log from STAGE 1 showed a cement top of 2326 ft bls; Cement STAGE 2; 30 barrels of neat cement; Temperature log from STAGE 2 showed a cement top of 2270 ft bls; Cement STAGE 3; 184 barrels of 12% cement
14-MAR-08	Temperature log from STAGE 2 showed a cement top of 2270 ft bls; Cement STAGE 3; 184 barrels of 12% cement
15-MAR-08	Temperature log from STAGE 3 showed a cement top of 2149 ft bls; Cement

TABLE 2-9
CHRONOLOGY OF SIGNIFICANT DIW-1
CONSTRUCTION AND TESTING ACTIVITIES

DATE	ACTIVITY
	STAGE 4; 50 barrels of 12% cement. Temperature log from STAGE 4 showed a cement top of 2140 ft bls; Cement STAGE 5; 50 barrels of 12% cement. Temperature log from STAGE 5 showed a cement top of 2130 ft bls; Cement STAGE 6; 50 barrels of 12% cement
16-MAR-08	Temperature log from STAGE 6 showed a cement top of 2106 ft bls; Cement STAGE 7; 125 barrels of 12% cement. Temperature log from STAGE 7 showed a cement top of 1968 ft bls; Cement STAGE 8; 125 barrels of 12%
17-MAR-08	Temperature log from STAGE 8 showed a cement top of 1823 ft bls; Cement STAGE 9, 195 barrels of 12% cement.
18-MAR-08	Temperature log from STAGE 9 showed a cement top of 1502 ft bls; Cement STAGE 10, 195 barrels of 12%. Temperature log from STAGE 10 showed a cement top of 1094 ft bls; Cement STAGE 11, 195 barrels of 12% cement
19-MAR-08	Temperature log from STAGE 11 showed a cement top of 758 ft bls; Cement STAGE 12, 222 barrels of 12% cement
20-MAR-08	Temperature log from STAGE 12 showed a cement top of 326 ft bls; Conduct CBL log; Cement STAGE 13 with 114 barrels of 12% cement and 54 barrels of neat cement, full cement return at landsurface.
24- MAR-08	Conduct casing pressure test on final 24 inch casing at DIW-1; Pressure test passed with 2.5% loss over all, witnessed by FDEP
25-MAR-08	After well development the Background Water Quality sample was taken from DIW-1
26-MAR-08	Begin demobilization of the DIW-1 drilling rig
31-MAR-08	Conduct background gamma and temperature geophysical logs in preparation for the RTS test
01-APR-08	Conduct the video survey of the well and the RTS test, RTS test is passed
02-APR-08	Continue demobilization
17-APR-08	Conduct Injection Test

Figure 2-23

24″ FINAL CASING

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Florida Governmental Utility Authority
Lehigh Acres WWTP Class I Deep Injection Well
Deep Injection Well Pilot Hole Deviation Survey

TABLE 2-10
DIW-1 PILOT HOLE DEVIATION SURVEY

Date	Depth (ft)	Deviation (degrees)
11/22/2007	240	<0.25
11/22/2007	320	0.4
11/22/2007	400	0.25
11/23/2007	480	0.5
11/23/2007	560	0.4
11/23/2007	640	0.40
11/23/2007	720	0.25
11/23/2007	800	0.25
11/24/2007	880	0.3
11/24/2007	960	0.4
11/24/2007	1040	<0.25
11/24/2007	1120	<0.25
11/24/2007	1200	<0.25
12/14/2007	1280	0.25
12/14/2007	1350	0.25
12/14/2007	1430	0.25
12/14/2007	1510	0.25
12/15/2007	1590	0.25
12/15/2007	1670	0.25
12/15/2007	1750	<0.25
1/8/2008	1830	0.25
1/10/2008	1910	0.25
1/10/2008	1990	0.3
1/13/2008	2070	0.3
1/14/2008	2150	0.3
1/16/2008	2230	0.4
1/16/2008	2310	0.4
1/19/2008	2390	0.4
1/20/2008	2470	0.3
1/20/2008	2550	0.3
1/20/2008	2630	0.3
1/21/2008	2710	0.25
1/22/2008	2790	0.25
1/24/2008	2870	0.3
1/25/2008	2950	0.3
1/26/2008	3030	0.3
1/28/2008	3110	0.3
1/29/2008	3190	0.3

presents a summary of the pilot hole deviation survey while **Table 2-11** presents a summary of the reamed borehole deviation survey. All of the deviation surveys were within the allowable limits of less than 1-degree deviation over the tested interval.

The surface casing of DIW-1 consisted of nominal 42-foot sections of 0.375-inch wall, 42-inch diameter steel casing that were butt-welded together as the casing was installed. Centralizers at 90-degrees orientation were placed at 5, 20, and 40 feet from the bottom of the casing and every 100 feet thereafter. The casing was installed to a total depth of approximately 1,180 feet on December 6 and 7, without encountering any obstructions.

The contractor cemented the 42-inch surface casing with one pressure grout stage and three tremmie pipe grout stages completed on December 9. The pressure grout stage consisted of pumping 86 barrels of Type II neat cement and 350 barrels of Type II cement with a 12% bentonite gel additive. The cement top in the annulus, using the temperature log, was estimated at 730 feet approximately 12 hours after grouting. The second grout stage consisted of pumping 317 barrels of 12% bentonite gel additive cement via the tremmie method. Approximately 8 hours after the pumping of stage two, a temperature log was utilized to determine the top of the cement at approximately 328 feet. The third grout stage consisted of 230 barrels of 12% bentonite gel additive cement pumped into the annular space. The resulting temperature log showed a cement top tag of 100 feet. The remaining 100 feet was tremmie grouted to land surface during the fourth grouting stage of the surface casing, which consisted of 96 barrels of 4% bentonite gel additive cement.

The total volume of cement pumped was 1,078 barrels, which is comparable to the theoretical cement volume of 1,098 barrels estimated for the annulus of the surface casing. Cement quantities from all of the grouting stages during construction of DIW-1 are presented in **Table 2-12**.

2.5.1.3. DIW-1 Intermediate Casing (34-Inch)

The cemented 42-inch surface casing was allowed to cure for a period of approximately 24 hours prior to resuming drilling activities on December 13. A 12.25-inch pilot hole was advanced to approximately 1,800 feet using reverse-air drilling techniques and subsequently completed on December 15. Lithology, groundwater quality data, geophysical evaluations, and recommendations for an intermediate casing depth of 1,800 feet were submitted to the TAC for review on December 17. Following TAC approval on December 18, of the intermediate casing setting depth of 1,800 feet, YBI opted to backfill the pilot hole with 12% bentonite gel additive Type II cement to an approximate depth of 1,180 feet. YBI performed this backfill cementing operation in order to avoid potential deviated boreholes, a situation where the reamer drilling bit does not follow the pilot hole, which creates two separate boreholes open in the same zones, thus leading to potential contamination concerns. After the cement had cured

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Florida Governmental Utility Authority
Lehigh Acres WWTP Class I Deep Injection Well
Deep Injection Well Ream Hole Deviation Survey

TABLE 2-11
DIW-1 REAM HOLE DEVIATION SURVEY

Date	Depth (ft)	Deviation (degrees)
11/25/2007	160	0.25
11/26/2007	240	<0.25
11/26/2007	320	<0.25
11/27/2007	400	0.25
11/27/2007	480	0.25
11/28/2007	560	0.4
11/28/2007	640	<0.25
11/29/2007	720	<0.25
11/30/2007	800	<0.25
12/1/2007	880	<0.25
12/1/2007	960	0.25
12/3/2007	1040	0.4
12/3/2007	1120	0.25
12/20/2007	1210	<0.25
12/21/2007	1290	<0.25
12/21/2007	1370	0.25
12/22/2007	1450	0.4
12/22/2007	1530	0.3
12/23/2007	1610	0.25
12/27/2007	1690	0.25
12/27/2007	1770	0.25
2/10/2008	1850	<0.25
2/11/2008	1930	0.4
2/11/2008	2010	0.3
2/12/2008	2090	0.3
2/14/2008	2170	0.25
2/15/2008	2250	0.25
2/17/2008	2330	0.3
2/19/2008	2410	0.25
2/20/2008	2490	0.4
3/1/2008	2520	0.35
3/2/2008	2600	0.45
3/3/2008	2680	0.5
3/4/2008	2760	0.3
3/5/2008	2840	0.3
3/5/2008	2920	0.15
3/6/2008	3000	0.25
3/7/2008	3080	0.45
3/8/2008	3160	0.4

TABLE 2-12
SCHEDULE OF GROUT PLACEMENT FOR DIW-1

Date	Stage No.	Interval Filled (feet)	Linear Fill (feet)	Volume Pumped (barrels)	Theoretical Volume (barrels)	Method of Emplacement	Additives to Cement
54" Pit Casing							
11/20/2007	1	60-0	57	49	37	pressure grout	neat
Totals		**60**	**64**	**49**	**37**		
42" Surface Casing							
12/7/2007	1A	1180-730	450	86	0	pressure grout	neat
12/7/2007	1B	-	-	350	388	pressure grout	12%
12/8/2007	2	730-328	402	317	364	tremmie pipe	12%
12/8/2007	3	328-100	228	230	244	tremmie pipe	12%
12/9/2007	4	100-LS	100	96	102	tremmie pipe	4%
Totals		**1180**	**1150**	**1078**	**1098**		
34" Intermediate Casing							
1/2/2008	1A	1800-1303	497	55		pressure grout	neat
1/2/2008	1B	-	-	315	273		12%
1/3/2008	2	1303-1113	190	100	112	tremmie pipe	12%
1/4/2008	3	1113-803	310	157	164	tremmie pipe	12%
1/4/2008	4	803-568	235	156	172	tremmie pipe	12%
1/5/2008	5	568-290	278	156	172	tremmie pipe	12%
1/6/2008	6	290-LS	290	307	300	tremmie pipe	12%
Totals		**1800**	**1800**	**1246**	**1193**		

TABLE 2-12
SCHEDULE OF GROUT PLACEMENT FOR DIW-1

Date	Stage No.	Interval Filled (feet)	Linear Fill (feet)	Volume Pumped (barrels)	Theoretical Volume (barrels)	Method of Emplacement	Additives to Cement
24" Final Casing							
3/11/2008	1	2370-2355	15	<1	-	tremmie pipe	neat
3/11/2008	2	-	-	<1	-	tremmie pipe	neat
3/12/2008	3	-	-	2	8	tremmie pipe	neat
3/13/2008	4	2355-2326	29	17	15	tremmie pipe	neat
3/14/2008	5	2326-2270	56	30	32	tremmie pipe	neat
3/14/2008	6	2270-2149	121	184	70	tremmie pipe	12%
3/14/2008	7	2149-2140	9	50	8	tremmie pipe	12%
3/15/2008	8	2140-2130	10	50	6	tremmie pipe	12%
3/15/2008	9	2130-2106	24	50	13	tremmie pipe	12%
3/16/2008	10	2106-1968	138	125	77	tremmie pipe	12%
3/16/2008	11	1968-1823	145	125	86	tremmie pipe	12%
3/17/2008	12	1823-1502	321	195	168	tremmie pipe	12%
3/18/2008	13	1502-1094	408	195	204	tremmie pipe	12%
3/18/2008	14	1094--758	336	195	168	tremmie pipe	12%
3/19/2008	15	758-326	432	220	216	tremmie pipe	12%
3/20/2008	16	326-0	-	114	-	tremmie pipe	12%
3/20/2008	16	326-0	326	54	163	tremmie pipe	neat
Totals		**2370**	**2370**	**1606**	**1234**		

for approximately 8 hours, YBI proceeded to ream the 12.25-inch pilot hole to a nominal 40 inches to an approximate depth of 1,805 feet. The reamed borehole was completed on December 28, in preparation for the installation of the 34-inch intermediate casing. A geophysical logging suite was completed on December 28, to verify borehole dimensions and estimate cement quantities.

The intermediate casing of DIW-1 consisted of nominal 38-foot sections of 0.375-inch wall, 34-inch diameter steel casing that was butt-welded together as the casing was installed. Centralizers at 90-degrees orientation were placed at 5, 20, and 40 feet from the bottom of the casing and every 100 feet thereafter. The intermediate casing was installed on January 1 and 2, to an approximate depth of 1,800 feet without encountering any obstructions.

Cementing of the intermediate casing was completed in six cementing stages consisting of a pressure grout stage and five tremmie grout stage (**Table 2-12**). The pressure grout stage consisted of pumping 315 barrels of 12% bentonite gel additive cement and 55 barrels of Portland neat cement in the annular space of the intermediate casing. The shut-in pressure at the header of the casing following pressure cementing stage reached 160 psi. A temperature log of the cement top on the outside of the 34-inch casing approximately 13-hours after grouting indicated that the cement had risen to approximately 1,257 feet. A physical tag to confirm the cement top revealed a cement top at 1,303 feet bls. Stage two consisted of 100 barrels of 12% bentonite gel additive cement, which resulted in a cement top of approximately 1,134 ft bls, as indicated by the temperature log and a physical tag of the cement top at 1,113 feet bls. The third stage consisted of 157 barrels of 12% bentonite gel additive cement. The resulting temperature log indicated a cement top of 791 feet and the physical tag showed the top of cement at 803 feet bls. The fourth stage consisted of 156 barrels pumped via tremmie method into the annular space of the 34-inch intermediate casing. The temperature log conducted after approximately 8 hours had elapsed indicated a cement top of 565 feet, with the physical tag showing a cement top at 568 feet bls. The cement quantity of the fifth stage was 156 barrels of 12% bentonite gel additive cement. After the cement was pumped and allowed to cure, a temperature log was conducted indicating a cement top tag of 370 feet, the physical cement top tag showed that the cement had risen to a depth of 290 feet. Cementing activities were suspended in order to conduct the Cement Bond Log (CBL) on the 34-inch intermediate casing on January 6. The CBL is utilized to verify the integrity of the cement bond between the casing and the cement and the cement and the formation behind. It utilizes sonic waves to verify the density and distribution of the cement in the annular space, verifying the integrity of the cement bond, which is depicted on the log by uniform sonic arrival times. The CBL is also utilized to indicate potential prevalent void spaces, where channeling would have occurred. The results of the CBL will be discussed in **Section 3.6.3.** The remaining 370 feet of un-cemented casing was tremmie grouted with 307 barrels of 12% bentonite gel additive cement on January 6. The total volume of cement pumped was 1,246 barrels,

which is comparable to the theoretical cement volume of 1,193 barrels estimated for the annulus of the intermediate casing.

2.5.1.4. DIW-1 Final Casing (24-Inch)

Following an approximate 20-hour cure period for the cement pumped during the 34-inch intermediate casing installation, reverse-air drilling of a 12.25-inch pilot hole commenced on January 8, and was completed on January 29. During drilling of the pilot hole to an approximate depth of 3,200 feet, collection of four rock cores, ground water quality data, geophysics and hydraulic packer testing were completed and submitted to the TAC for final casing setting depth concurrence on February 7. The additional testing methods and results are presented in **Section 3.**

Following the TAC approval on February 8, of the final casing setting depth of 2,370 feet, YBI backfilled the pilot hole with cement to approximately 1,800 feet. YBI performed this cementing operation to avoid potential cross-connect problems in the event the reamed hole deviated from the original pilot hole. After the cement had cured for approximately 12 hours, YBI proceeded to ream the upper section of the pilot hole with a 30.5-inch drill bit between a depth range of approximately 1,800 and 2,360 feet. The borehole diameter was stepped down with a 26-inch drill bit between 2,360 and 2,370 feet to facilitate installation of the final casing plug. Additionally, the lower section of the pilot hole was reamed to 22 inches from approximately 2,370 to 3,200 feet. Reaming operations were completed on March 8.

A casing plug was attached at the bottom of the 24-inch final casing to facilitate the formation of a grout plug around the bottom of the casing that would prevent cement from entering the open borehole interval (approximately 2,370 to 3,200 feet) during the remaining grouting operations (**Figure 2-24**). The casing plug (28-inch diameter) consisted of a steel float shoe surrounded by several layers of molded urethane. The final casing of DIW-1 consisted of nominal 42-foot sections of 0.5-inch wall, 24-inch diameter steel casing which were butt-welded together as the casing was installed. Centralizers at 90 degree orientations were placed at 20 and 40 feet from the bottom of the final casing and every 100 feet thereafter. The final casing was installed to an approximate depth of 2,370 feet without encountering any obstructions.

The casing was grouted in sixteen total stages, consisting of three small tremmie spot shots and thirteen larger volume tremmie grout stages (**Table 2-12**). Stages 1 through 3 consisted of a total of 6 barrels of neat cement that were pumped following one barrel of gravel tremmied above the casing plug. The cement was tagged by tremmie pipe at approximately 2,359 feet following stage 3, assuring that the casing plug had effectively isolated the open borehole from the grouted casing.

Figure 2-24 **CASING PLUG AND FLOAT SHOE**

Immediately following the formation of the cement plug, the first stage of cementing was performed consisting of 17 barrels of neat cement that were pumped through tremmie pipe set within the annulus above the previous cement tag. A temperature log completed approximately 11 hours after grouting indicated the top of cement was located at an approximate depth of 2,326 feet. The cement was tagged by tremmie pipe at approximately 2,328 feet following the temperature log. The second stage was completed in the same manner as the first stage and was comprised of 30 barrels of neat cement. A temperature log and cement tag performed approximately 10 hours after grouting indicated the top of cement at approximately 2,270 feet.

The third stage consisted of 184 barrels of 12% bentonite gel additive cement. A temperature log and cement tag performed approximately 13 hours after grouting indicated the cement top at approximately 2,149 feet. The amount of linear fill for stage three was 121 feet, which was far less than the approximated 400 feet of theoretical lift expected. It was determined that there was a loss of circulation zone at approximately 2,149 feet and to overcome it, YBI tremmie grouted three smaller stages of cement.

The fourth, fifth and sixth stages of cementing were performed consisting of 50 barrels of 12% bentonite gel additive cement that were pumped through tremmie pipe set within the annulus above the previous cement tag. A temperature log completed approximately 11 hours after each grouting stage indicated the top of cement was approximately 2,140 feet, 2,130 feet, 1,978 feet respectively. After the sixth stage the cement was tagged by tremmie pipe at approximately 2,106 feet.

The seventh stage was comprised of 125 barrels of 12% bentonite gel additive cement. A temperature log and cement tag performed approximately 12 hours after grouting indicated the top of cement at approximately 1,968 feet.

The eighth stage consisted of 125 barrels of 12% bentonite gel additive cement. A temperature log and cement tag performed approximately 11 hours after grouting indicated the cement top at approximately 1,823 feet.

The ninth stage was comprised of 195 barrels of 12% bentonite gel additive cement. A temperature log and cement tag performed approximately nine hours after grouting indicated the top of cement at approximately 1,502 feet.

The tenth stage consisted of 195 barrels of 12% bentonite gel additive cement. A temperature log and cement tag performed approximately 10 hours after grouting indicated the cement top at approximately 1,094 feet.

The eleventh stage was comprised of 195 barrels of 12% bentonite gel additive cement. A temperature log and cement tag performed approximately 12 hours after grouting indicated the top of cement at approximately 758 feet.

The twelfth stage consisted of 222 barrels of 12% bentonite gel additive cement. A temperature log and cement tag performed approximately eight hours after grouting indicated the cement top at approximately 326 feet. A cement bond log was conducted approximately 14 hours after grouting the twelfth stage indicated that the cement had bonded properly around the final casing from the approximate interval from 2,370 feet to 326 feet. The remaining 326 feet of final casing was tremmie grouted (stage 13) immediately after completion of the cement bond log with 114 barrels of 12% bentonite gel additive cement and 54 barrels of neat cement. Cement returns at land surface were observed during the thirteenth stage on March 20. The total volume of cement pumped was 1,610 barrels, which exceeded the theoretical cement volume of 1,341 barrels estimated for the annulus of the final casing.

2.5.2. Injection Zone Development

Approximately four days following the installation of the final casing, final development and collection of the background water sample at DIW-1 was performed on March 25. YBI utilized reverse-air development techniques to develop out the three drill rod volumes required before sampling, at a rate of approximately 265 gpm for approximately forty-five minutes. Prior to the collection of water quality samples, a total of approximately 11,700 gallons of groundwater was discharged to on-site storage tanks during development. The discharge water at the end of the injection zone development appeared to be clear and free of any sediment or particulates.

At the beginning of development, field measurements of the discharge water indicated a specific conductivity of 53,300 µS/cm, and a temperature of 34.7 degrees Celsius. At the end of development, the discharge water contained a specific conductivity of 52,700 µS/cm, and a temperature of 36.0 degrees Celsius. The stabilization in conductivity of the development water after three drill rod volumes (approximately 11,200 gallons of water) had been pumped from the injection zone confirmed that native background conditions had been reached. Personnel from Sanders Laboratories, Inc. were on-site to collect the background water sample at the end of well development and the analytical results are presented in **Section 3**.

After conducting the Injection Test on April 1 (addressed in **Section 3.7**), the wellhead of the DIW-1 was completed in April (**Figure 2-26)**. Laboratory results from the background sample are presented in **Section 3.** An as-built drawing of the DIW-1 in addition to the various geologic formations that were encountered during the drilling of the well is depicted in **Figure 2-27**.

2.6. Mechanical Integrity Testing (MIT)

As part of the mechanical integrity testing (MIT) of the wells, casing pressure tests were performed on the 6-inch final casings of LZMW-1B and UZMW-1 in addition to the 24-

DIW-1 CASING PRESSURE TEST

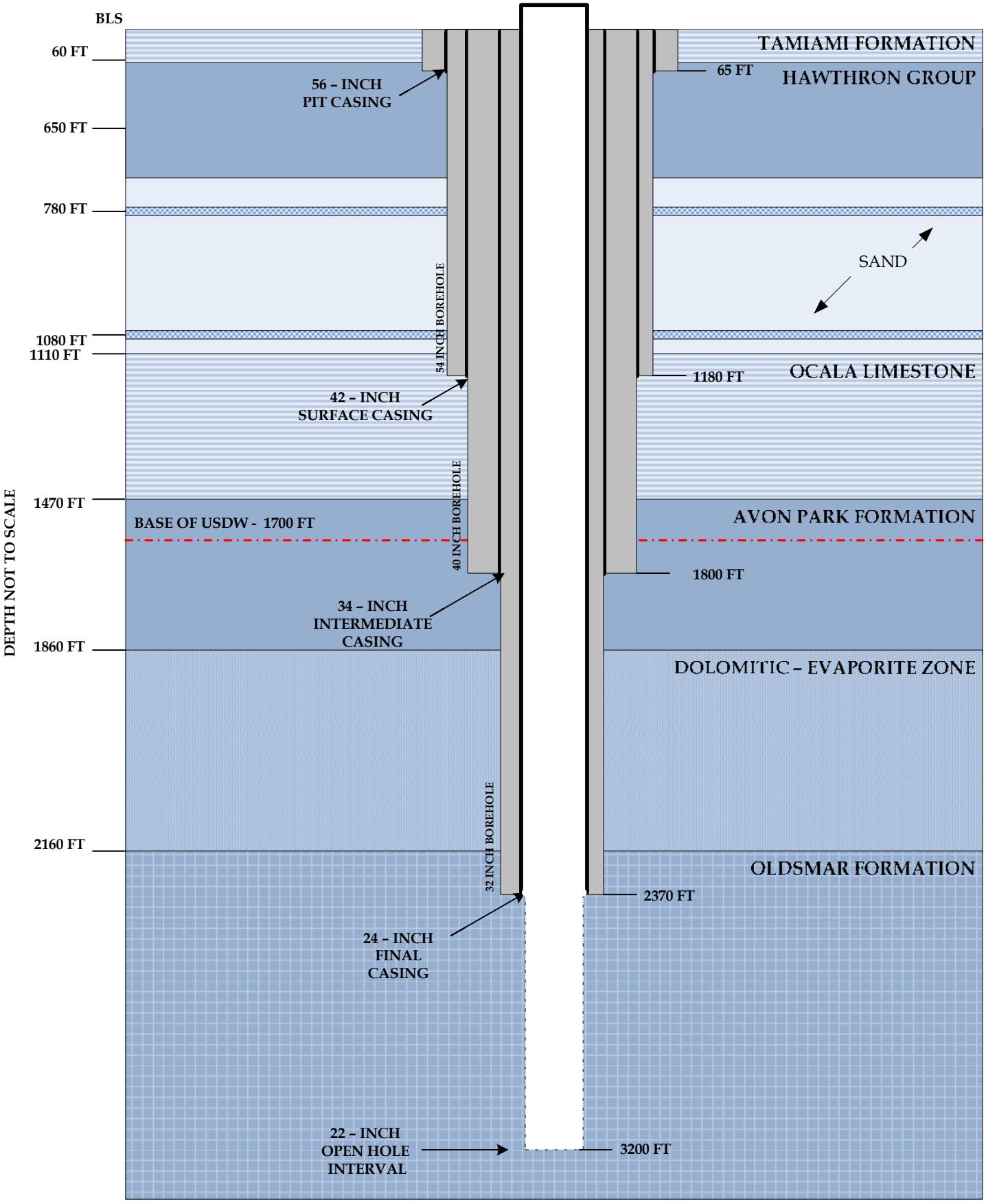
Figure 2-25

Figure 2-26

DIW-1 – Completed Well

FIGURE 2-27
LEHIGH ACRES DIW PROJECT

AS-BUILT DRAWING OF DIW-1
INCLUDING FORMATION CONTACTS



inch final casing of the DIW-1. YBI conducted a radioactive tracer survey (RTS) on the injection well to demonstrate the external mechanical integrity of the injection well.

2.6.1. Casing Pressure Tests

2.6.1.1. LZMW-1B and UZMW-1

In fulfillment of the permit requirements for the monitoring wells, the 6-inch final casings of LZMW-1B and UZMW-1 were pressure tested as part of the installation procedures (**Figure 2-25)**. LZMW-1B and UZMW-1 final casings were pressure tested on September 7 and 25, 2007, respectively. A temporary header assembly was attached to the final stainless steel flange to seal in the top of the wells. The 7-inch inflatable packer (expandable to 15-inch in diameter) was installed below the first string of casing in both wells. The packer was inflated to approximately 200 psi, to isolate the casing from the open hole section of each well. The inside of the final casings were pressurized with water to 50 pounds per square inch (psi) and then shut-in for a period of one hour (**Tables 2-13 and 2-14**). After 60 minutes, the pressure changed by only 0.25 psi (0.4 percent) at LZMW-1B and 2.5 psi (5 percent) at UZMW-1, which were both within the range of the test tolerance limit of +/- 5 percent as established by FDEP guidelines. Both final well casing pressure tests were performed under the observation of PBS&J personnel.

2.6.1.2. DIW-1

The 24-inch final casing of DIW-1 was pressure tested as a condition of the construction permit. The pressure test of the 24-inch final casing was conducted on March 24, 2008 with a 17-inch inflatable packer (expandable to 24 inches) set to approximately 2,300 feet. The top of the 24-inch casing was sealed with a temporary header assembly and the test was conducted by pressurizing the inside of the 24-inch casing to 156.5 psi for 60 minutes (**Table 2-15)**. After 60 minutes, the pressure had decreased to 155 psi. The 1.5-psi decrease represents less than a 2.5% pressure change, which is within the 5% allowable pressure change during the test. Mr. David Rhodes (FDEP) of the TAC was on-site to witness the successful performance of the casing pressure test. The internal mechanical integrity of the injection well was demonstrated.

2.6.2. Radioactive Tracer Survey (RTS)

In order to demonstrate the external mechanical integrity of the injection well, a radioactive tracer survey (RTS) was performed on April 1, by YBI's Geophysical Logging Division out of Ft. Myers, Florida. The RTS procedures as outlined in the

Florida Governmental Utility Authority
Lehigh Acres WWTP Class I Deep Injection Well
Lower Zone Monitoring Well Final Casing Pressure Test

TABLE 2-13
LZMW-1B CASING PRESSURE TEST

6-inch Casing				
Time	**Elapsed Time (min)**	**Pressure (psi)**	**Change in Pressure (psi)**	**% Change**
8:15	0	50	0	0.0
8:25	10	50	0	0.0
8:35	20	50	0	0.0
8:45	30	50	0	0.0
8:55	40	50.25	0.25	0.4
9:05	50	50.25	0.25	0.4
9:15	60	50.25	0.25	0.4

Florida Governmental Utility Authority
Lehigh Acres WWTP Class I Deep Injection Well
Upper Zone Monitoring Well Final Casing Pressure Test

TABLE 2-14
UZMW-1 CASING PRESSURE TEST

6-inch Casing				
Time	**Elapsed Time (min)**	**Pressure (psi)**	**Change in Pressure (psi)**	**% Change**
8:50	0	50.0	0.0	0.0
9:00	10	50.3	0.3	0.5
9:10	20	50.5	0.5	1.0
9:20	30	51.0	1.0	2.0
9:30	40	51.5	1.5	3.0
9:40	50	52.0	2.0	4.0
9:50	60	52.5	2.5	5.0

Florida Governmental Utility Authority
Lehigh Acres WWTP Class I Deep Injection Well
Deep Injection Well Final Casing Pressure Test

TABLE 2-15
DIW-1 CASING PRESSURE TEST

6-inch Casing				
Time	Elapsed Time (min)	Pressure (psi)	Change in Pressure (psi)	% Change
13:45	-	156.5	-	-
13:50	0	156.5	0	0.0
13:55	5	156.5	0	0.0
14:00	10	156	0.5	0.8
14:05	15	156	0.5	0.8
14:10	20	156	0.5	0.8
14:15	25	156	0.5	0.8
14:20	30	156	0.5	0.8
14:25	35	155	1.5	2.5
14:30	40	155	1.5	2.5
14:35	45	155.5	1	1.7
14:40	50	155.5	1	1.7
14:45	55	155.5	1	1.7
14:50	60	155.5	1	1.7

FDEP approved MIT program contained in the specifications for the construction of DIW-1 were followed. PBS&J personnel observed the RTS.

The RTS logging program consisted of conducting a background temperature and gamma ray log of the entire injection well, followed by a dynamic RTS. Two dynamic RTS tests were performed on April 1, under the observation of PBS&J. One millicurie of radioactive tracer (Iodine 131) was ejected five feet above the bottom of the final well casing under a flow velocity of approximately five feet per minute. During the two tests, no tracer was detected above the ejection point of approximately 2,365 feet below land surface thus demonstrating the external mechanical integrity of the injection well. The RTS tests are discussed in further detail in the mechanical integrity demonstration report.

2.7. RTS Report

2.7.1. Introduction

External mechanical integrity testing consists of conducting a dynamic radioactive tracer survey (RTS) in the injection well. Dynamic testing typically consists of positioning the logging tool (ejector port) approximately five feet inside the casing and ejecting tracer while water is being injected into the well at a rate not exceeding five feet per minute. The logging tool remains stationary and tracer movement is monitored for a period of one-hour (time log mode). If upward tracer movement is not observed, then the test is deemed successful and a repeat test is performed for verification.

YBI Geophysical Division, as part of the requirements, performed the RTS and background geophysical logs, which consisted of a caliper and gamma log, temperature, and video survey. Copies of all the geophysical logs for the MIT are presented in **Appendix R**. Daily field reports are included in **Appendix D**.

2.7.2. Background Logs

A caliper and background gamma ray (GR) was run on March 31, to establish baseline conditions prior to conducting the RTS survey. The caliper log was used to identify the bottom of the well casing and confirm the depth of the borehole obstruction that was observed during the video logging, which is described in Section 3.0. The bottom of the well casing is noted at 2,370 feet below pad level where the borehole diameter goes from 24 inches to approximately 22 inches. The background GR log was logged from the bottom of the well to land surface. The American Petroleum Institute (API) gamma counts ranged from approximately 20 to 70 API units.

2.7.3. Video Survey

The final casing appeared to be in good condition with no visible damage including holes, cracks, or breaks. Scaling on casing walls was not visible. Casing joints appeared tight with no cracks or visible separation. The borehole was open to the bottom with no obstructions or constrictions.

2.7.4. Temperature Log

The temperature log showed a fairly constant temperature of 81 degrees Fahrenheit (^{o}F) near land surface to 82 ^{o}F at a depth of 1,100 feet bls, reached a maximum of 103 of 3,150 feet bls. The lack of any substantial temperature spikes (> 0.3 ^{o}F+/-) along the length of the final casing is evidence that there are no leaks in the final casing.

2.7.5. First Dynamic RTS

For the first dynamic test, the RTS tool was positioned with the ejector port at 2,365 ft bls (5 feet above the bottom of the 6-inch casing). A hose was attached from a 3-inch water line to the wellhead with an in-line flow meter. Copies of the flow meter report (a new flowmeter was used) and radioactive assay are presented in **Appendix H**. Flow to the well was regulated at 100 gpm (approximately 5 feet per minute downhole velocity). Two minutes of pre-ejection time logging was conducted after which one millicurie of tracer (Iodine 131) was ejected at 2,365 ft bls. Tracer was first observed at GRM detector after approximately 20 seconds. Tracer was observed at GRB detector approximately 2 minutes after ejection, which correlates to a downhole velocity of 5.1 ft/min. Throughout the course of the one hour dynamic test, no tracer was observed on the GRT detector indicating no upward movement of tracer occurred inside or outside the casing. Readings at the GRB and GRM detectors returned to near background levels by the end of the test. The first dynamic RTS was considered successful.

The RTS tool was then logged out of position up to approximately 2,185 ft bls. API gamma counts on all three detectors were at background levels and no staining was apparent. A flushing of the well was not required prior to the second dynamic RTS.

2.7.6. Second Dynamic RTS

The second dynamic test was begun by positioning the ejector port again to 2,365 ft bls and regulating the flow to the well at 100 gpm. Two minutes of pre-ejection time logging was conducted after which one millicurie of tracer was ejected. Tracer was first observed at GRM detector after approximately 20 seconds. Tracer was observed at GRB detector approximately 1 minute and 50 seconds after ejection, which correlates to a downhole velocity of 5.0 ft/min. No tracer was observed at GRT detector throughout

the course of the 30-minute second dynamic test and readings at all three detectors returned to near background levels by the end of the test. The second dynamic RTS was considered successful.

The RTS tool was then logged out of position all the way to the top of the well at land surface. The GRT, GRM and GRB detectors mimicked the background GR log. No evidence of tracer was noted at throughout the well including the point of ejection at 2365 ft bls demonstrating the external integrity of the injection well.

2.7.7. MI RTS Test Results

The dynamic RTS test was conducted successfully on April 1. The RTS tool used is approximately 24.5 feet long and consists of multiple logging capabilities including GR, temperature and tracer ejector. The general configuration of the RTS tool is presented at the bottom of the RTS log. The RTS tool contains three gamma ray detectors - gamma ray bottom (GRB), gamma ray middle (GRM), and gamma ray top (GRT). The GRB detector is located 1.2 feet from the bottom of the tool, while the GRM and the GRT are located 10.4 feet and 23.8 feet from the tool bottom, respectively. The tracer ejector port is located 13.75 feet from the bottom, which places the tracer ejector port 12.6 feet above the GRB, 3.4 feet above the GRM and 10.0 feet below GRT. The RTS testing was witnessed by Mr. Mike Micheau, Mr. Kevin Dorsey and Ms. Michelle Regon with PBS&J.

3.0 Hydrogeologic Data and Analysis

An extensive hydrogeologic data collection program was undertaken during construction of the injection well system with the objective of obtaining the hydrogeologic information necessary to establish monitoring zones for LZMW-1B and UZMW-1, to identify an acceptable injection zone, and to ultimately receive FDEP approval to operationally test the injection well system. The hydrogeologic data consisted of the following: formation (lithologic) sampling, water quality sampling, hydraulic testing (packer tests), rock coring, geophysical logging and short-term injection testing. Regional and site-specific data are presented in the sections below.

3.1. Regional Hydrogeology

The regional hydrogeologic framework has been described in studies conducted along the southwest portion of the Florida coast. **Figures 3-1** present the trace of and a generalized hydrogeologic cross section for the region. **Figure 3-2** presents a general summary and description of the geologic and hydrogeologic framework in the vicinity of the site based on data published by the United States Geological Survey (USGS).

Stratigraphic units found at the site consist of (in descending order), Terrace or Undifferentiated Deposits followed by the Caloosahatchee Marl and Tamiami Formation, the Hawthorn Group, which is made up of the Peace River Formation, the Arcadia Formation, the Suwannee Limestone, the Ocala Limestone, Avon Park Formation and Oldsmar Formation.

The Caloosahatchee Marl and Tamiami Formations are considered to be confining units separating the Surficial Aquifer System (SAS) from the underlying Intermediate Aquifer System (IAS). The IAS is composed primarily of the geologic units of the Hawthorn Group and is separated from the underlying Upper Floridan Aquifer (UFA) by the Basal Hawthorn layers.

Underlying the Hawthorn Group are thick sequences of marine deposited carbonates, which comprise the Suwannee Limestone, the Ocala Limestone, the Avon Park Formation, and the Oldsmar and Cedar Keys Formations. These geologic units comprise the Floridan Aquifer System. The targeted injection zone occurs in the highly fractured and permeable zone of the Oldsmar Formation.

The Suwannee permeable zone is the uppermost permeable unit within the UFA and is confined above by clayey carbonate rocks within the IAS and below by low-permeability limestone at the base of the Suwannee or upper part of the Ocala Limestone (Hutchinson, 1992). The Suwannee unit is approximately 450 feet thick (650 to 1100 feet below land surface) at the Lehigh Acres site. While drilling the LZMW-1,

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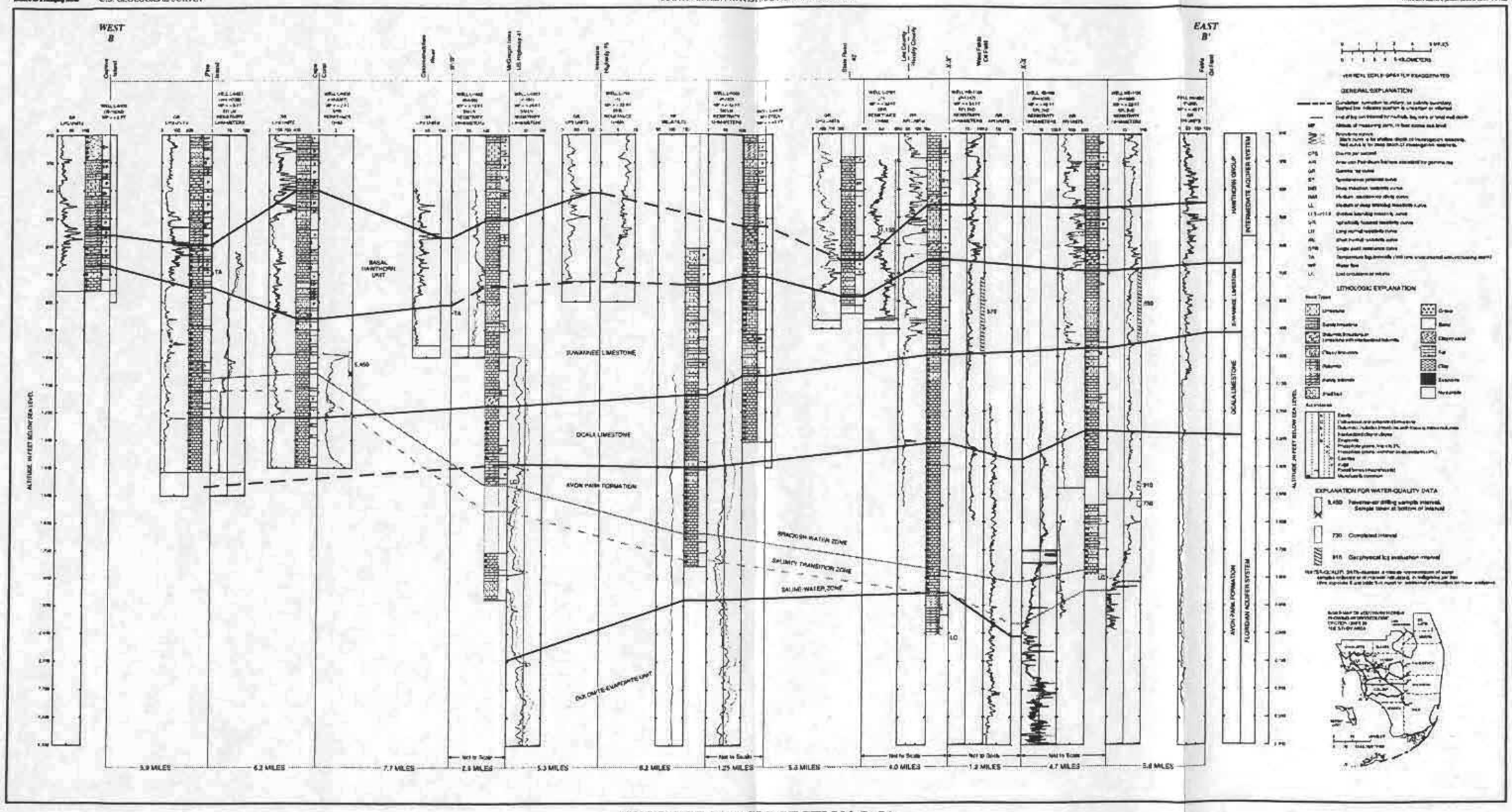
WATER-RESOURCES INVESTIGATIONS REPORT 98-4253
Hydrogeologic section *B-B'* Plate 2



HYDROGEOLOGIC SECTION *B-B'*
By
Ronald S. Reese
2000

Figure 3–1

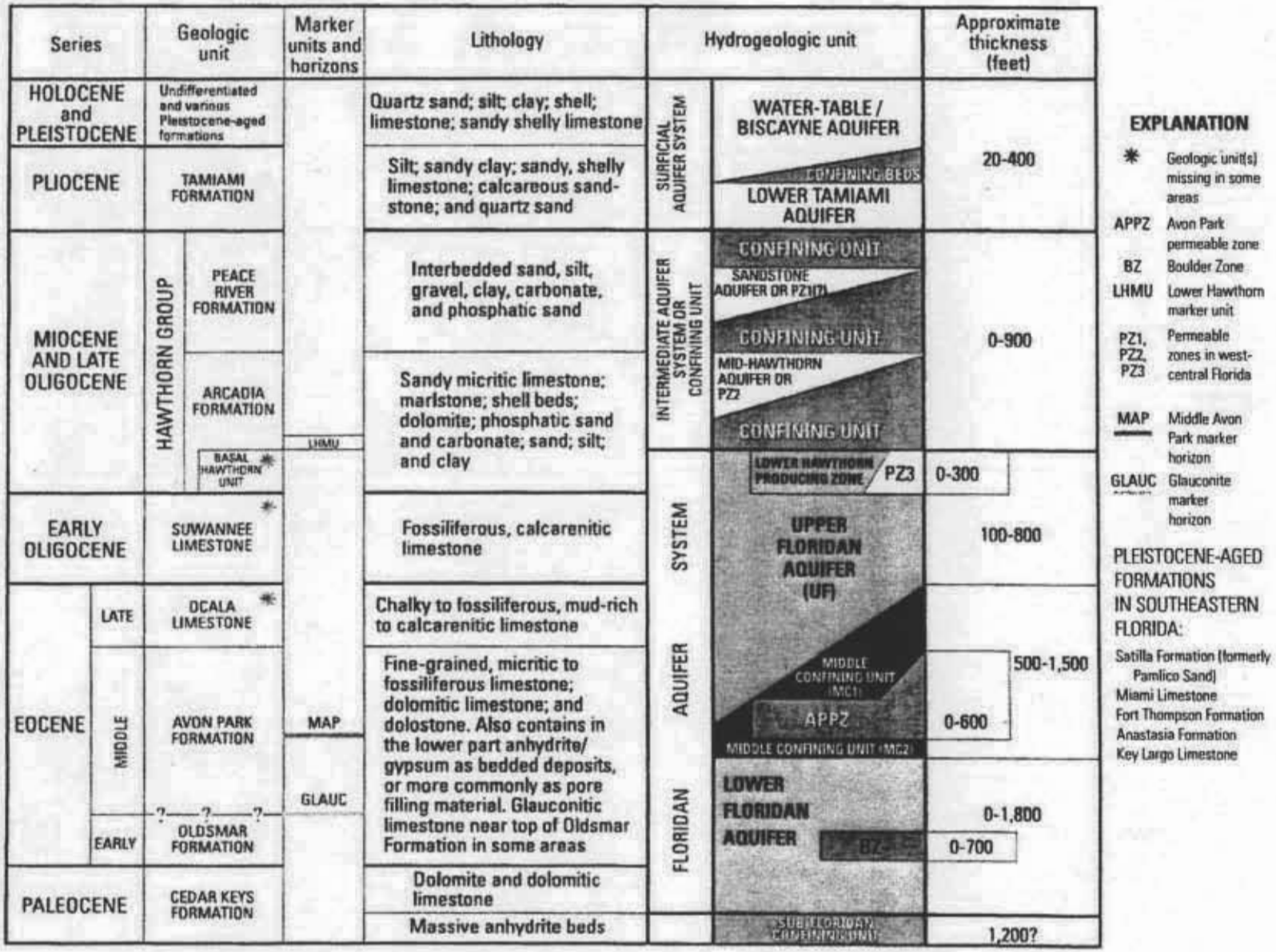


Chart showing relation of hydrogeologic units as defined in this study to geologic units and their lithology.

Figure 3–2

two distinct sand layers were encountered in the Suwannee Limestone; this is not typical of the Suwannee Limestone observed at other constructed injection wells, (North Ft. Myers, 1988).

The top of the Ocala Limestone, a semi confining unit, occurs below a micritic limestone marker bed (approximately 1,100 feet at Lehigh Acres) that is distinguished by high activity on gamma-ray logs. The Ocala unit itself exhibits low gamma radiation and is a fine-grained, soft to partially indurated, micritic limestone containing abundant milfoil remains and scattered large foraminifera that were identified over a wide area of southwest Florida through drilling and testing at injection-well sites in the 1980's (Hutchinson, 1992). The Ocala unit extends from approximately 1,100 to below 1,470 feet below land surface at the Lehigh Acres site.

Underlying the Ocala Limestone is the Avon Park Formation at 1470 feet bls, which is comprised of the several confining layers that make up the Dolomitic- Evaporite zone between 1860 feet and 2160 feet bls. The upper sections the of Avon park are made up of units of micritic dolomitized limestone, that contains the base of the USDW at 1700 feet bls. In the lower units of the Avon Park Formation, with in the Dolomitic- Evaporite zone, is where the top semi-confining unit of the underlying injection zone is located, it consists of dark brown crystalline dolomite.

The injection zone comprises about 735 feet of permeable rocks of the FA below the Dolomitic - Evaporite semi confining unit and within the Oldsmar Formation of the Floridan Aquifer System. The permeable unit within the injection zone was identified through drilling and testing at the injection well site (Hutchinson, 1992). It consisted of the Boulder Zone of the Oldsmar Formation (approximately 2,370 to 3,100 ft below land surface), which contains massive, hard dark brown dolomite that contains large solution channels that have developed along fractures, large voids, large boulders and cobbles.

3.2. Formation Sampling

Formation (lithologic) samples were obtained during the drilling operations from the injection well and the monitor wells. These samples were collected at 10 foot intervals, where possible, throughout the total depth of the injection well system. The formation samples were collected from the discharge line during mud rotary and reverse-air drilling. YBI provided one set of formation samples to the engineer and stored a second set of samples on-site for the FDEP, which were shipped to the Florida Geological Survey upon well completion.

Formation samples were described on the basis of composition, color, texture, visible porosity, fossil content and structure. Analyses of the formation samples were used to prepare a lithologic log of the wells at the site. **Figure 3-1** illustrates a geologic cross

section of Lee County, Fl, modified from Reese (2008). The geology encountered at the DIW-1 site is similar to the published regional geologic data and to the geology observed at the North Fort Myers DIW-1 site (PBS&J, 1988), located northwest of the Lehigh Acres DIW-1 site. Copies of the lithologic logs prepared from samples collected during construction of both wells are presented in **Appendix F**.

3.3. Rock Cores

A total of four rock core samples were collected while advancing the DIW-1 pilot hole. Targeted coring depths were determined from the regional geologic information and results of a packer test completed on the LZMW-1B. The cores were collected using a 15-foot long core barrel with a 4-inch receiver sleeve inside the barrel. The rock cores were collected by advancing the pilot hole to the targeted coring depth and attaching the coring tool to the drilling rod. The core barrel (**Figure 3-3)** was lowered to the proposed coring depth and was drilled into the rock formation at a constant rotation and depth. After the core barrel was advanced approximately 10 to 12 feet, it was withdrawn from the pilot hole. Rock core samples were extracted from the inner core barrel sleeve and placed directly into wooden core boxes (**Figure 3-4**). Core sample boxes were labeled with the core number, core interval, date, and time. **Table 3-1** presents a summary of each coring event, percent recovery, and results of laboratory analysis (hydraulic data).

Representative sections of each core, which had pieces greater than 6-inches in length, were submitted to the Ardaman and Associates, Inc. laboratory in Orlando, Florida for analysis of selected physical and hydraulic parameters. A total of 8 rock sections from the DIW-1 (interval 1,961 to 2,172 feet bls) were analyzed. Results of the vertical hydraulic conductivity test ranged from 4.2E-06 ft/d to 0.11 ft/d with an average of 3.2E-02 ft/d. The horizontal hydraulic conductivity values ranged from 1.1E-07 ft/d to 0.18 ft/d with an average of 6.1E-02 ft/d. The low hydraulic conductivity values determined from the analyzed rock cores indicate the potential for low formation permeability. Porosity values from all samples range from 0.1 to 0.32 (dimensionless). A copy of the complete laboratory report is presented in **Appendix G**.

3.4. Hydraulic Testing

Hydraulic testing performed during the injection well construction project consisted of four packer tests on LZMW-1B, and four packer tests and a short-term (12-hour) injection test on DIW-1. Discharge water generated during the packer tests was pumped to the mud tanks for temporary storage and subsequently hauled offsite for proper disposal at Aggregate Limestone Quarry disposal site. All of the packer tests were four hours in duration in order to limit the volume of water which required offsite disposal.

CORE BARREL

Figure 3-3

Figure 3-4

CORE SAMPLE

PBS&J

Florida Governmental Utility Authority
Lehigh Acres WWTP Class I Deep Injection Well

TABLE 3-1
SUMMARY OF ROCK CORES - DIW-1

CORE NUMBER	DATE CORED	PERCENT RECOVERY	INTERVAL CORED		SEGMENT LENGTH (ft)	REMARKS	SEGMENT NUMBER	POROSITY	VERTICAL K FT/DAY	HORIZON K FT/DAY
			BEGIN	END						
DIW-1	1/10/08	83%	1961	1973	0.44	Dolomite, crystaline, moderate hard, slight vuggy at the base, light brown	1-A	0.236	0.0090480	0.034008
DIW-1	1/10/08	83%	1961	1973	0.375	Dolomite, micritic, moderately hard, bedding planes present, light tan	1-B	0.233	0.0068016	0.0244800
DIW-2	1/12/08	93%	2000	2015	0.42	Dolomite, micritic, hard, buff	2-A	0.279	0.0201240	0.053760
DIW-2	1/12/08	93%	2000	2015	0.33	Dolimite, micritic, hard, granular, buff; trace formanifera casts	2-B	0.287	0.0167232	0.039600
DIW-3	1/14/08	100%	2065	2080	0.625	Dolomite, micritic, hard, buff; trace of fornamifera casts	3-C	0.287	0.093360	0.116160
DIW-3	1/14/08	100%	2065	2080	0.58	Dolomite, micritic, hard, buff; trace fornamifera casts	3-D	0.329	0.113280	0.186960
DIW-4	1/16/08	64%	2161	2172	0.79	Dolomite, crystaline, very hard, brown, buff with crystaline veins and vugs	4-A	0.10	0.0000042480	0.00000011328
DIW-4	1/16/08	64%	2161	2172	0.54	Dolomite, micritic, moderately hard, buff with planes of cyrstaline dolomite.	4-B	0.231	0.00053760	0.036960

1. Cored intervals are referenced in feet below land surface
2. Porosity is dimensionless
3. Hydraulic Conductivity is in centimeters per second
4. DIW-1: Deep Injection Well

3.4.1. LZMW-1B Packer Tests

Four packer tests were performed during pilot hole drilling of LZMW-1B in order to obtain hydraulic data across selected intervals to verify native water quality conditions, identify the base of the USDW, evaluate potential confining characteristics of the rock formations, and determine the final monitoring interval of the LZMW-1B. Packer tests were run in the pilot hole of the monitor well at selected depths ranging between approximately 1,523 feet and 1,907 feet.

An 11-inch diameter (expandable to 17-inch) single seal, open hole packer assembly was used for the first off-bottom packer tests. The packer assembly (6.6 feet in length) was attached to the 6-inch I.D. drill rod and lowered to the selected depth (approved by engineer) for testing. For the remaining tests (2 - 4) a straddle packer was utilized, consisting of two packer assemblies separated by 60 feet of drill rod, making each testing interval 60 feet.

The single packer was inflated using water pressure to approximately 300 psi in order to isolate the selected test interval below the packer setting depth. Immediately prior to each test, airlift pumping was used to develop the isolated interval until development water was clear and specific conductivity had stabilized. A 4-inch submersible pump was then lowered into the drill rod assembly and background water level data were collected until the water quality became relatively stable. Water was pumped through the drill rod assembly for the packer tests, which were four hours in duration. Discharge rates were measured with a flow meter installed in the discharge line assembly. Water levels were measured with an In-Situ Hermit 3000 data logger. **Table 3-2** summarizes the hydraulic test results of the four packer tests completed on the LZMW-1B. The collected data and the graphical presentations of the development data are presented in **Appendix I**.

3.4.1.1. LZMW-1B Packer Test 1: 1,788 – 1,907 feet

The LZMW-1B pilot hole was initially drilled to a depth of 1,907 feet using a 12.25-inch drilling bit. An X-Y caliper log was run on the pilot hole to verify borehole dimensions and to determine the exact packer setting depth. The log indicated that the packer could be successfully set with the seal approximately centered at 1,788 feet. The single packer was then set to 1,788 feet on August 17, 2008 and inflated to approximately 300 psi. Changes in the string weight indicated that the seal was firmly set in the borehole. The pressure was maintained between 260 and 300 psi on the packer throughout the testing.

Following development of the open hole interval and after performance of a short pre-test to establish suitable pumping rates, the packer test was started at 6:30 on August 18. Approximately 20,400 gallons of water were pumped during the 204-minute test. The laboratory determined TDS concentration of the water sample collected at the end of the

Florida Governmental Utility Authority
Lehigh Acres WWTP Class I Deep Injection Well
Lower Zone Monitoring Well LZMW-1B

TABLE 3-2
PACKER TEST RESULTS - LZMW-1B

Date	Test #	Interval (ft bls)	Pump Rate (gpm)	Drawdown (ft)	Spec Cap (gpm/ft)	T (DD) (ft^2/D)	T (Recovery) (ft^2/D)	K (ft/day) Drawdown	K (ft/day) Recovery
8/18/2007	1	1788-1907	82.0	98.1	0.8	50.7	45.9	1.70	1.53
8/19/2007	2	1753-1693	22.5	104.9	0.2	10.6	8.5	0.18	0.14
8/20/2007	3	1673-1613	7.0	121.6	0.1	3.2	2.4	0.04	0.05
8/21/2007	4	1583-1523	23.0	117.3	0.2	8.7	7.8	0.15	0.13

Hydraulic Conductivity (K) calculated from pumping and recovery data of packer pumping test using the Jacob Straight Line solution.

test was 34,400 mg/L, indicating the tested interval was below the base of the USDW (United States Drinking Water Standard). The well was allowed to recover for a total of 120 minutes in order to collect recovery water levels before the pump was removed from the well (**Figure 3-5**).

The drawdown observed at the end of the packer test (LZMW-1B-1) was 98.1 feet. The water level in the well recovered above the pre-pumping water level 120 minutes after the end of pumping (**Figure 3-6**). The specific capacity for this interval is approximately 0.8 gpm/ft (**Table 3-2**). The hydraulic conductivity values determined for this 119 foot interval were calculated using the Cooper-Jacob solution on the drawdown and recovery data. Results of analysis on both sets of data indicated a hydraulic conductivity of 1.7 and 1.5 feet per day, respectively.

3.4.1.2. LZMW-1B Packer Test 2: 1,693 – 1,753 feet

After completion of the first packer test, the straddle packer assembly was installed, lowered to approximately 1,723 feet at the center of the 60 foot packer assembly, and then inflated to 300 psi. Changes in the string weight indicated that the seal was firmly set in the borehole. A pressure of 260 to 300 psi was maintained on the packer throughout the testing.

Approximately 450 feet of 2 3/8-inch airline was lowered inside the drill rod to air develop the open-hole interval between 1,693 and 1,753 feet. After the discharge water had cleared sufficiently in clarity, a 1.5 horsepower pump was set to a depth of 100 feet in preparation for the packer test. After performance of a short pre-test, the packer test was started at 19:00 on August 19. The pumping rate averaged 22 gpm with a total of 15,400 gallons of water pumped during the 240-minute test. The laboratory determined TDS concentration of the water sample collected at the end of the test was 12,320 mg/L. The well was allowed to recover for a total of 120 minutes followed by the collection of recovery water levels before the pump was removed from the well (**Figure 3-7**).

The drawdown observed at the end of the packer test (LZMW-1B-2) was 104.8 feet (**Figure 3-8**). The water level in the well recovered above the pre-pumping water level 120 minutes after the end of pumping. The specific capacity for this interval is approximately 0.2 gpm/ft (Table 3-3). The hydraulic conductivity values determined for this 60 foot interval using the Cooper-Jacob solution on the drawdown and recovery data are 0.2 and 0.1 feet per day, respectively, which also indicate low formation permeability.

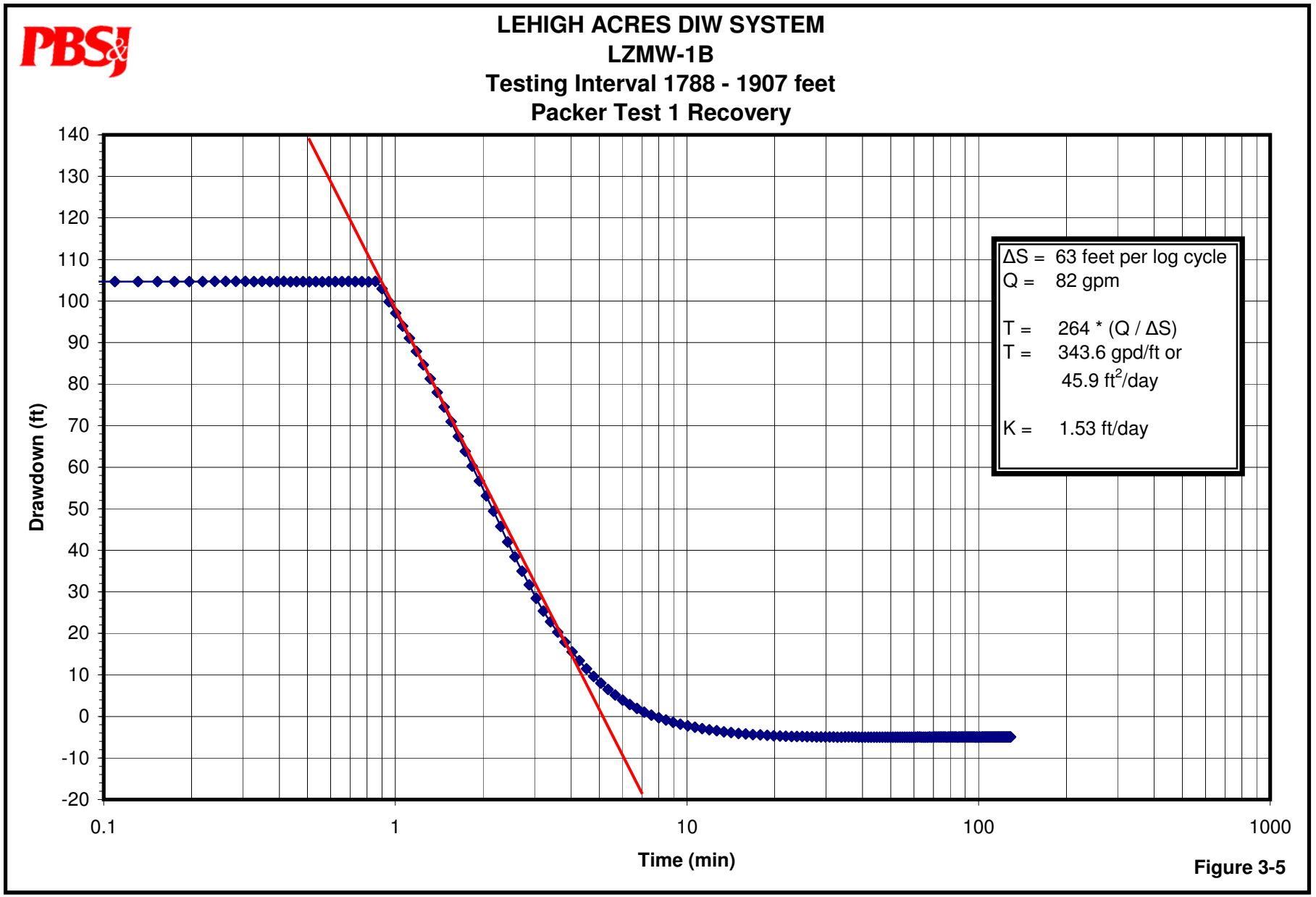

LEHIGH ACRES DIW SYSTEM
LZMW-1B
Testing Interval 1788 - 1907 feet
Packer Test 1 Recovery
Drawdown (ft)
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
0.1
1
10
100
1000
Time (min)
ΔS = 63 feet per log cycle
Q = 82 gpm
T = 264 * (Q / ΔS)
T = 343.6 gpd/ft or
45.9 ft2/day
K = 1.53 ft/day

Figure 3-5

LEHIGH ACRES DIW SYSTEM
LZMW-1B
Testing Interval 1788 - 1907 feet
Packer Test 1 Drawdown

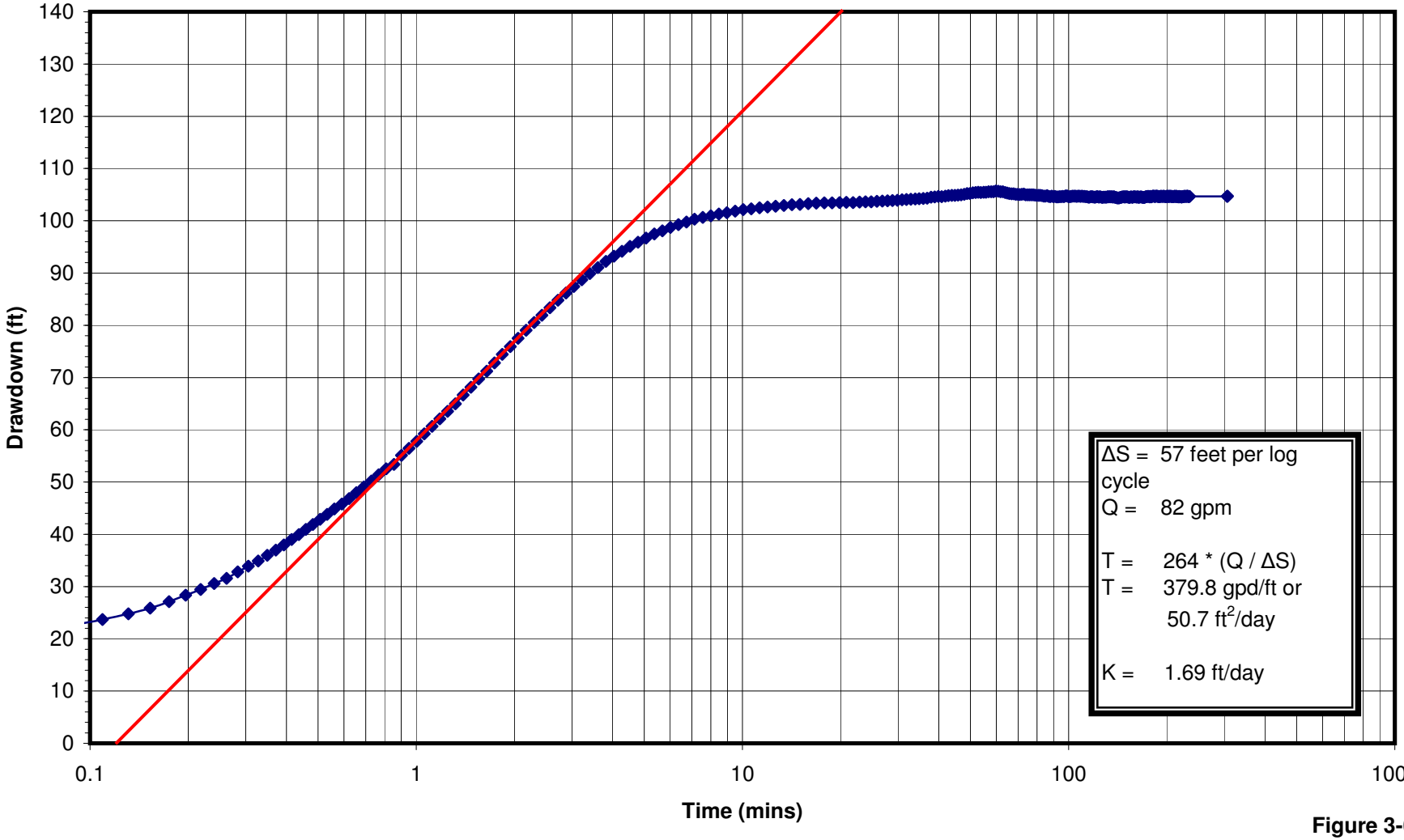


Figure 3-6

LEHIGH ACRES DIW SYSTEM
LZMW-1B
Testing Interval 1693 - 1753 feet
Packer Test 2 Recovery

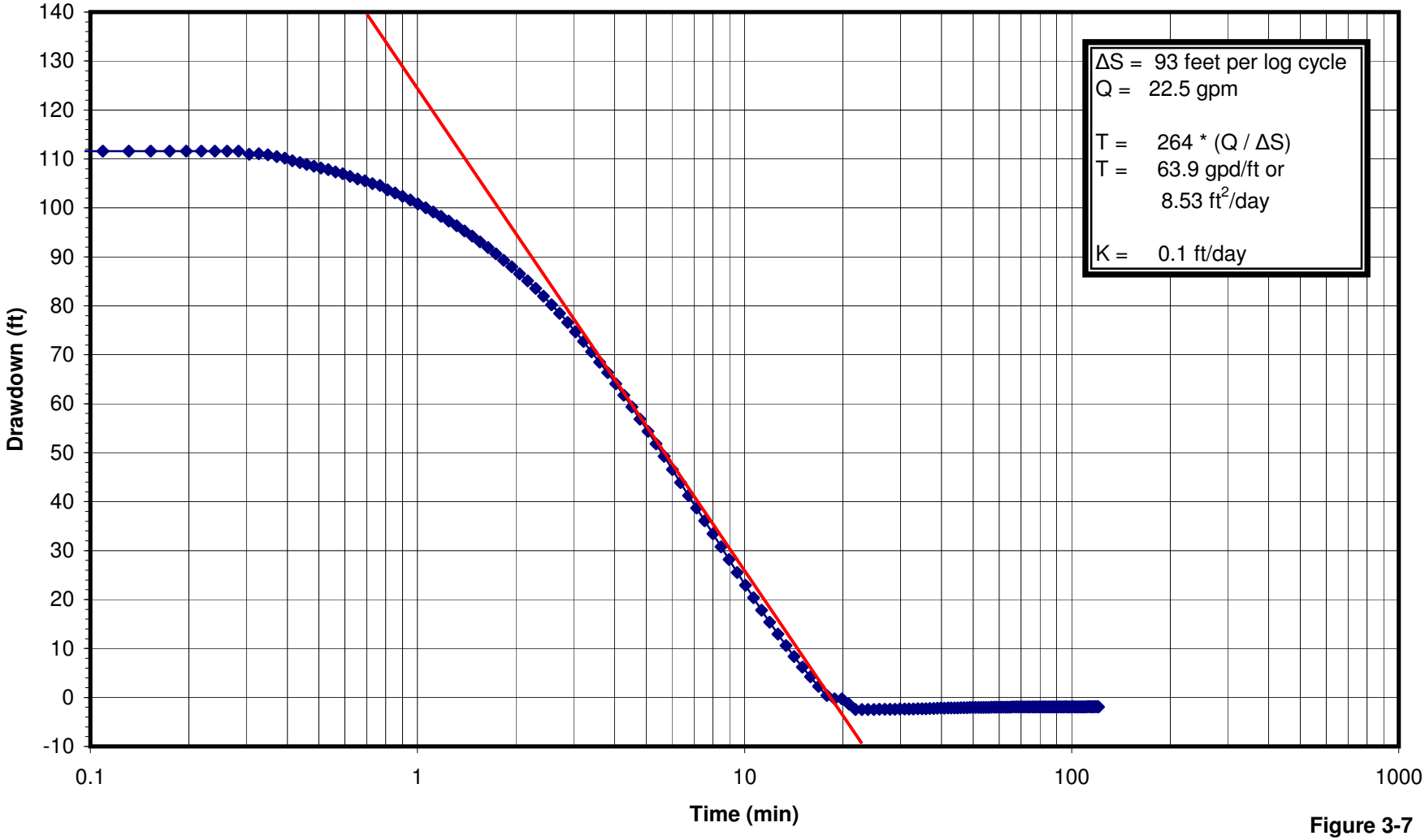


Figure 3-7

LEHIGH ACRES DIW SYSTEM
LZMW-1B
Testing Interval 1693 - 1753 feet
Packer Test 2 Drawdown

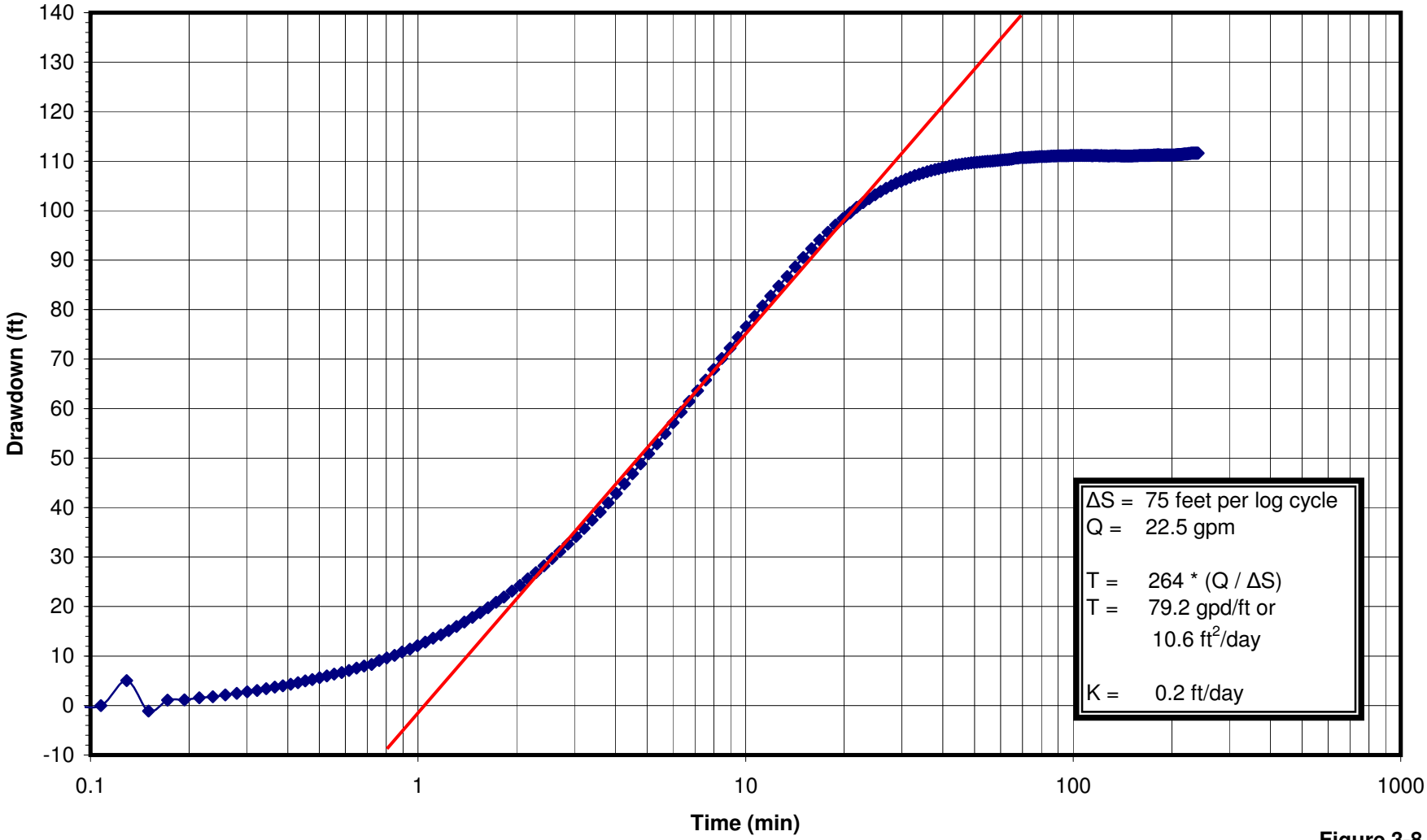


Figure 3-8

3.4.1.3. LZMW-1B Packer Test 3: 1,613 – 1,673 feet

Water quality results from the previous two packer tests indicated that the base of the USDW is at or above approximately 1,700 ft. A packer test of the interval from approximately 1,613 to 1,673 feet was performed to determine a more precise location of the base of the USDW. The straddle packer was lowered to approximately 1,643 feet on the center of the 60 foot packer assembly and inflated to 300 psi. Changes in the string weight indicated that the seal was firmly set in the borehole. The pressure was maintained on the packer throughout the testing.

Following development of the open hole interval and after performance of a short pre-test to establish suitable pumping rates, the packer test was started at 16:00 on August 20. Approximately 1,680 gallons of water were pumped during the 240-minute test. The laboratory determined TDS concentration of the water sample collected at the end of the test was 3,460 mg/L. The well was allowed to recover for a total of 120 minutes in order to collect recovery water levels before the pump was removed from the well (**Figure 3-9**).

The drawdown observed at the end of the packer test (LZMW-1B-3) was 121 feet (**Figure 3-10)**. The water level in the well recovered to within 0.5 feet of the pre-pumping water level 120 minutes after the end of pumping. The specific capacity for this interval is approximately 0.1 gpm/ft. The hydraulic conductivity values determined for this interval using the Cooper-Jacob solution on both the drawdown and recovery data are 0.05 and 0.04 feet per day, respectively, which indicate very low formation permeability. The TDS concentration across the interval of 1,613 to 1,673 feet indicates rapidly freshening of the groundwater in this zone. Therefore the base of the USDW was conservatively estimated to be at 1,700 feet bls.

3.4.1.4. LZMW-1B Packer Test 4: 1,523 – 1,583 feet

After completion of the third packer test, the straddle packer was raised to approximately 1,553 feet at the center of the 60 foot packer assembly, and inflated to 300 psi. The purpose of this packer test was to identify a more permeable zone above the base of the USDW that could be used as an upper zone monitoring interval. Also, mud drilling of the upper zone well, necessitated by the sand dredging precluded the performance of any packer pumping tests. Changes in the string weight indicated that the seal was firmly set in the borehole. A pressure of 260 to 300 psi was maintained on the packer throughout the testing.

Approximately 450 feet of 2 3/8-inch airline was lowered inside the drill rod to air develop the open-hole interval between approximately 1,523 and 1,583 feet. After the discharge water had cleared sufficiently in clarity, a 1.5 horsepower pump was set to a depth of 100 feet in preparation for the packer test. After performance of a short pre-

LEHIGH ACRES DIW SYSTEM
LZMW-1B
Testing Interval 1613 - 1673 feet
Packer Test 3 Recovery

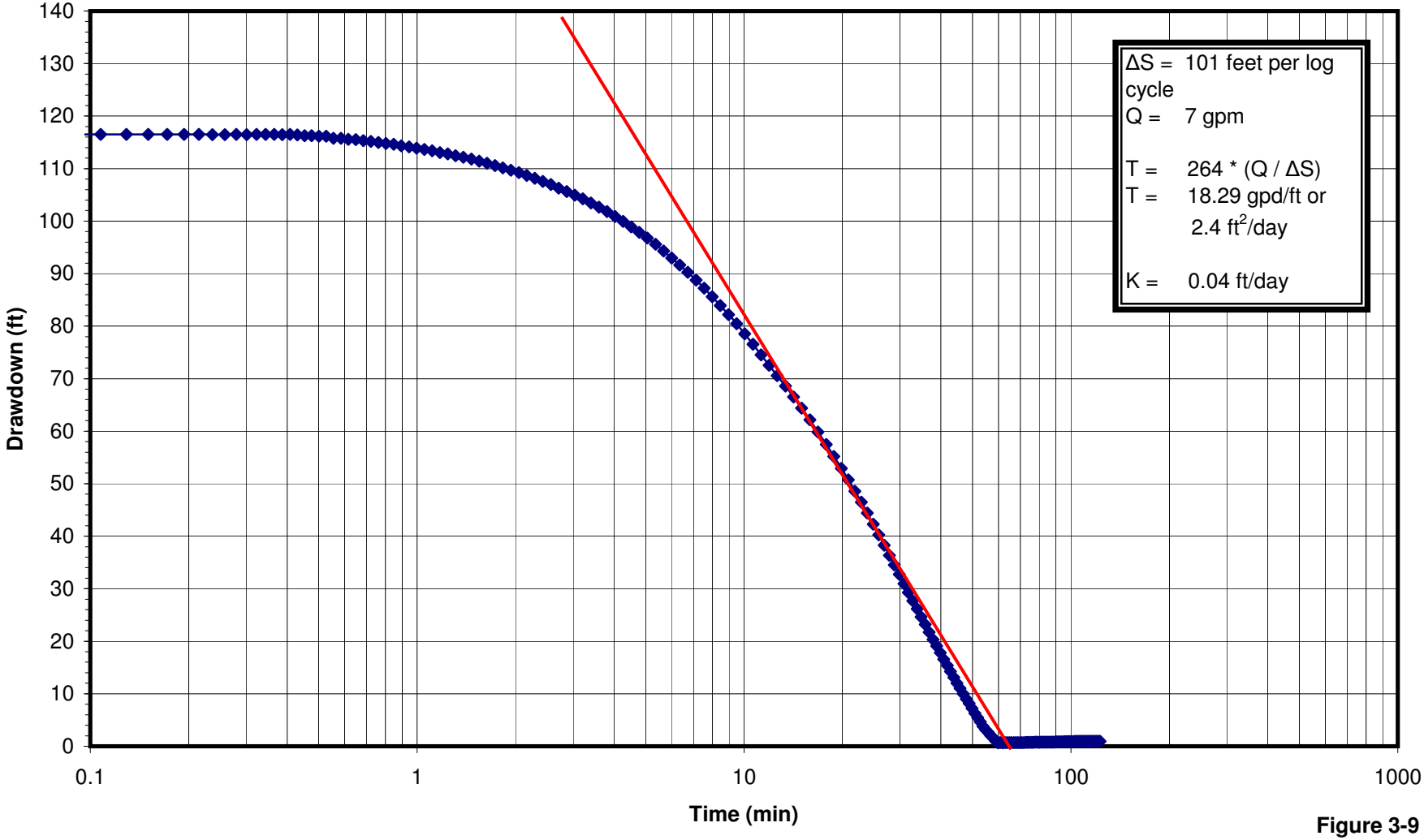


Figure 3-9

LEHIGH ACRES DIW SYSTEM
LZMW-1B
Testing Interval 1613 - 1673 feet
Packer Test 3 Drawdown

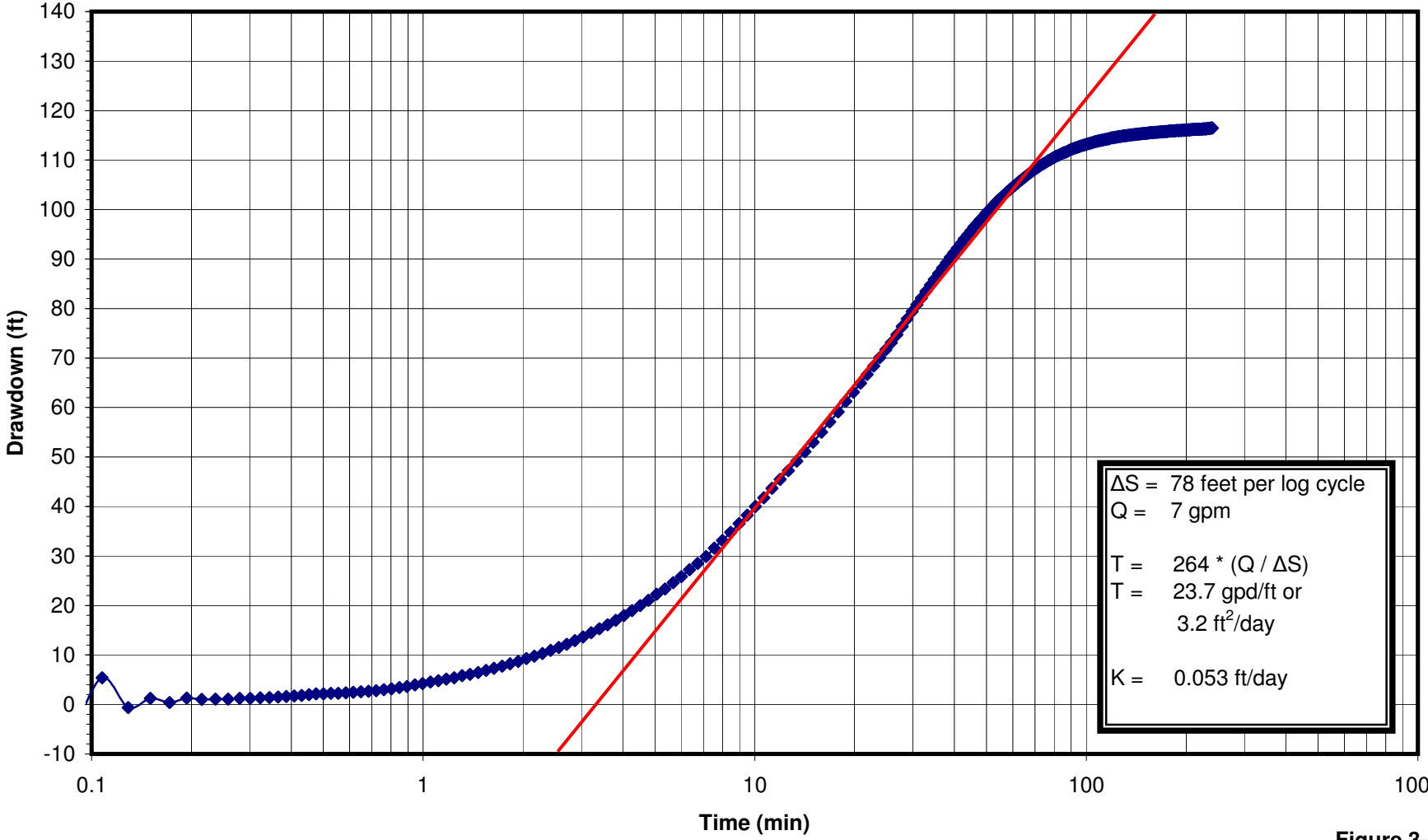


Figure 3-10

test, the packer test was started at 10:00 on August 21. The pumping rate averaged 23 gpm with a total of 5,520 gallons of water pumped during the 240-minute test. The laboratory determined TDS concentration of the water sample collected at the end of the test was 2,330 mg/L. The well was allowed to recover for a total of 120 minutes in order to collect recovery water levels before the pump was removed from the well (**Figure 3-11**).

The drawdown observed at the end of the packer test (LZMW-1B-4) was 117.3 feet (**Figure 3-12)**. The water level in the well recovered above the pre-pumping water level 120 minutes after the end of pumping. The specific capacity for this interval is approximately 0.2 gpm/ft (**Table 3-2**). The hydraulic conductivity values determined for this 60 foot interval using the Cooper-Jacob solution on both the drawdown and recovery data are 0.15 and 0.13 feet per day, respectively. These slightly higher hydraulic conductivity values indicated the formation contained sufficient permeability for the upper zone monitoring interval.

3.4.1.5. LZMW-1B Packer Test Data Summary

The packer test hydraulic data indicated that permeability decreased with depth within the Ocala Limestone and upper portion of the Avon Park Formation. Packer test water quality data indicated that the USDW occurred within the Avon Park Formation at a depth of approximately 1,700 feet and is discussed in more detail in **Section 3.5**. Based on the very low permeability encountered at the semi-confining unit found at the 1,613 to 1,673 ft interval, the monitoring interval for the UZMW-1 was selected to be above this interval between 1,500 and 1,580 feet below land surface.

3.4.2. Injection Well Packer Tests

Packer testing of the injection well was performed to further characterize the potential confining characteristics and water quality of the rock formations located above the injection zone and below the lower monitoring interval of LZMW-1B. Packer tests were run in the pilot hole of the injection well at the following approximate intervals: 1,940-1,970 feet, 1,885-1,915 feet, 1,990-2,088 feet, and 2,130-2,230 feet.

A straddle packer assembly was used for the four of the injection well packer tests. The straddle packer assembly consisted of upper and lower packer units separated by 30 and then 100 feet of perforated pipe. The straddle packer assembly was lowered to the selected depth using drill rods. The perforated pipe between the packers allowed native water produced from the pilot hole test interval to be pumped out. The straddle packer assembly was inflated using water pressure in order to isolate the selected test interval. Well development, measurement of static water levels, pump testing, and recovery observations were performed in the same manner as described for the DIW-1. Packer test data and analyses are presented in detail in **Table 3-3** and **Appendix I**.

LEHIGH ACRES DIW SYSTEM
LZMW-1B
Testing Interval 1523 - 1583 feet
Packer Test 4 Recovery

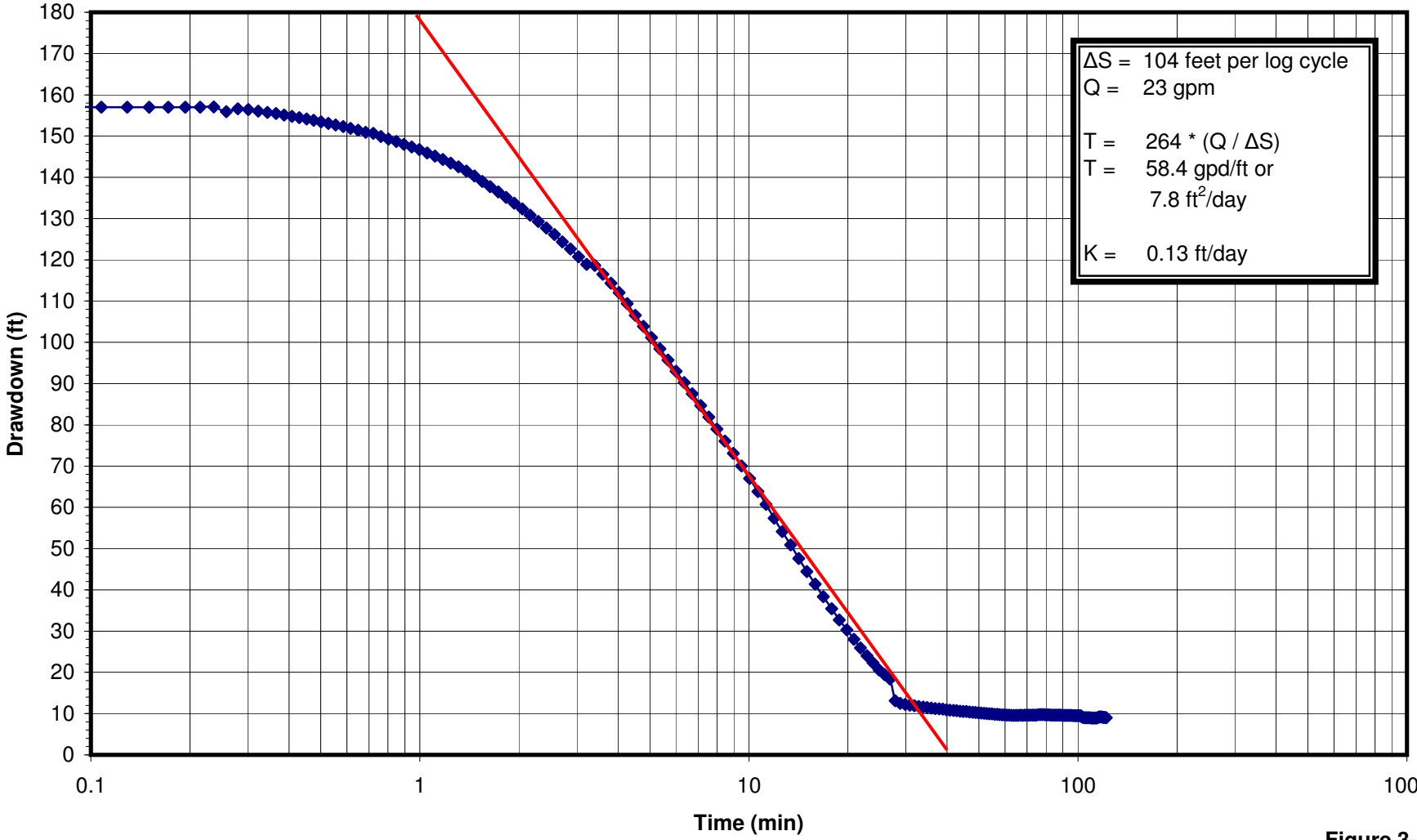


Figure 3-11

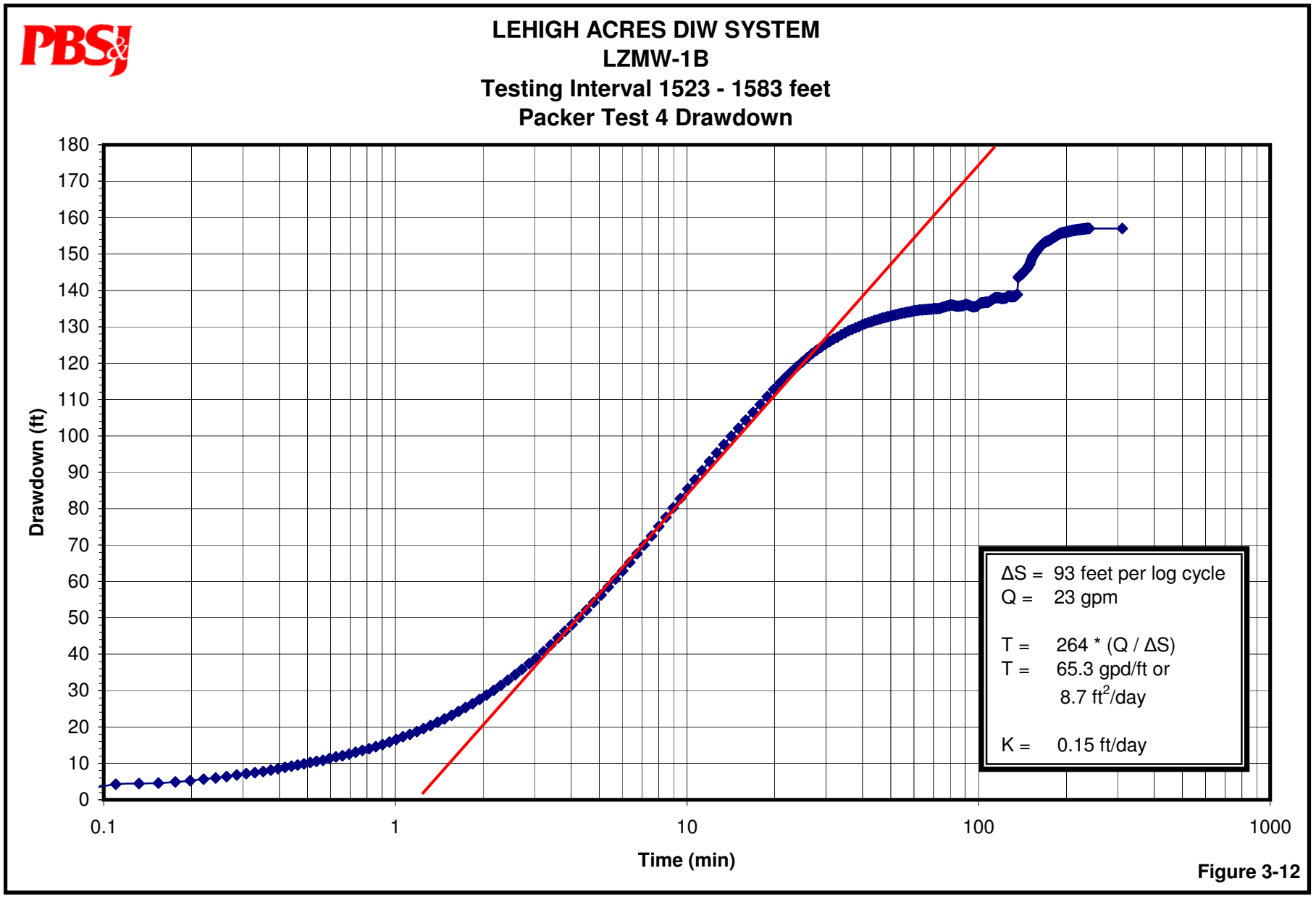

LEHIGH ACRES DIW SYSTEM
LZMW-1B
Testing Interval 1523 - 1583 feet
Packer Test 4 Drawdown
Drawdown (ft)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0.1
1
10
100
1000
Time (min)
ΔS = 93 feet per log cycle
Q = 23 gpm
T = 264 * (Q / ΔS)
T = 65.3 gpd/ft or
8.7 ft²/day
K = 0.15 ft/day

Figure 3-12

TABLE 3-3
PACKER TEST RESULTS - DIW-1

Date	Test #	Interval (ft bls)	Pump Rate (gpm)	Drawdown (ft)	Spec Cap (gpm/ft)	T (DD) (ft^2/D)	T (Recovery) (ft^2/D)	K (ft/day) Drawdown	K (ft/day) Recovery
2/3/2008	1	1940-1970	32.0	62.8	0.5	18.0	17.2	0.6	0.6
2/4/2008	2	1885-1915	21.0	106.3	0.2	11.1	8.6	0.4	0.3
2/5/2008	3	1990-2088	36.0	64.2	0.6	27.6	25.9	0.3	0.3
2/5/2008	4	2130-2230	115.0	0.6	189.8	13,527	13,527	135	135

Hydraulic Conductivity (K) calculated from pumping and recovery data of packer pumping test using the Jacob Straight Line solution.

3.4.2.1. DIW-1 Packer Tests 1,940 - 1,970 feet and 1,885 – 1,915 feet

Following installation of the 34-inch intermediate casing to a depth of 1,800 feet, the DIW-1 pilot hole was drilled to a total depth of approximately 3,200 feet using a 12.25-inch drilling bit. An X-Y caliper log was run on the pilot hole to verify borehole dimensions and to determine the exact packer setting depth. The log indicated that the packer could be successfully set with the centerline at 1,955 feet. The straddle packer assembly was lowered to approximately 1,955 feet and inflated to 280 psi in preparation for the first packer test. Changes in the string weight indicated that the seal was firmly set in the borehole.

Following development of the open borehole interval and after performance of a short pre-test to establish suitable pumping rates, packer test 1 and 2 were performed across two separate intervals between February 3 and 4, 2008. The straddle packer assembly setup was the same for both tests consisting of two 11-inch single packers (expandable to 17 inches) that were attached to 6-inch drill pipe and interconnected to 2.375-inch drill rods used to lower the packer assembly into place. The mid-point of the packers was separated by 30 feet of 6-inch perforated pipe. A 0.5 horsepower submersible pump was set to 180 feet below land surface inside the pipe assembly. Each packer was inflated simultaneously through a single water line with pressure of approximately 280-320 psi maintained on the packer assembly throughout the testing.

Each tested interval was developed until a minimum of three well volumes had been pumped and the discharge water appeared to be clear and free clear of sediment. Water levels in the isolated zone were allowed to recover back to static before starting the pumping test. The pumping rate ranged from 32.0 to 21.0 gpm in the 4-hour tests that were followed by a 2-hour recovery period.

The specific capacity of the 1,940 to 1,970-foot interval is 0.5 gpm/ft of drawdown at a pumping rate of 32 gpm (**Figures 3-13** and **3-14)**. The hydraulic conductivity value for this 30-foot interval calculated using the Cooper-Jacob solution on both the drawdown and recovery data is 0.6 feet per day. The laboratory tested TDS for this interval was 28,900 mg/L. The specific capacity of the 1,885 to 1,915-foot interval is 0.2 gpm/ft of drawdown at a pumping rate of 21 gpm (**Figures 3-15** and **3-16)**. The hydraulic conductivity value for this 30-foot interval calculated using the Cooper-Jacob solution on both the drawdown and recovery data is 0.4 and 0.3 feet per day, respectively. The laboratory tested TDS concentration in this interval was 25,100 mg/L. Results of these two packer tests indicate low formation permeability which extends below the base of the USDW to at least 1,915 feet bls.

LEHIGH ACRES DIW SYSTEM
DIW-1
Testing Interval 1940-1970 feet
Packer Test 1 Drawdown

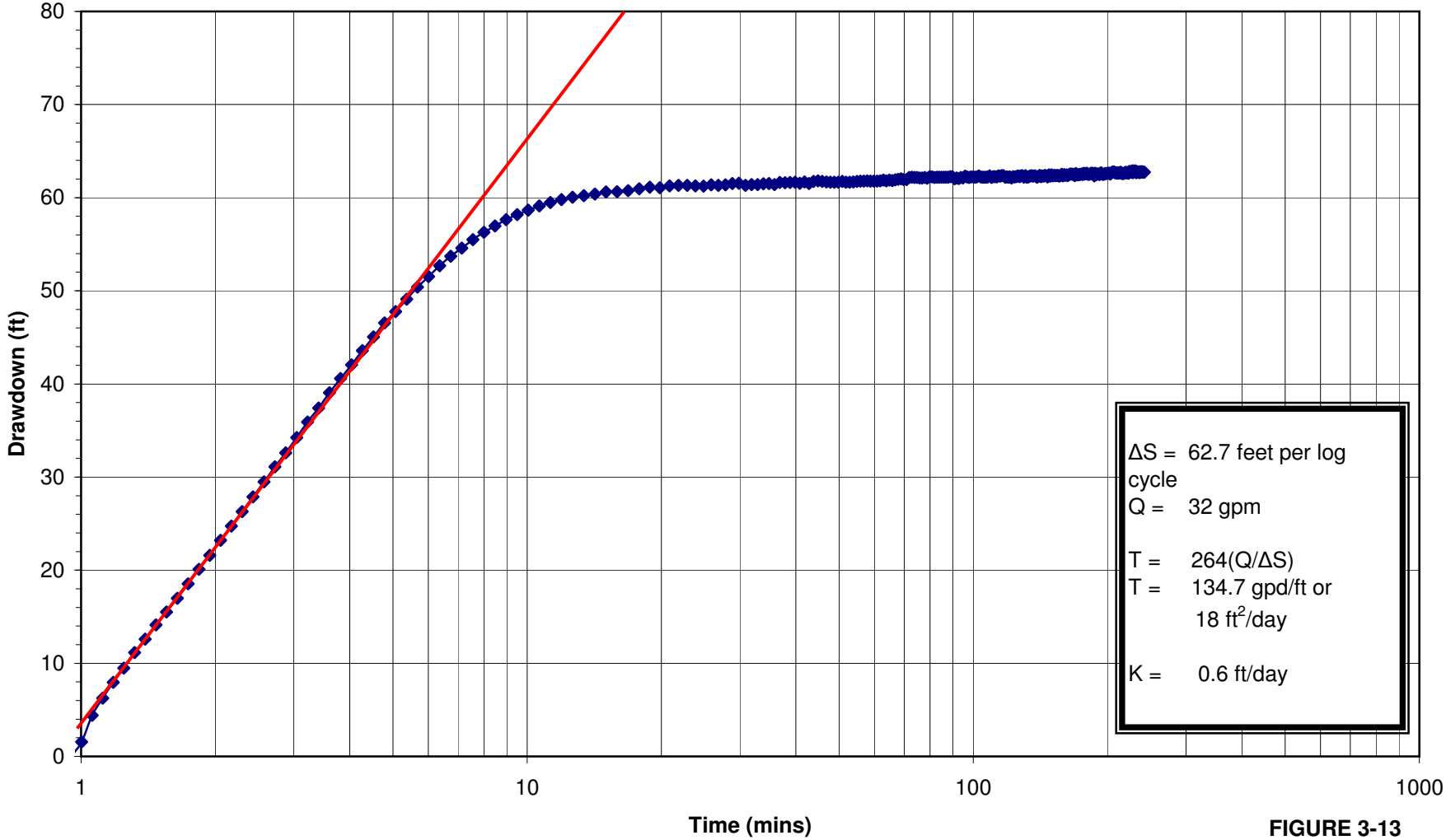


FIGURE 3-13

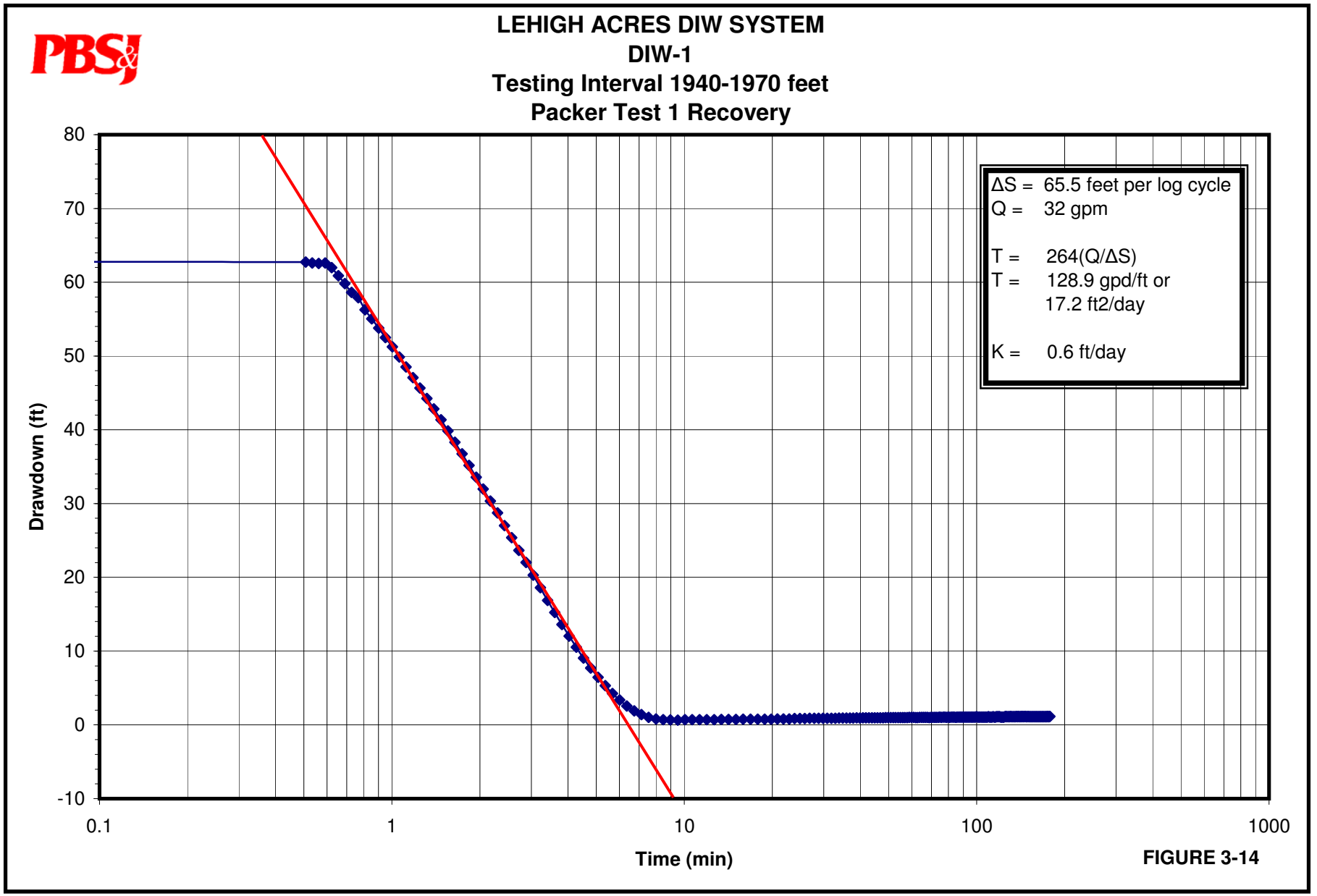

LEHIGH ACRES DIW SYSTEM
DIW-1
Testing Interval 1940-1970 feet
Packer Test 1 Recovery
ΔS = 65.5 feet per log cycle
Q = 32 gpm
T = 264(Q/ΔS)
T = 128.9 gpd/ft or
17.2 ft2/day
K = 0.6 ft/day
Drawdown (ft)
80
70
60
50
40
30
20
10
0
-10
0.1
1
10
100
1000
Time (min)

FIGURE 3-14

LEHIGH ACRES DIW SYSEM
DIW-1
Testing Interval 1885-1915 feet
Packer Test 2 Drawdown

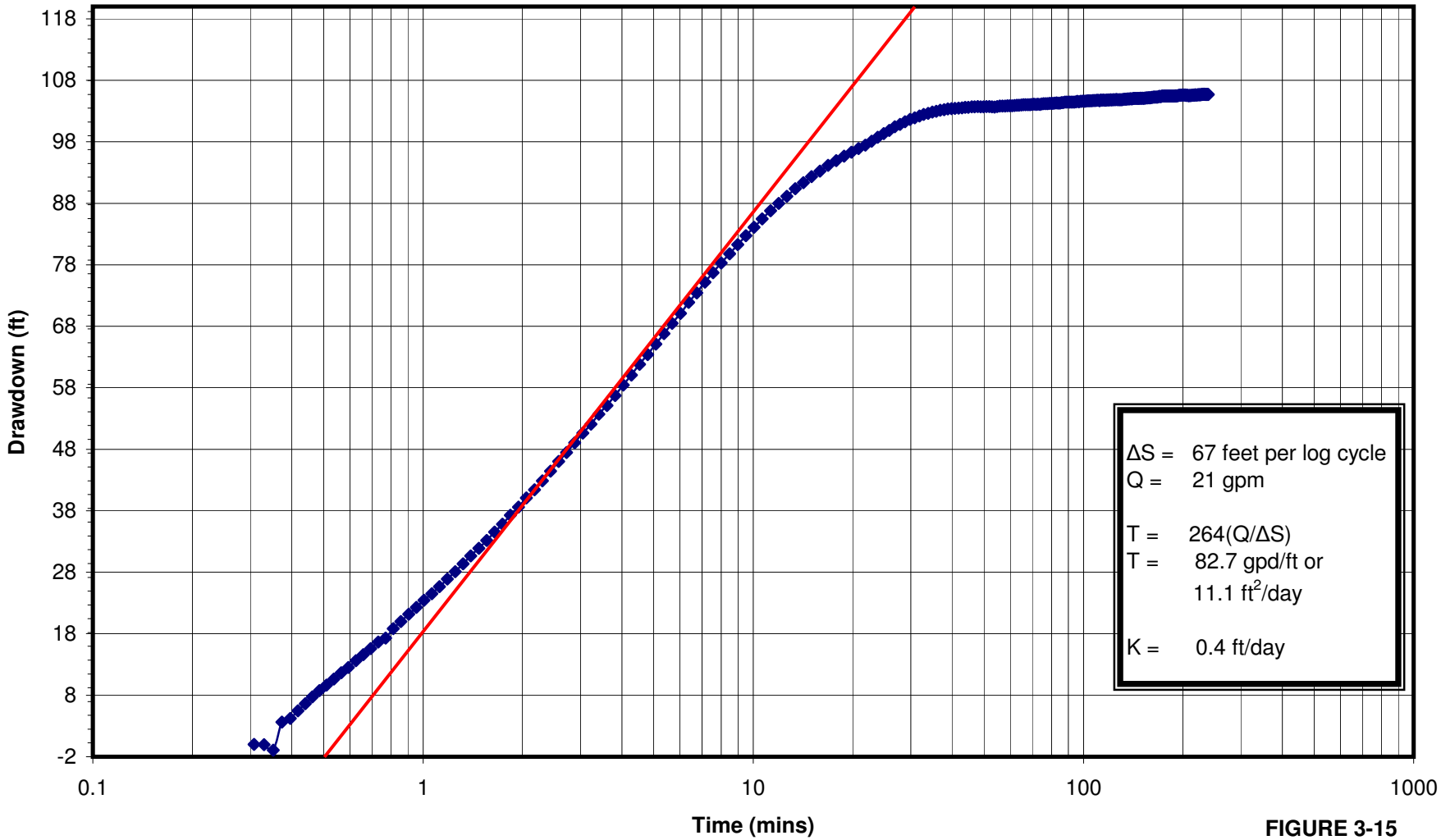


FIGURE 3-15

LEHIGH ACRES DIW SYSTEM
DIW-1
Testing Interval 1885-1915 feet
Packer Test 2 Recovery

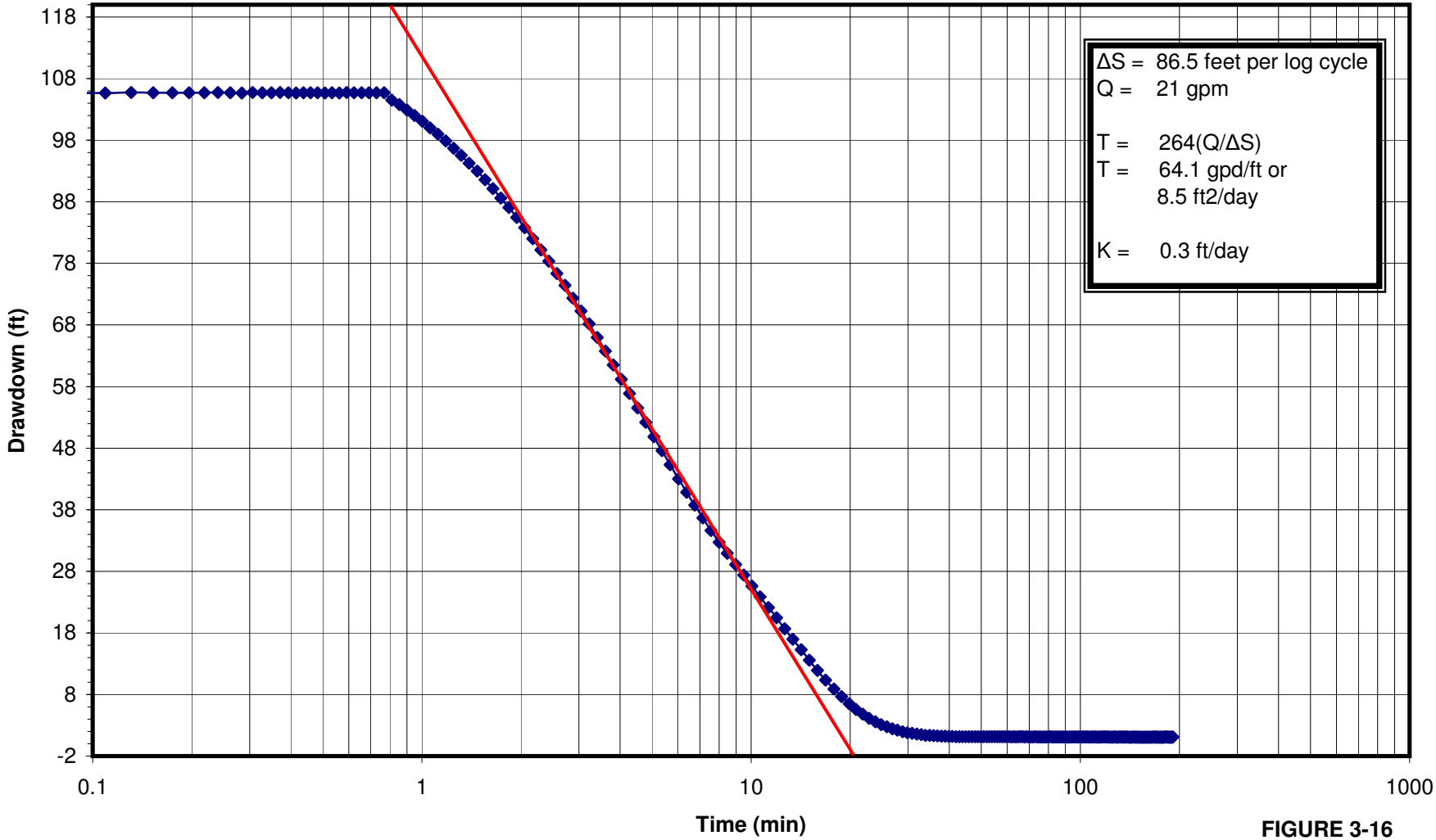


FIGURE 3-16

3.4.2.2. DIW-1 Packer Tests 1,990 – 2,088 feet and 2,130 – 2,230 feet

Straddle packer tests 3 and 4 were performed across two separate intervals between February 5 and 6. The straddle packer assembly setup was the same for both tests as described for tests 1 and 2 except the mid-point of the packers were separated by 100 feet of 6-inch perforated pipe. A 0.5 horsepower submersible pump was set to 180 feet below land surface inside the pipe assembly. Each packer was inflated simultaneously through a single water line with pressure of approximately 280-320 psi maintained on the packer assembly throughout the testing.

Each tested interval was developed until a minimum of three well volumes had been pumped and the discharge water appeared to be free and clear of sediment. Water levels in the isolated zone were allowed to recover back to static before starting the pumping test. The pumping rate ranged from 36 to 115 gpm in the 4-hour tests that were followed by a 2-hour recovery period.

The specific capacity of the 1,990 to 2,088-foot interval is 0.6 gpm/ft of drawdown at a pumping rate of 36 gpm (**Figures 3-17 and 3-18**). The hydraulic conductivity value for this 100-foot interval calculated using the Cooper-Jacob solution on both the drawdown and recovery data is 0.3 feet per day. This indicates relatively low permeability and confining characteristics of the limestone and dolomite extending down to 2,088 feet bls. The laboratory determined TDS value for this interval was 30,300 mg/L.

The specific capacity of the 2,130 to 2,230-foot interval is 189 gpm/ft of drawdown at a pumping rate of 115 gpm (**Figures 3-19 and 3-20**). The hydraulic conductivity value for this 100-foot interval calculated using the Cooper-Jacob solution on both the drawdown and recovery data is 135 feet per day, which indicates high formation permeability. Due to the extremely high permeability of this interval the water level data was not uniform as exhibited in other previous packer tests. The data appears to be "noisy" due to the pumps inability to effectively influence and stress this interval. The observed drawdown in **Figure 3-19** is dues almost entirely to friction loss with in the pump column, which makes the values determined for hydraulic conductivity suspect. The laboratory tested TDS value for this interval was 30,700 mg/L.

3.4.2.3. DIW-1 Packer Test Summary

The injection well packer test hydraulic data indicate that the rock formations between approximately 1,885 and 2,088 feet (below the LZMW-1B lower monitoring zone and above the injection zone) exhibit relatively low permeability and good confining characteristics with hydraulic conductivity values ranging from 0.3 to 0.6 feet per day. The hydraulic conductivity of this interval, which lies in the middle of the Dolomitic-Evaporite Formation, is comparable to the hydraulic conductivity observed in the

LEHIGH ACRES DIW SYSTEM
DIW-1
Testing Interval 1990-2088 feet
Packer Test 3 Drawdown

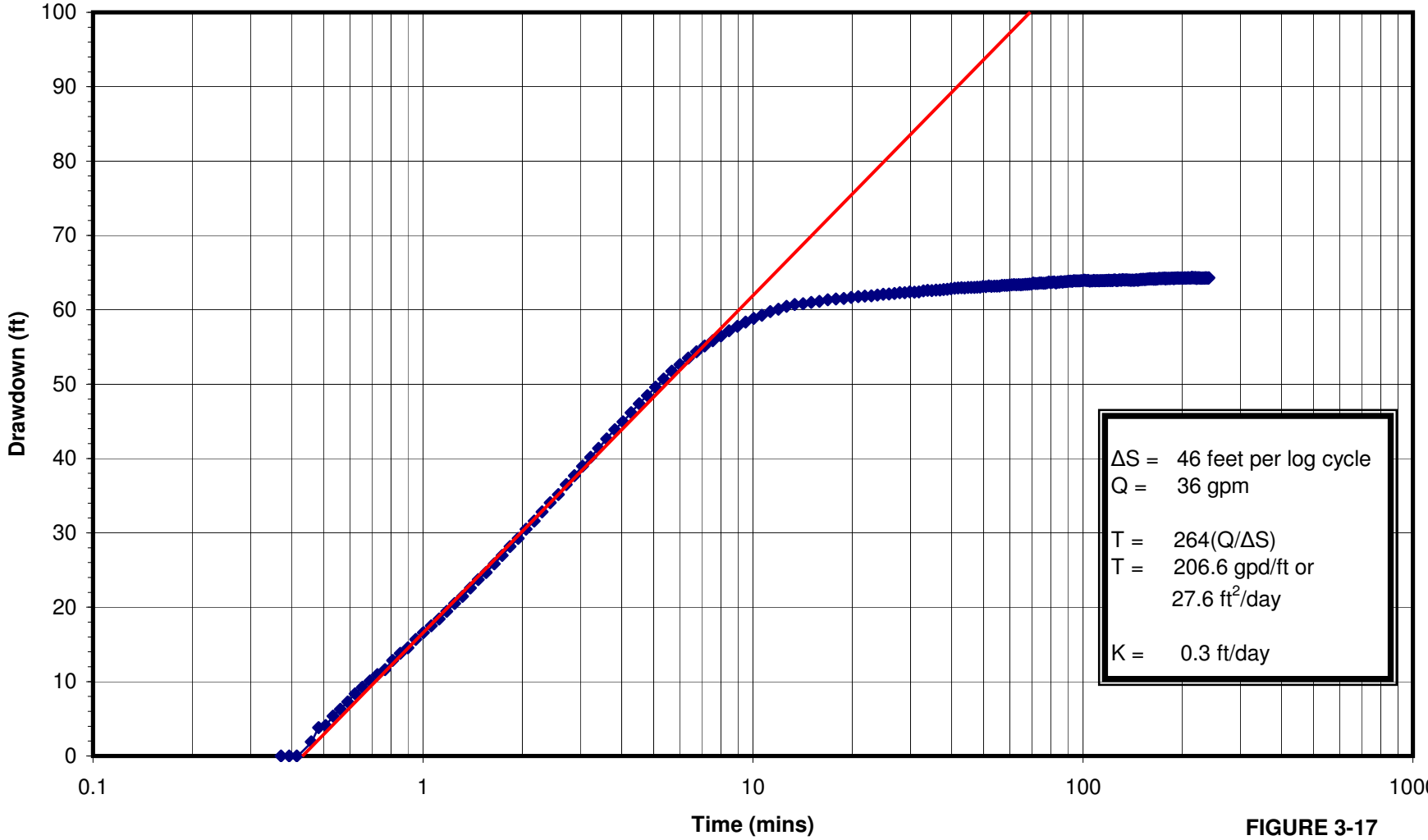


FIGURE 3-17

LEHIGH ACRES DIW SYSTEM
DIW-1
Testing Interval 1990-2088 feet
Packer Test 3 Recovery

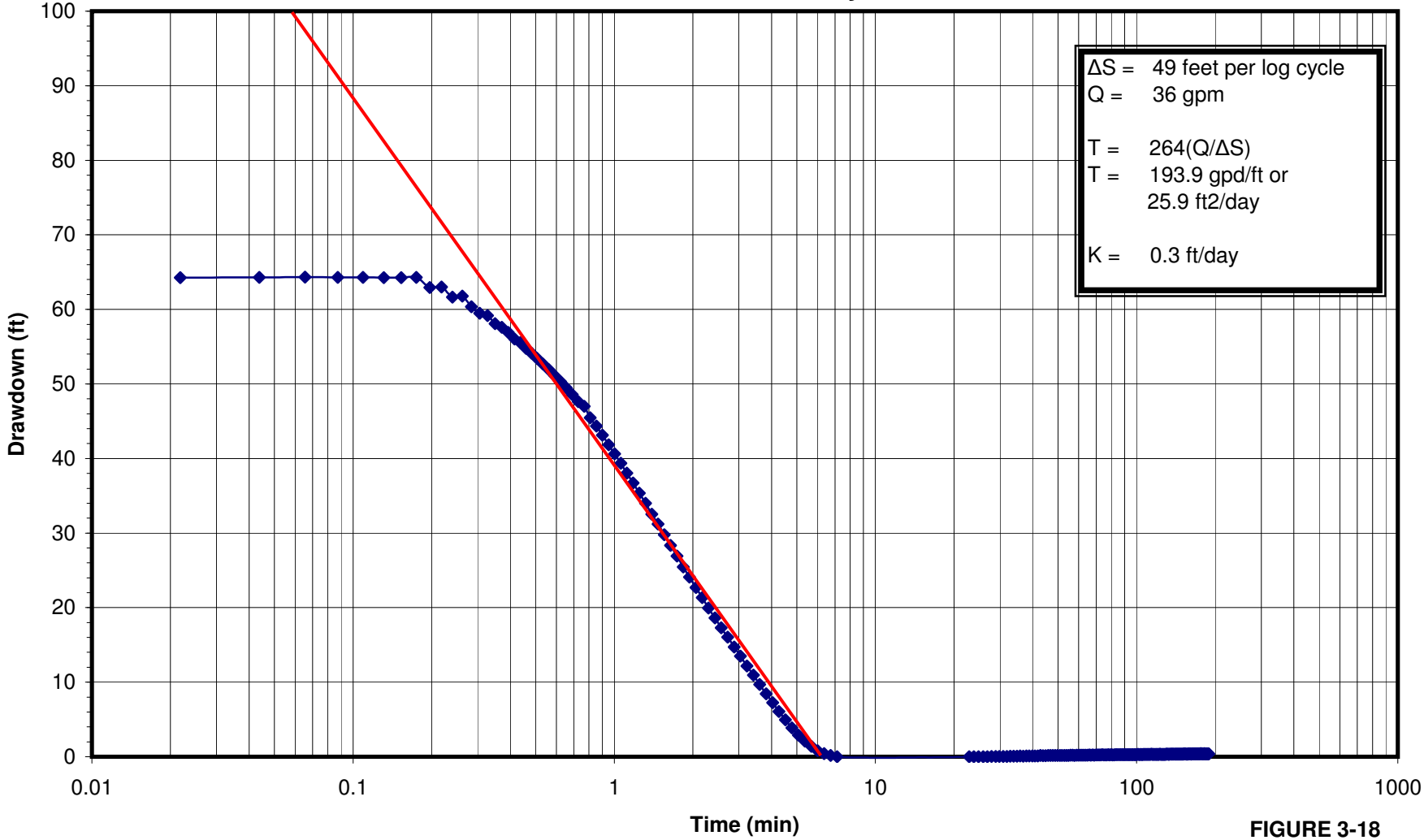


FIGURE 3-18

LEHIGH ACRES DIW SYSTEM
DIW-1
Testing Interval 2130-2230 feet
Packer Test 4 Drawdown

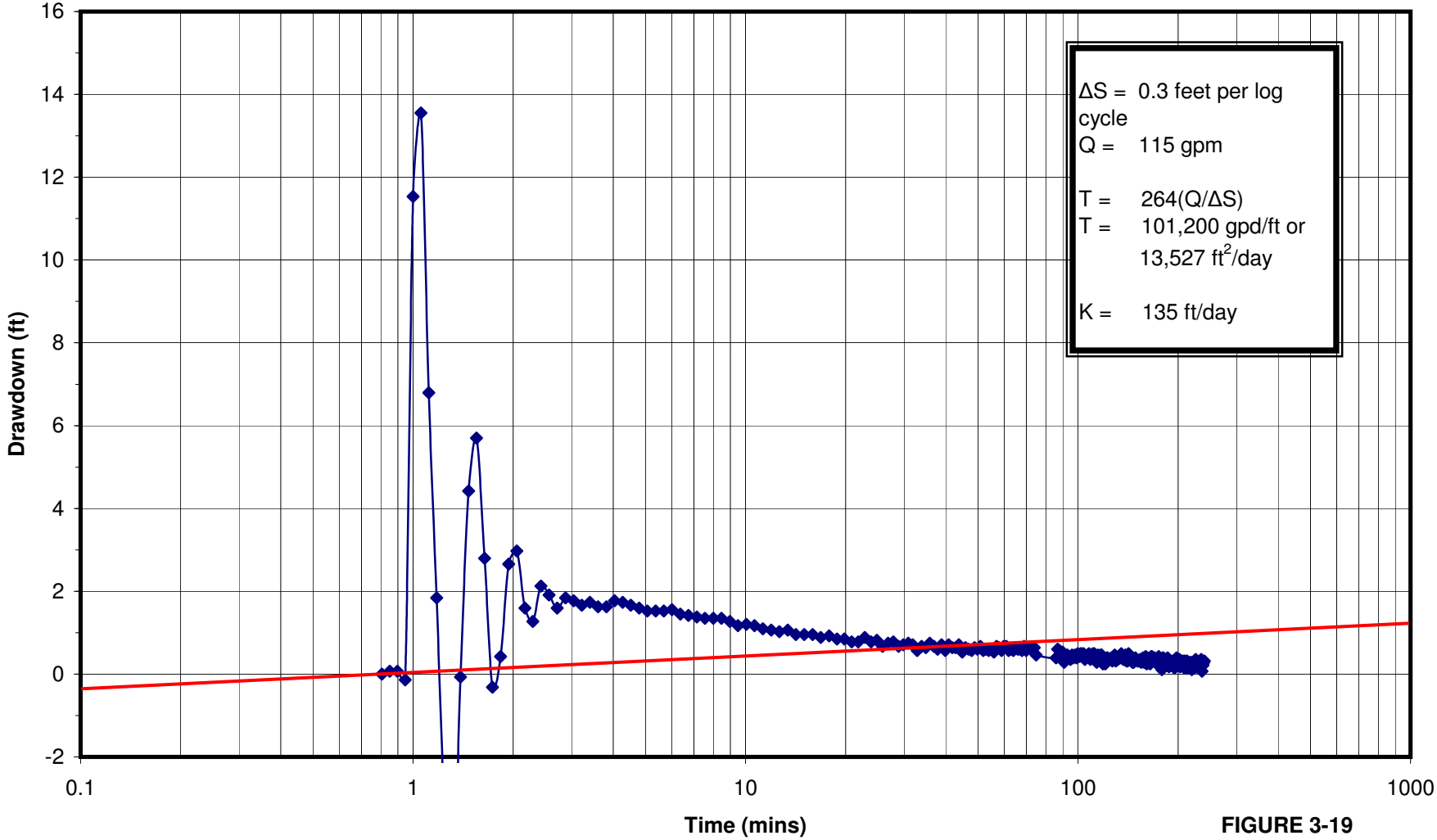


FIGURE 3-19

LEHIGH ACRES DIW SYSTEM
DIW-1
Testing Interval 2130-2230 feet
Packer Test 4 Recovery

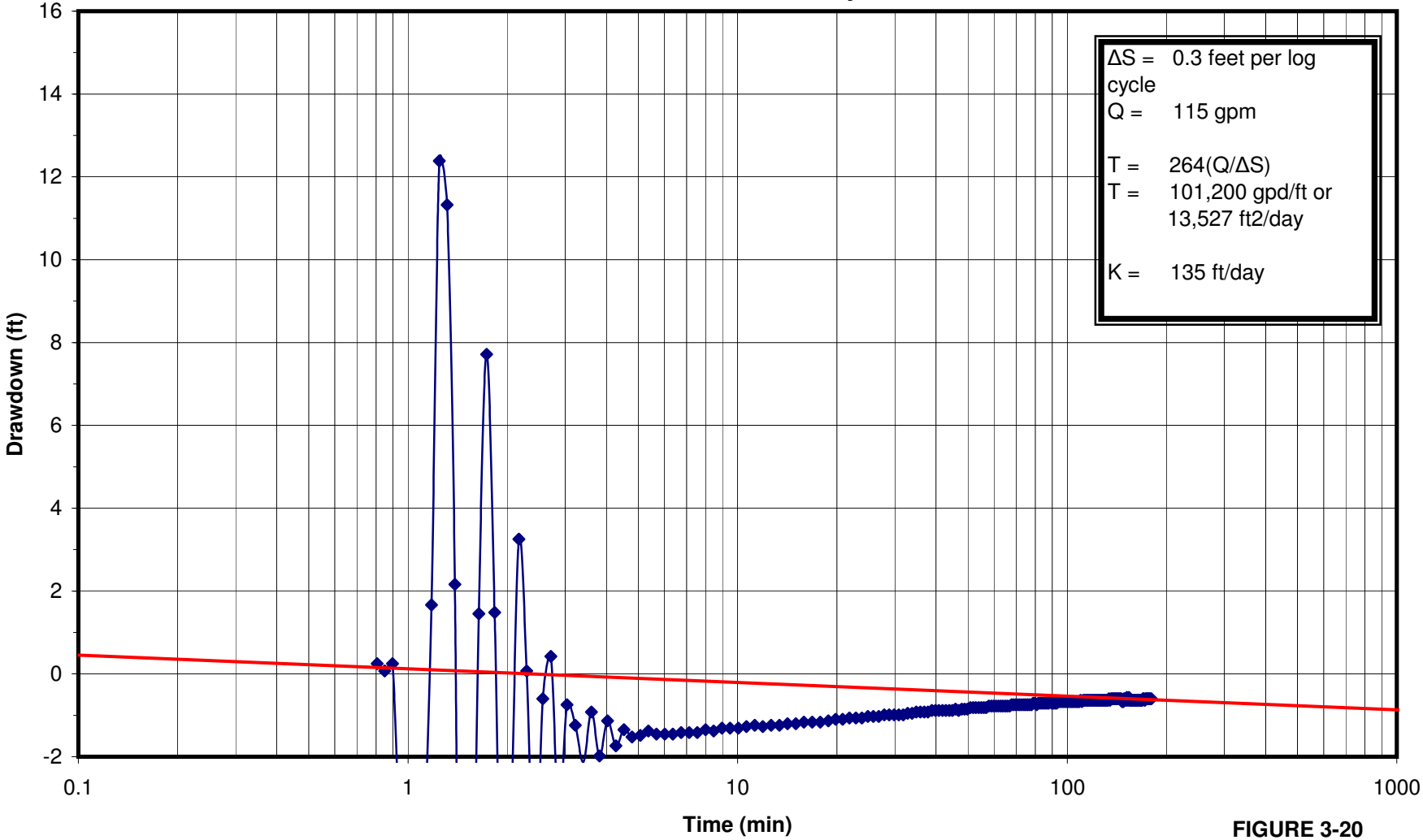


FIGURE 3-20

middle part of the Avon Park Formation, as determined from tests conducted at the LZMW-1B.

3.5. Water Quality Sampling

The water quality sampling program implemented during the injection well system construction project consisted of four sampling types. The Surficial Aquifer was monitored during construction of the injection well system by sampling four water table aquifer wells located near the drilling pad. During reverse-air drilling operations, airlift water samples were collected in order to monitor potential changes in ground water quality during drilling. Water quality samples were also collected from isolated intervals during the performance of the packer tests. Final background water quality samples were collected following drilling and development of LZMW-1B, UZMW-1 and DIW-1.

3.5.1. Surficial Aquifer

The four Surficial Aquifer monitoring wells (SMW-1 through SMW-4) located around the drill pad were sampled weekly to monitor for any potential water quality changes resulting from the drilling operation. The pad wells were installed and initially sampled prior to any deep drilling activities in order to establish ambient ground water conditions.

Sanders Laboratory personnel, who were subcontracted to YBI during execution of the project, collected and analyzed weekly water levels and water samples. Each well was purged and sampled using a peristaltic pump. Discharge water was captured in a 1-liter bottle after a minimum three well volumes had been purged. The water samples were analyzed at the laboratory for the following parameters: chloride, conductivity, dissolved oxygen, pH, temperature and turbidity (**Tables 3-4** through **3-7)**. **Figures 3-21** through **3-28** graphically present the results of the water quality analyses and indicate a few variations in concentration of the conductivity, pH and chloride. Based on the analytical monitoring results, it was determined that the Surficial Aquifer had been affected at pad monitor wells SMW-2 and SMW-4 by drilling operations. YBI took steps to remediate the impact of the contamination, by pumping both SMW-2 and SMW-4 with an external 4 hp centrifugal pump for sixteen hours. The discharge water was pumped to a tanker truck onsite then transported off site for disposal. This action proved successful when water quality samples taken after the remediation showed a return to background conditions in both SMW-2 and SMW-4. Copies of the laboratory reports for both wells are included in **Appendix L**.

Florida Governmental Utility Authority
Lehigh Acres WWTP Class I Deep Injection Well
Shallow Water Table Monitoring Well

Analyses conducted by Sanders Laboratories, Inc.

TABLE 3-4
WATER TABLE WELL MONITORING DATA - SMW-1

LABORATORY ANALYSIS RESULTS								
Date	Time	Chloride (mg/L)	D.O. (mg/L)	pH (S.U.)	Specific Conductivity (µmhos/cm)	Turbidity (NTU)	Depth to Water (ft)	Temp. (C°)
5/23/2007	15:11	105	2.19	6.39	1010	15.9	9.05	25.6
6/1/2007	13:40	95	2.21	6.34	1200	0.1	9.11	24.8
6/8/2007	12:44	105	2.31	6.30	1070	1.8	8.83	26.2
6/15/2007	13:15	70	2.10	6.45	979	3.0	8.81	26.0
6/22/2007	12:54	105	1.78	7.43	1060	8.6	8.41	25.8
6/29/2007	12:55	95	2.46	7.00	1150	10.5	8.57	29.1
7/6/2007	9:55	100	1.52	6.91	991	2.4	7.64	26.3
7/13/2007	10:32	97	2.10	7.29	1050	13.5	6.90	26.4
7/20/2007	10:34	102	2.01	6.98	1010	2.7	6.78	26.5
7/27/2007	13:21	102	2.90	6.41	1410	2.9	6.81	26.9
8/2/2007	15:08	100	2.64	6.90	1000	1.2	6.78	26.6
8/10/2007	13:21	105	1.92	6.68	848	14.0	7.14	26.6
8/17/2007	9:31	107	2.01	6.79	1110	0.7	7.03	26.3
8/24/2007	8:12	117	2.21	6.33	1180	0.4	7.01	26.4
8/31/2007	10:02	117	1.71	6.52	1140	1.6	7.04	26.7
9/6/2007	11:48	110	1.77	6.42	952	1.0	6.38	26.9
9/13/2007	15:07	112	2.51	6.39	922	18.8	7.27	27.8
9/21/2007	14:34	107	2.43	6.91	1140	1.0	7.04	26.6
9/28/2007	14:27	107	2.39	6.74	701	1.4	6.68	27.1
10/4/2007	17:20	110	2.29	6.76	1040	1.2	6.88	27.4
10/11/2007	14:54	102	1.59	6.58	891	3.6	7.05	26.7
10/19/2007	15:04	115	3.05	6.87	1000	4.0	6.99	27.5
10/26/2007	14:18	102	2.81	6.89	1090	0.5	6.95	26.7
11/7/2007	7:46	105	2.53	6.80	1330	11.3	5.74	25.9
11/17/2007	10:29	115	4.86	7.08	1150	10.0	5.71	26.2
11/21/2007	11:27	110	3.71	7.01	1170	3.6	5.78	26.4
11/30/2007	15:08	112	2.71	6.96	1170	27.6	5.24	26.2
12/7/2007	15:12	115	2.97	7.00	1170	2.9	5.61	26.3
12/14/2007	13:24	105	1.97	7.04	1180	5.2	5.56	26.3
12/20/2007	9:27	117	2.14	6.93	1190	2.4	4.93	25.7
12/28/2007	10:03	107	2.43	6.98	1190	3.5	5.56	25.7
1/4/2008	14:20	100	2.48	6.95	1170	6.1	5.96	24.2
1/10/2008	10:02	112	2.43	6.67	1170	5.3	6.13	25.3
1/18/2008	13:59	102	4.07	7.03	1170	4.9	6.20	25.3
1/25/2008	14:43	107	3.34	7.04	1160	15.2	6.23	24.9
2/1/2008	14:16	125	3.27	7.29	1020	8.9	6.58	24.9
2/8/2008	12:55	115	3.57	7.31	1170	20.9	6.49	25.2
2/15/2008	12:23	87	2.17	7.00	1050	57.9	6.81	24.6
2/22/2008	9:05	102	2.72	7.29	1020	30.8	6.31	24.9
2/29/2008	12:19	115	3.00	6.95	1200	32.0	6.47	24.5
3/7/2008	15:30	92	2.92	7.28	1120	26.2	6.25	25.0
3/14/2008	13:55	112	2.01	7.14	1160	9.2	6.00	24.5
3/21/2008	12:57	117	1.89	7.03	1200	25.6	6.05	24.7
3/27/2008	10:57	112	1.83	6.90	1170	9.9	6.03	24.3
4/4/2008	14:17	100	1.43	7.04	1040	15.8	5.41	24.6
4/13/2008	11:08	114	1.74	7.18	1100	29.4	5.38	24.9
4/18/2008	12:48	158	1.69	7.19	1220	20.9	5.46	25.0
4/25/2008	11:56	115	1.84	6.97	1240	13.5	5.68	24.5
5/2/2008	14:46	118	2.64	6.94	1220	26.4	5.78	24.6
5/8/2008	10:59	115	2.11	6.92	1250	16	5.84	24.9
5/16/2008	14:36	120	2.37	6.93	1210	27.2	5.81	25.3
5/23/2008	11:00	127	2.84	6.79	1180	217	5.82	25.7
5/30/2008	15:15	117	2.67	6.78	1240	9.2	6.24	25.4
6/6/2008	11:40	120	1.99	6.65	1160	26.4	6.29	27.0
6/11/2008	11:50	110	2.53	6.89	1090	23.5	6.20	26.0

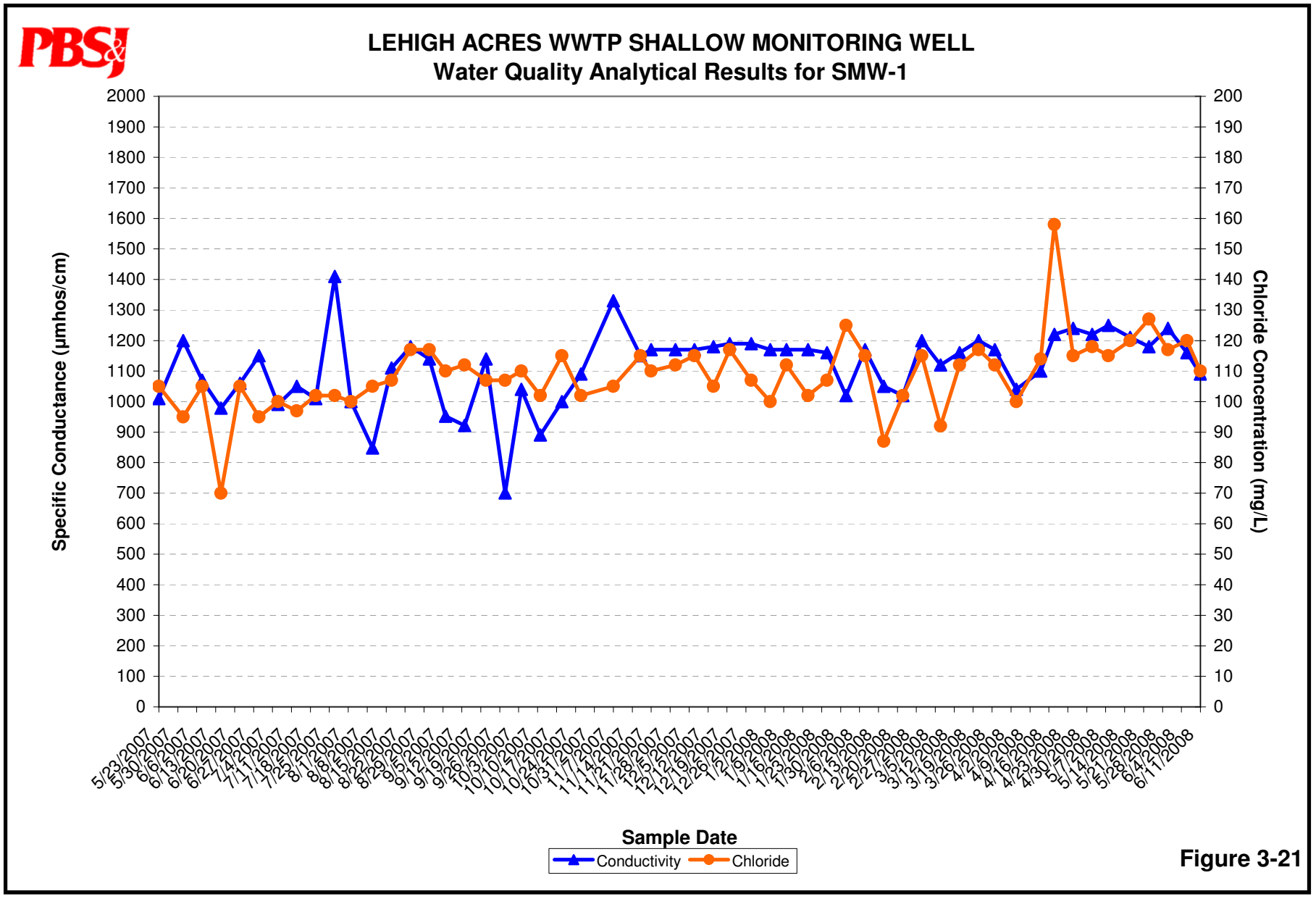

LEHIGH ACRES WWTP SHALLOW MONITORING WELL
Water Quality Analytical Results for SMW-1
Specific Conductance (µmhos/cm)
Chloride Concentration (mg/L)
Sample Date
Conductivity
Chloride

Figure 3-21

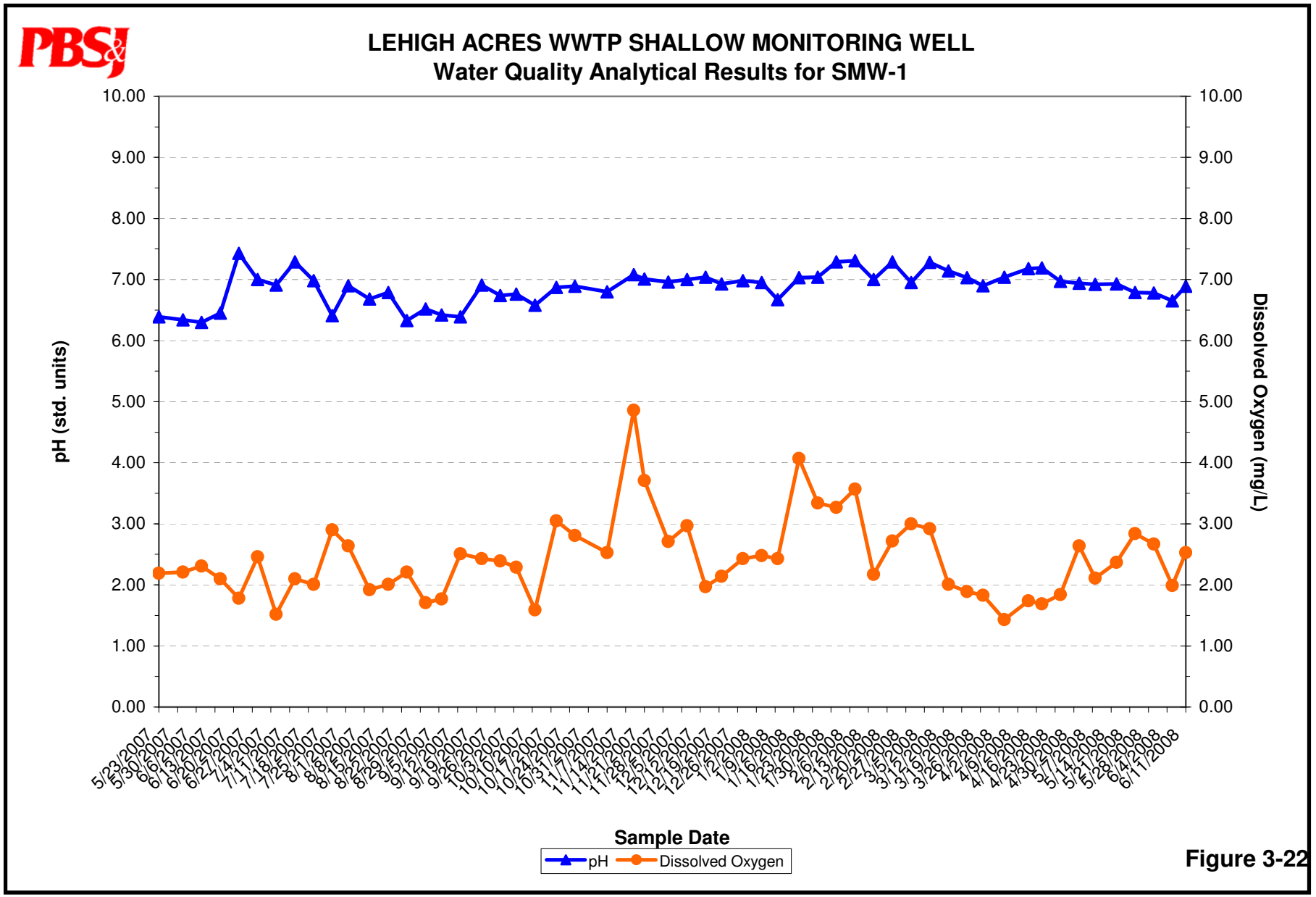

LEHIGH ACRES WWTP SHALLOW MONITORING WELL
Water Quality Analytical Results for SMW-1
pH (std. units)
Dissolved Oxygen (mg/L)
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
5/23/2007
5/30/2007
6/6/2007
6/13/2007
6/20/2007
6/27/2007
7/4/2007
7/11/2007
7/18/2007
7/25/2007
8/1/2007
8/8/2007
8/15/2007
8/22/2007
8/29/2007
9/5/2007
9/12/2007
9/19/2007
9/26/2007
10/3/2007
10/10/2007
10/17/2007
10/24/2007
10/31/2007
11/7/2007
11/14/2007
11/21/2007
11/28/2007
12/5/2007
12/12/2007
12/19/2007
12/26/2007
1/2/2008
1/9/2008
1/16/2008
1/23/2008
1/30/2008
2/6/2008
2/13/2008
2/20/2008
2/27/2008
3/5/2008
3/12/2008
3/19/2008
3/26/2008
4/2/2008
4/9/2008
4/16/2008
4/23/2008
4/30/2008
5/7/2008
5/14/2008
5/21/2008
5/28/2008
6/4/2008
6/11/2008
Sample Date
pH
Dissolved Oxygen

Figure 3-22

Florida Governmental Utility Authority
Lehigh Acres WWTP Class I Deep Injection Well
Shallow Water Table Monitoring Well

Analyses conducted by Sanders Laboratories, Inc.

TABLE 3-5
WATER TABLE WELL MONITORING DATA -SMW-2

LABORATORY ANALYSIS RESULTS								
Date	Time	Chloride (mg/L)	D.O. (mg/L)	pH (S.U.)	Specific Conductivity (µmhos/cm)	Turbidity (NTU)	Depth to Water (ft)	Temp. (C°)
5/23/2007	15:33	130	2.07	6.48	1020	5.3	8.83	25.6
6/1/2007	13:15	120	2.70	6.37	1220	0.81	8.96	24.7
6/8/2007	13:23	125	2.17	6.49	1090	0.6	8.77	25.6
6/15/2007	13:35	115	2.01	6.34	1020	4.0	8.55	26.1
6/22/2007	12:54	125	1.79	7.42	1120	2.1	8.25	25.8
6/29/2007	12:05	127	2.42	7.28	1160	1.5	8.10	26.3
7/6/2007	9:20	120	1.76	6.95	1060	0.7	7.29	26.2
7/13/2007	11:18	132	1.84	7.11	1140	8.1	7.00	26.3
7/20/2007	11:37	112	2.13	6.57	1190	0.8	6.89	26.5
7/27/2007	14:12	115	2.68	5.64	1440	1.1	6.84	26.5
8/2/2007	15:45	130	1.63	6.51	1100	0.3	6.84	26.7
8/10/2007	14:07	117	2.24	6.67	1980	3.3	7.04	26.8
8/17/2007	9:56	122	1.73	6.48	1250	1.2	7.01	26.4
8/24/2007	8:52	122	2.02	6.42	1380	0.8	6.99	26.4
8/31/2007	10:36	117	1.89	6.33	1260	0.9	6.68	26.8
9/6/2007	14:35	130	3.01	6.35	1040	1.1	6.46	27.1
9/13/2007	14:41	127	1.96	6.40	1000	0.9	6.72	27.0
9/21/2007	14:08	127	1.59	6.88	1290	1.2	6.71	27.0
9/28/2007	14:09	125	1.83	6.75	748	1.5	6.41	27.2
10/4/2007	17:25	127	1.98	7.06	1150	0.7	6.83	27.3
10/11/2007	14:40	122	1.62	6.60	963	2.9	6.65	27.0
10/19/2007	13:52	120	2.71	6.85	1040	1.7	6.74	26.9
10/26/2007	14:41	110	3.01	6.88	1140	0.5	6.64	26.7
11/7/2007	8:03	120	2.59	6.39	1380	3.2	4.72	26.2
11/17/2007	10:49	122	4.48	7.01	1190	6.1	4.60	26.2
11/21/2007	11:03	115	3.89	7.00	1190	7.0	5.08	26.4
11/30/2007	15:28	125	1.84	6.93	1200	3.2	4.59	26.0
12/7/2007	14:16	135	3.27	7.07	1220	4.5	4.68	26.7
12/14/2007	13:47	162	2.87	7.13	1400	27.7	4.85	26.3
12/20/2007	10:13	230	2.30	7.07	1650	44.6	4.90	25.2
12/28/2007	10:36	175	1.87	6.97	1480	37.9	4.78	25.4
1/4/2008	14:38	160	2.61	7.04	1430	9.6	5.00	24.3
1/10/2008	10:38	300	3.92	6.91	2230	476.0	5.21	23.6
1/18/2008	14:32	135	4.12	6.99	1240	170.0	5.37	25.1
1/25/2008	14:22	127	2.84	6.99	1220	2.0	5.52	24.6
2/1/2008	14:34	127	2.69	7.33	1060	1.9	5.74	24.5
2/8/2008	12:11	127	3.29	7.18	1210	3.3	5.79	25.2
2/15/2008	12:02	190	3.92	7.65	1230	22.2	5.81	23.4
2/22/2008	9:29	157	3.61	7.72	1160	51.3	5.70	24.5
2/29/2008	13:05	132	2.91	7.13	1260	21.9	5.55	24.1
3/7/2008	15:30	142	2.28	7.29	1210	24.5	5.33	24.8
3/14/2008	14:31	147	1.91	7.27	1220	16.8	5.23	23.7
3/21/2008	13:27	140	1.81	7.15	1240	4.6	5.18	24.2
3/27/2008	11:17	132	2.08	7.31	1070	8.7	4.87	23.9
4/4/2008	15:03	3400	3.70	8.74	11600	1100	4.61	24.5
4/13/2008	11:28	795	1.77	8.09	3050	6.26	4.58	25.2
4/18/2008	13:17	913	1.36	7.35	3530	135	4.84	24.3
4/25/2008	12:22	154	2.14	6.97	1380	7.7	4.79	24.2
5/2/2008	15:08	151	2.54	7.02	1340	3.5	4.96	24.3
5/8/2008	10:33	142	2.22	6.96	1340	1.9	4.82	24.6
5/16/2008	15:04	152	2.49	7.10	1290	99.5	5.08	25.0
5/23/2008	11:30	128	2.87	6.74	1210	2.3	4.95	25.4
5/30/2008	15:38	132	2.30	6.79	1310	5	5.43	25.0
6/6/2008	12:05	131	2.24	6.72	1170	0.7	5.21	26.0
6/11/2008	12:30	123	2.76	6.88	1140	14.8	5.41	25.6

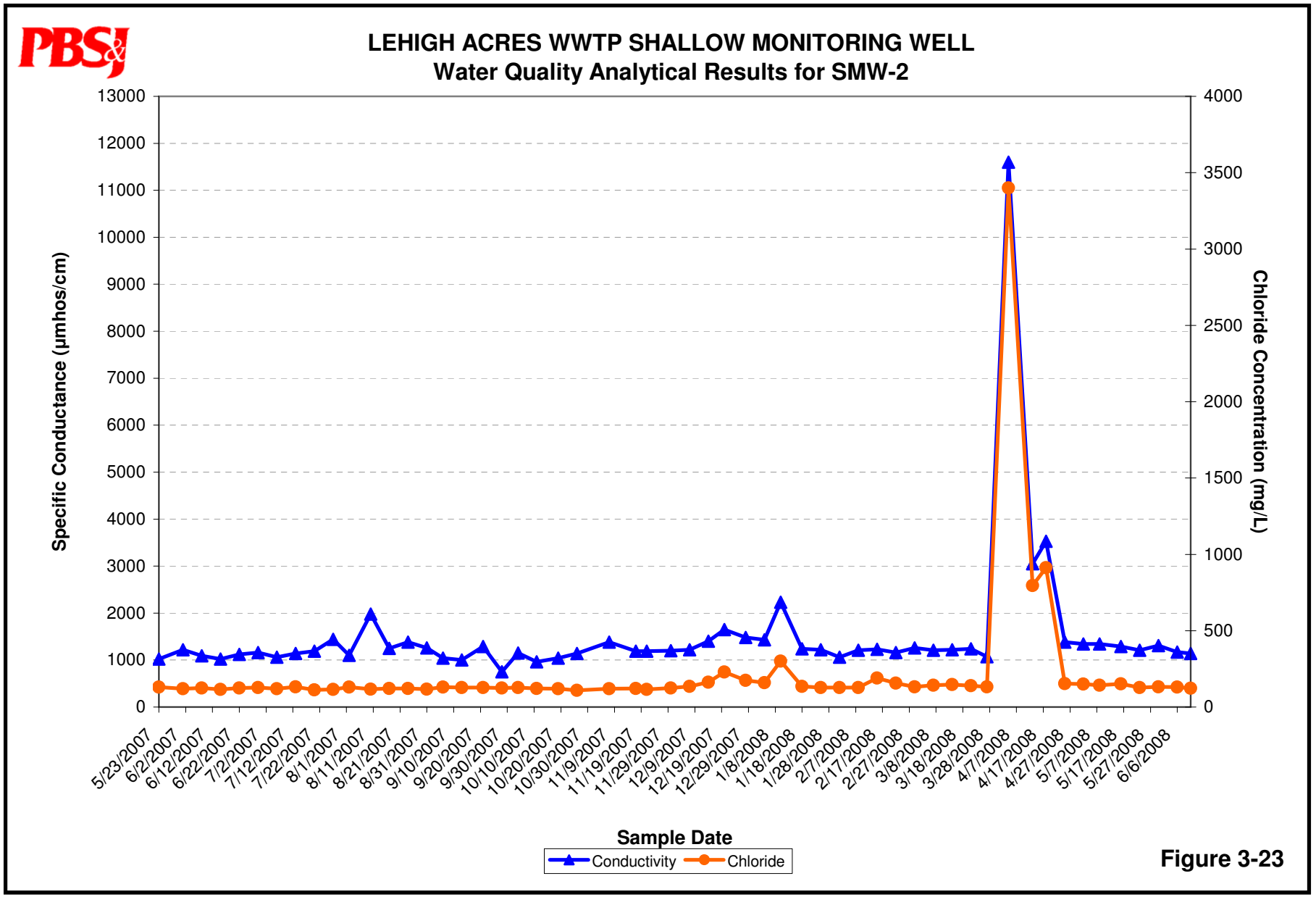

LEHIGH ACRES WWTP SHALLOW MONITORING WELL
Water Quality Analytical Results for SMW-2
Specific Conductance (µmhos/cm)
Chloride Concentration (mg/L)
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
4000
3500
3000
2500
2000
1500
1000
500
0
5/23/2007
6/2/2007
6/12/2007
6/22/2007
7/2/2007
7/12/2007
7/22/2007
8/1/2007
8/11/2007
8/21/2007
8/31/2007
9/10/2007
9/20/2007
9/30/2007
10/10/2007
10/20/2007
10/30/2007
11/9/2007
11/19/2007
11/29/2007
12/9/2007
12/19/2007
12/29/2007
1/8/2008
1/18/2008
1/28/2008
2/7/2008
2/17/2008
2/27/2008
3/8/2008
3/18/2008
3/28/2008
4/7/2008
4/17/2008
4/27/2008
5/7/2008
5/17/2008
5/27/2008
6/6/2008
Sample Date
Conductivity
Chloride

Figure 3-23

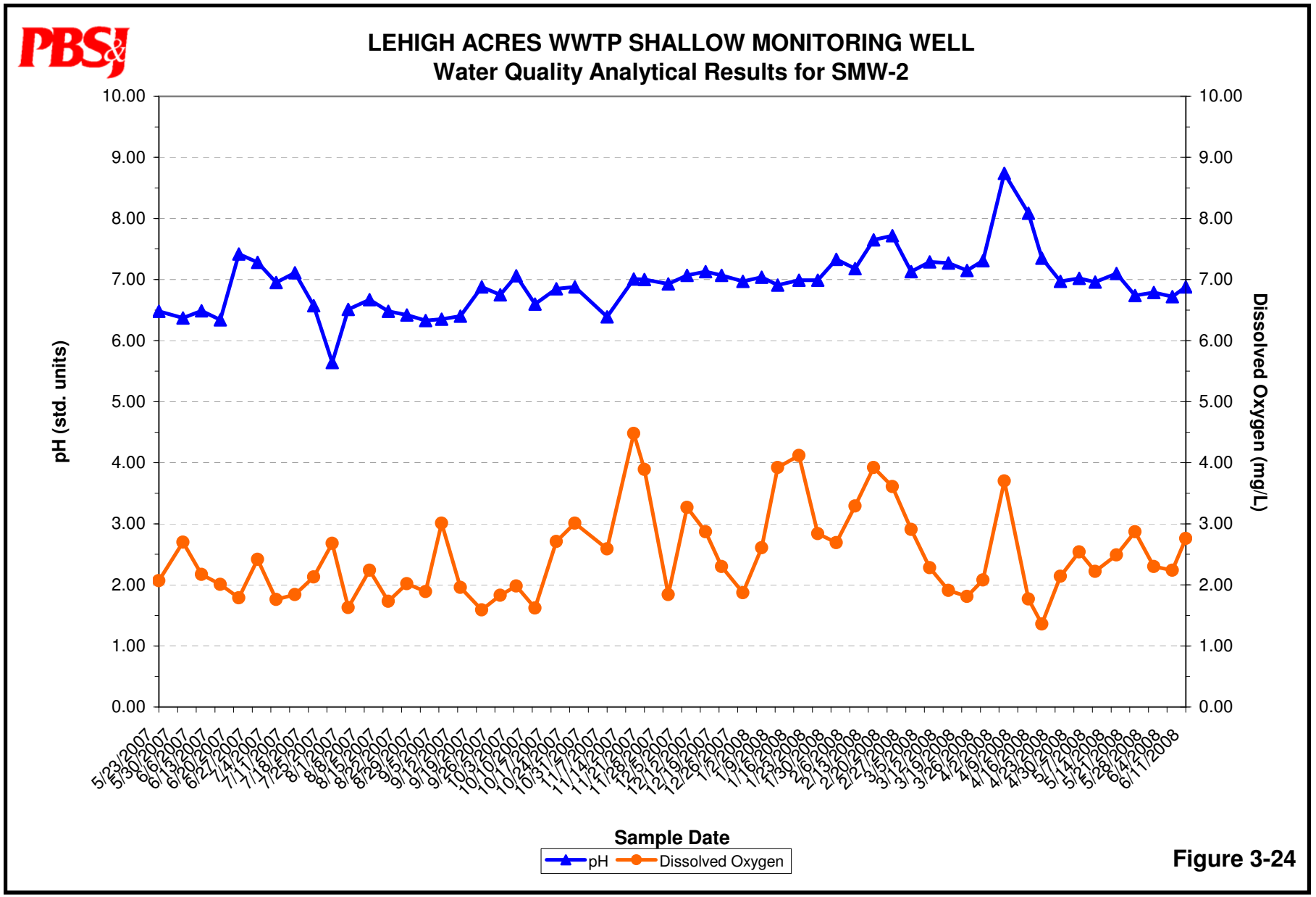

LEHIGH ACRES WWTP SHALLOW MONITORING WELL
Water Quality Analytical Results for SMW-2
pH (std. units)
Dissolved Oxygen (mg/L)
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
5/23/2007
5/30/2007
6/6/2007
6/13/2007
6/20/2007
6/27/2007
7/4/2007
7/11/2007
7/18/2007
7/25/2007
8/1/2007
8/8/2007
8/15/2007
8/22/2007
8/29/2007
9/5/2007
9/12/2007
9/19/2007
9/26/2007
10/3/2007
10/10/2007
10/17/2007
10/24/2007
10/31/2007
11/7/2007
11/14/2007
11/21/2007
11/28/2007
12/5/2007
12/12/2007
12/19/2007
12/26/2007
1/2/2008
1/9/2008
1/16/2008
1/23/2008
1/30/2008
2/6/2008
2/13/2008
2/20/2008
2/27/2008
3/5/2008
3/12/2008
3/19/2008
3/26/2008
4/2/2008
4/9/2008
4/16/2008
4/23/2008
4/30/2008
5/7/2008
5/14/2008
5/21/2008
5/28/2008
6/4/2008
6/11/2008
Sample Date
pH
Dissolved Oxygen

Figure 3-24

PBS&J

Florida Governmental Utility Authority
Lehigh Acres WWTP Class I Deep Injection Well
Shallow Water Table Monitoring Well

Analyses conducted by Sanders Laboratories, Inc.

TABLE 3-6
WATER TABLE WELL MONITORING DATA -SMW-3

LABORATORY ANALYSIS RESULTS									
Date	**Time**	**Chloride (mg/L)**	**D.O. (mg/L)**	**pH (S.U.)**	**Specific Conductivity (µmhos/cm)**	**Turbidity (NTU)**	**Depth to Water (ft)**	**Temp. (C°)**	**Remarks**
5/23/2007	14:30	90	2.21	6.35	1060	29.8	9.81	25.9	Background Sample
6/1/2007	13:40	95	1.88	6.24	1270	1.1	8.75	25.3	
6/8/2007	12:19	110	2.46	6.37	1120	42.2	7.44	26.2	
6/15/2007	12:55	115	2.45	6.67	856	10.8	7.21	26.6	
6/22/2007									Well was not sampled due to obstructed access.
6/29/2007	12:30	97	2.49	7.36	1190	33.4	7.05	26.7	
7/6/2007	10:10	77	1.78	6.90	1060	83.1	5.55	26.8	
7/13/2007	9:45	102	1.85	9.19	952	58.4	5.27	27.0	
7/20/2007	10:13	82	1.72	7.32	1110	16.9	5.26	27.2	
7/27/2007	12:56	82	3.29	6.35	1550	61.4	5.24	27.5	
8/2/2007	14:42	102	2.40	6.75	1210	3.7	7.61	28.0	SMW-3 was relocated due to the relocation of LZMW-1; Renamed SMW-3R.
8/10/2007	13:01	107	2.28	6.57	1050	13.4	8.72	28.4	
8/17/2007	9:05	115	2.23	6.60	1400	2.3	8.36	28.0	
8/24/2007	7:46	117	2.33	6.26	1510	0.6	8.31	27.7	
8/31/2007	9:41	112	1.96	6.54	1460	2.6	7.12	28.4	
9/6/2007	12:07	122	1.89	6.30	1200	1.9	7.47	28.7	
9/13/2007	15:28	110	2.36	6.34	1260	1.0	7.56	29.2	
9/21/2007	14:56	137	1.94	6.85	1640	0.6	7.45	28.4	
9/28/2007	14:47	102	2.59	6.69	926	5.3	7.51	28.4	
10/4/2007	17:30	100	2.32	6.72	1450	29.1	7.68	28.4	
10/11/2007	14:30	110	1.57	6.41	1260	3.8	7.67	28.1	
10/19/2007	14:40	117	3.46	6.70	1390	1.8	7.78	28.2	
10/26/2007	13:58	110	2.91	6.73	1500	0.6	5.68	28.0	
11/7/2007	7:27	105	2.46	6.44	1820	1.0	5.33	25.9	
11/17/2007	10:07	115	4.87	6.94	1560	6.0	5.58	26.0	
11/21/2007	11:49	117	3.57	6.83	1560	1.7	5.76	26.3	
11/30/2007	14:48	97	2.83	6.78	1310	2.6	5.25	26.8	
12/7/2007	13:47	82	3.64	6.98	1120	2.6	5.86	26.8	
12/14/2007	13:07	90	2.51	6.94	1270	1.7	5.74	26.4	
12/20/2007	9:47	102	2.63	6.94	1350	2.7	4.92	25.4	
12/28/2007	9:42	105	2.18	6.79	1410	1.8	6.15	25.0	
1/4/2008	13:57	90	2.67	6.94	1440	2.9	5.98	23.9	
1/10/2008	9:45	105	2.34	6.61	1470	4.0	6.57	24.2	
1/18/2008	13:40	100	4.45	6.86	1460	5.7	6.18	24.7	
1/25/2008	15:01	110	3.08	6.88	1460	3.3	6.82	25.0	
2/1/2008	13:54	105	3.18	7.08	1200	4.4	6.84	24.0	
2/8/2008	12:36	100	3.55	7.09	1400	5.1	6.78	24.6	
2/15/2008	12:43	110	3.41	6.75	1430	2.8	6.78	24.5	
2/22/2008	8:44	135	3.10	6.92	1480	2.5	6.92	24.4	
2/29/2008	12:41	110	2.45	6.78	1490	6.9	6.55	24.2	
3/7/2008	13:48	120	2.45	6.96	1460	2.2	6.03	24.7	
3/14/2008	13:36	102	1.89	6.90	1330	0.6	6.11	24.7	
3/21/2008	13:48	110	1.94	6.89	1400	0.5	6.21	24.7	
3/27/2008	11:36	112	1.98	6.72	1380	1	5.93	24.6	
4/4/2008	13:55	125	1.83	6.54	1290	0.3	5.41	24.7	
									well unable to sample due to Injection Test set up
4/18/2008	12:26	136	1.87	6.96	1350	2.2	5.38	25.1	
4/25/2008	11:37	133	2.30	6.79	1360	0.7	6.61	25.2	
5/2/2008	14:24	123	2.41	6.77	1390	3.5	5.64	25.5	
5/8/2008	11:19	122	2.02	6.77	1420	2.3	5.91	25.9	
5/16/2008	14:19	123	2.59	6.74	1370	6	6.78	26.5	
5/23/2008	10:20	123	2.57	6.66	1390	0.6	5.72	27.5	
5/30/2008	14:53	122	1.91	6.61	1480	0.7	6.28	27.3	
6/6/2008	11:00	120	2.67	6.56	1380	0.2	6.20	28.1	
6/11/2008	11:10	117	2.74	6.72	1360	0.2	6.12	28	

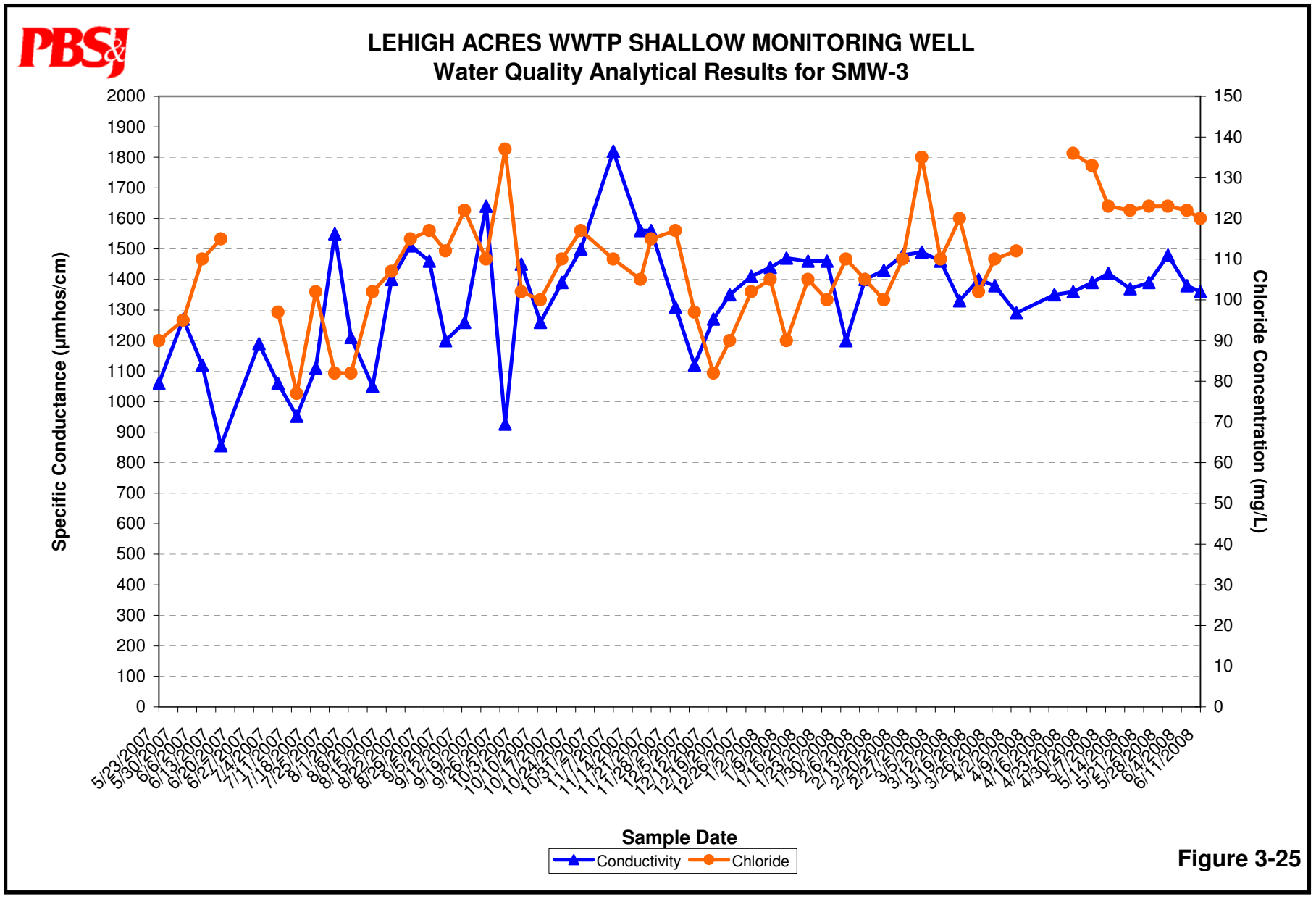

LEHIGH ACRES WWTP SHALLOW MONITORING WELL
Water Quality Analytical Results for SMW-3
Specific Conductance (µmhos/cm)
Chloride Concentration (mg/L)
Sample Date
Conductivity
Chloride

Figure 3-25

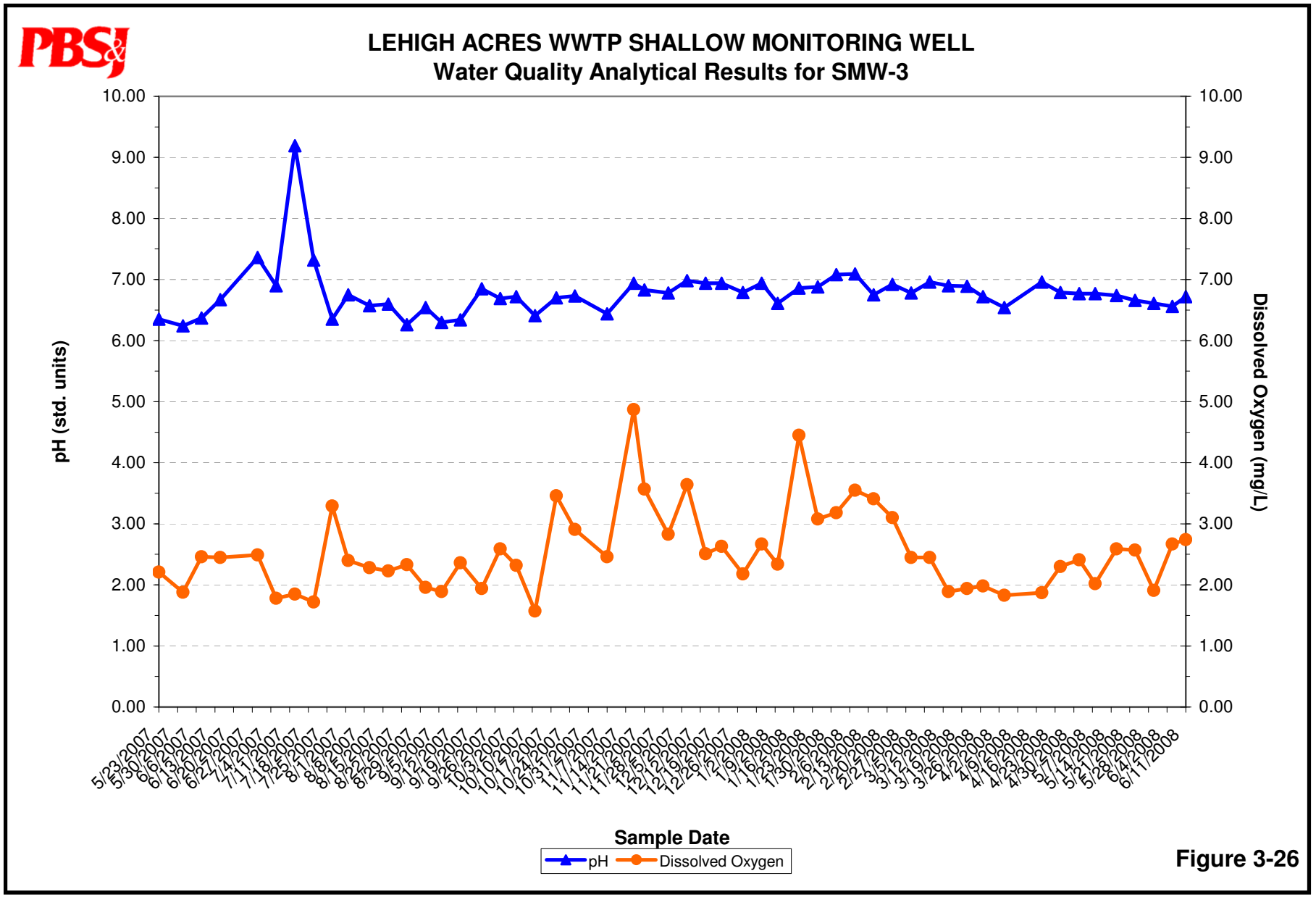

LEHIGH ACRES WWTP SHALLOW MONITORING WELL
Water Quality Analytical Results for SMW-3
pH (std. units)
Dissolved Oxygen (mg/L)
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
5/23/2007
5/30/2007
6/6/2007
6/13/2007
6/20/2007
6/27/2007
7/4/2007
7/11/2007
7/18/2007
7/25/2007
8/1/2007
8/8/2007
8/15/2007
8/22/2007
8/29/2007
9/5/2007
9/12/2007
9/19/2007
9/26/2007
10/3/2007
10/10/2007
10/17/2007
10/24/2007
10/31/2007
11/7/2007
11/14/2007
11/21/2007
11/28/2007
12/5/2007
12/12/2007
12/19/2007
12/26/2007
1/2/2008
1/9/2008
1/16/2008
1/23/2008
1/30/2008
2/6/2008
2/13/2008
2/20/2008
2/27/2008
3/5/2008
3/12/2008
3/19/2008
3/26/2008
4/2/2008
4/9/2008
4/16/2008
4/23/2008
4/30/2008
5/7/2008
5/14/2008
5/21/2008
5/28/2008
6/4/2008
6/11/2008
Sample Date
pH
Dissolved Oxygen

Figure 3-26

Florida Governmental Utility Authority
Lehigh Acres WWTP Class I Deep Injection Well
Shallow Water Table Monitoring Well

Analyses conducted by Sanders Laboratories, Inc.

TABLE 3-7
WATER TABLE WELL MONITORING DATA SMW-4

LABORATORY ANALYSIS RESULTS								
Date	Time	Chloride (mg/L)	D.O. (mg/L)	pH (S.U.)	Specific Conductivity (µmhos/cm)	Turbidity (NTU)	Depth to Water (ft)	Temp. (C°)
5/23/2007	16:00	105	2.14	6.37	1080	12.8	9.15	26.1
6/1/2007	12:50	115	1.87	6.23	1280	0.7	8.84	25.3
6/8/2007	13:04	100	2.04	6.37	1130	0.5	9.17	26.1
6/15/2007	12:20	115	2.40	6.60	1050	1.6	9.21	26.6
6/22/2007	10:05	105	1.78	7.05	1160	1.6	8.52	26.3
6/29/2007	11:35	117	2.69	7.32	1210	2.5	8.70	26.7
7/6/2007	9:25	110	1.31	6.86	1120	1.0	7.68	26.6
7/13/2007	10:55	117	1.81	7.01	1180	7.2	7.35	26.6
7/20/2007	10:55	110	1.96	6.76	1250	2.2	7.36	27.1
7/27/2007	13:50	107	2.11	6.03	1500	2.4	7.19	27.4
8/2/2007	15:31	117	2.43	6.46	1160	1.2	7.19	27.0
8/10/2007	13:30	112	2.12	6.67	1390	13.1	7.21	27.3
8/17/2007	10:15	132	2.27	6.33	1340	2.1	7.48	27.2
8/24/2007	8:31	120	1.95	5.89	1390	1.0	7.41	27.0
8/31/2007	10:20	120	1.99	6.34	1320	1.0	7.03	27.4
9/6/2007	14:35	120	1.99	6.61	1060	0.6	6.72	27.5
9/13/2007	14:19	120	2.21	6.21	1070	0.9	7.88	28.2
9/21/2007	13:50	122	1.41	6.85	1330	0.4	7.01	28.1
9/28/2007	13:44	117	1.71	6.81	800	1.6	6.78	28.0
10/4/2007	17:21	117	1.91	6.83	1180	1.2	7.09	28.1
10/14/2007								
10/19/2007	14:16	130	3.03	6.70	1240	2.5	7.72	28.8
10/26/2007	13:39	117	2.94	6.81	1380	1.5	7.66	28.0
11/7/2007	8:21	120	2.54	6.18	1680	8.6	8.06	26.9
11/17/2007	11:17	125	4.60	6.91	1460	4.5	8.15	27.2
11/21/2007	12:21	117	3.63	6.86	1470	2.0	8.10	27.1
11/30/2007	15:50	127	3.19	6.79	1510	2.1	7.89	26.8
12/7/2007	14:46	115	2.34	6.80	1520	3.5	8.08	26.8
12/14/2007	14:11	127	1.92	6.82	1530	3.5	8.11	26.9
12/20/2007	10:39	127	2.00	6.80	1530	2.8	8.28	26.6
12/28/2007	10:03	135	1.83	6.76	1540	5.0	8.19	26.4
1/4/2008	15:08	125	2.74	6.92	1540	6.3	8.28	25.2
1/10/2008	11:00	130	2.71	6.64	1540	5.4	8.69	26.3
1/18/2008	13:15	120	4.98	6.79	1540	10.4	8.75	26.3
1/25/2008	13:57	120	2.99	6.79	1530	3.6	10.65	25.8
2/1/2008	15:00	130	2.79	6.98	1320	2.9	8.89	25.7
2/8/2008	11:42	115	3.35	6.84	1520	5.6	9.11	26.1
2/15/2008	11:34	110	3.92	6.58	1500	3.4	8.96	25.5
2/22/2008	8:18	112	2.74	6.73	1540	7	8.94	25.4
2/29/2008	13:37	112	2.72	6.82	1560	4.9	9.68	25.2
3/7/2008	12:35	122	2.92	6.84	1520	0.2	8.38	25.8
3/14/2008	13:11	122	1.75	6.79	1530	1.6	8.60	25.6
3/21/2008	14:12	127	1.77	6.95	1540	0.8	8.28	25.6
3/27/2008	12:09	125	2.84	6.71	1520	2.5	8.48	25.7
4/4/2008	13:38	135	1.81	6.39	1510	1	8.02	26.1
4/13/2008	10:42	188	1.74	6.68	1620	2.3	7.94	26.2
4/18/2008	12:05	195	1.70	6.78	1710	1.1	8.09	26.1
4/25/2008	12:50	147	1.86	6.66	1580	4.2	8.46	26.0
5/2/2008	14:03	168	2.21	6.65	1610	3.1	8.31	26.4
5/8/2008	10:07	160	2.36	6.65	1630	1.4	8.39	26.4
5/16/2008	13:57	163	2.48	6.67	1550	3.1	8.47	26.8
5/23/2008	9:50	155	2.96	6.55	1540	1.9	8.30	27.1
5/30/2008	14:32	155	2.13	6.57	1600	0.5	8.86	27.3
6/6/2008	10:30	147	2.86	6.40	1480	0.4	8.71	27.7
6/11/2008	10:35	139	2.71	6.57	1470	0.2	8.72	27.6

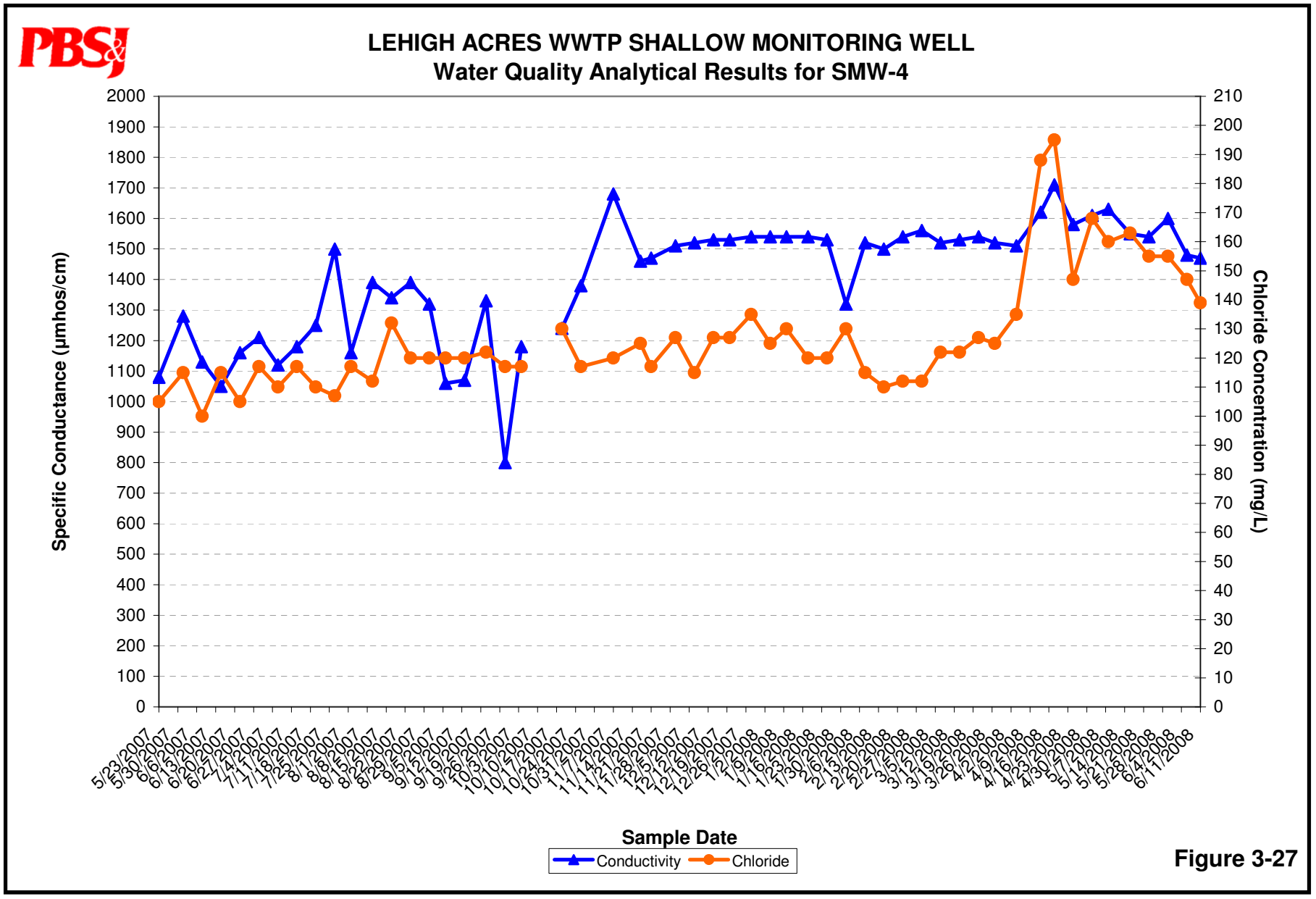

LEHIGH ACRES WWTP SHALLOW MONITORING WELL
Water Quality Analytical Results for SMW-4
Specific Conductance (µmhos/cm)
Chloride Concentration (mg/L)
Sample Date
Conductivity
Chloride

Figure 3-27

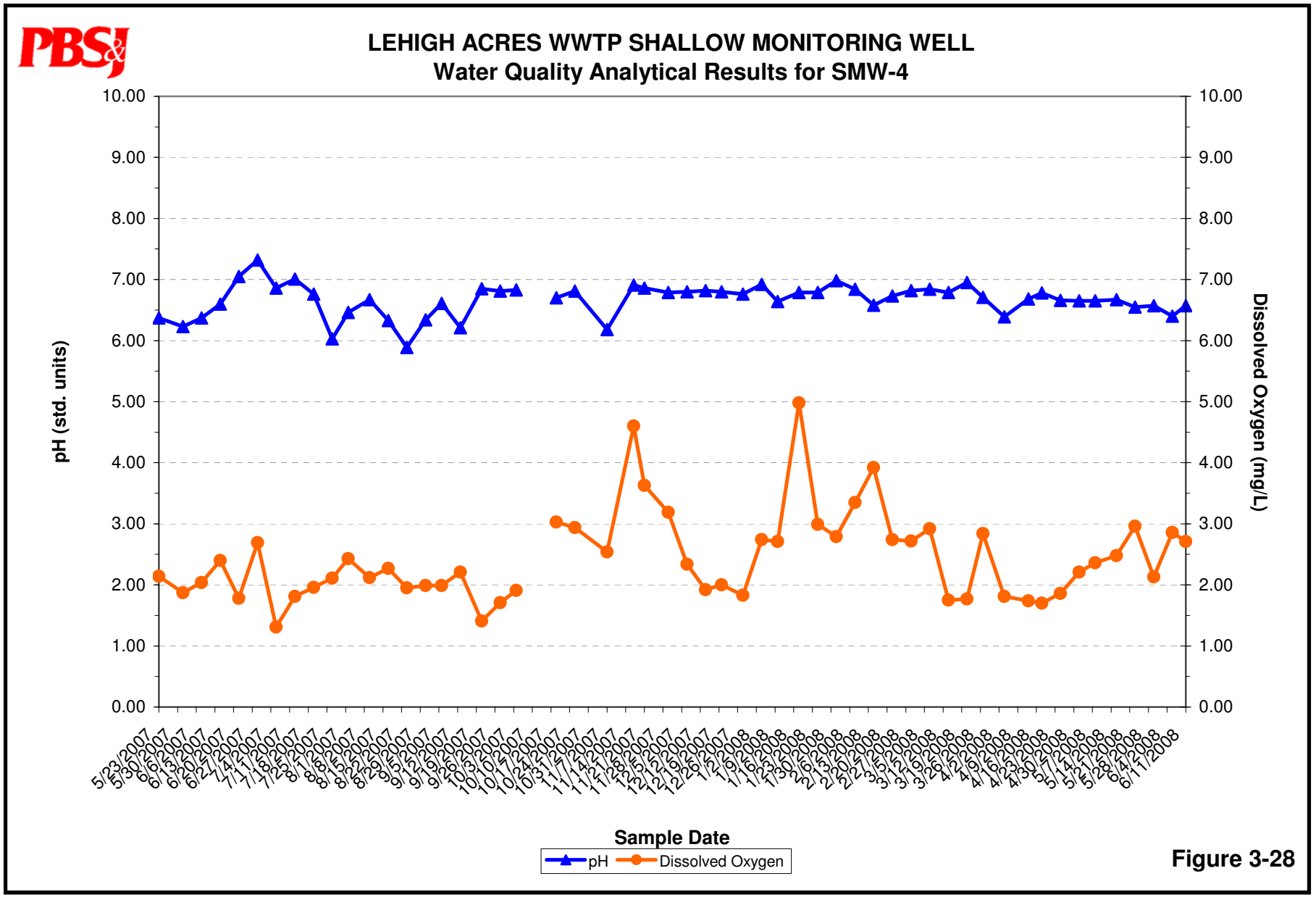

LEHIGH ACRES WWTP SHALLOW MONITORING WELL
Water Quality Analytical Results for SMW-4
pH (std. units)
Dissolved Oxygen (mg/L)
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
5/23/2007
5/30/2007
6/6/2007
6/13/2007
6/20/2007
6/27/2007
7/4/2007
7/11/2007
7/18/2007
7/25/2007
8/1/2007
8/8/2007
8/15/2007
8/22/2007
8/29/2007
9/5/2007
9/12/2007
9/19/2007
9/26/2007
10/3/2007
10/10/2007
10/17/2007
10/24/2007
10/31/2007
11/7/2007
11/14/2007
11/21/2007
11/28/2007
12/5/2007
12/12/2007
12/19/2007
12/26/2007
1/2/2008
1/9/2008
1/16/2008
1/23/2008
1/30/2008
2/6/2008
2/13/2008
2/20/2008
2/27/2008
3/5/2008
3/12/2008
3/19/2008
3/26/2008
4/2/2008
4/9/2008
4/16/2008
4/23/2008
4/30/2008
5/7/2008
5/14/2008
5/21/2008
5/28/2008
6/4/2008
6/11/2008
Sample Date
pH
Dissolved Oxygen

Figure 3-28

3.5.2. Airlift Water Quality Samples

During the reverse-air drilling phase of the LZMW-1B and the DIW-1, water samples were collected at approximately every 60 feet. These samples were collected to provide indicators of water quality changes at depth during drilling activities and to help identify the base of the USDW (10,000 mg/L TDS interface). The samples were collected by the contractor in two, 1-liter bottles and labeled with the well ID, depth, date and collection time. Samples were submitted to PBS&J personnel for field testing of conductivity, total dissolved solids, salinity and temperature with a HACH field instrument. The duplicate samples were submitted to Sanders Laboratories in Ft Myers, Florida for analysis of chloride, conductivity, pH, sulfate and total dissolved solids. Copies of the laboratory reports for both wells are included in **Appendices M** and **N**, respectively.

3.5.2.1. LZMW-1B Airlift Samples

Due to the drilling technique of recirculating discharge water back to the well and as the open-hole section of the pilot hole, airlift water quality results at specific depths are not considered very accurate; however, relative changes in water quality with depth were used in evaluating changes in formation hydraulic capacity and groundwater quality. Field and laboratory results (**Tables 3-8** and **3-9)** for the LZMW-1B indicate little change in conductivity, TDS and chloride concentrations between the approximate depths of 1,217 and 1,637 feet below land surface, which indicates little flow combined with little change in ambient groundwater quality. Airlift samples indicate moderate increases in chloride, conductivity and TDS concentrations below 1,700 feet, which correlate to the ocurance of the base of the USDW.

3.5.2.2. UZMW-1 Airlift Samples

Water quality and specific capacity testing were not available at the UZMW-1 due to the unique formation restrictions. After the intermediate casing as seated at approximately 680 feet the pilot hole was advanced to approximately 780 feet, where a sand formation was encountered. The heaving sand prevented the advancement of the drill bit deeper than 816 feet while drilling utilizing the reverse-air method. The decision was made with concurrence by the TAC members to resume mud rotary drilling to the total depth of the well followed by the installation of the final 6-inch casing. All water quality and specific capacity data for the upper monitoring interval were collected in the LZMW-1B pilot hole.

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Florida Governmental Utility Authority
Lehigh Acres WWTP Class I Deep Injection Well
Lower Zone Monitoring Well LZMW-1B

TABLE 3-8
AIRLIFT WATER QUALITY FIELD RESULTS - LZMW-1B

FIELD RESULTS						
Date	**Time**	**Depth (ft bls)**	**Conductivity (µS/cm)**	**TDS (mg/L)**	**Temp (°C)**	**Sal (‰)**
8/14/2007	0:30	1217	696	339	29.6	0.30
8/14/2007	2:25	1277	882	432	29.3	0.40
8/14/2007	4:30	1337	854	418	29.3	0.40
8/14/2007	6:15	1397	896	438	29.1	0.40
8/14/2007	9:15	1457	901	441	22.2**	0.40
8/14/2007	11:49	1517	1033	508	27.7	0.50
8/14/2007	14:00	1577	1100	542	28.9	0.50
8/15/2007	13:15	1637	1096	539	30.1	0.50
8/15/2007	16:13	1697	1038	510	29.1	0.50
8/15/2007	19:15	1757	1062	522	29.5	0.50
8/15/2007	22:45	1817	1110	546	28.2	0.50
8/16/2007	3:07	1877	1381	684	28.4	0.70
8/16/2007	0:00	1907	1641	818	27.6	0.80

Notes:
The specific capacity tests were conducted under artisian conditions, therefore, no airlift was use
** Sample was refrigerated following the sample collection.

Florida Governmental Utility Authority
Lehigh Acres WWTP Class I Deep Injection Well
Lower Zone Monitoring Well 1-B

TABLE 3-9
AIRLIFT WATER QUALITY LABORATORY RESULTS - LZMW-1B

LABORATORY RESULTS								
Site	Depth (ft)	Date	Time	Chloride (mg/L)	pH (s.u.)	Specific Conductivity (µmhos/cm)	Sulfate (mg/L)	Total Dissolved Solids (mg/L)
LZMW1B-1217	1217	8/14/2007	0:30	62	10.84	704	40	300
LZMW1B-1277	1277	8/14/2007	2:25	65	11.12	840	45	332
LZMW1B-1337	1337	8/14/2007	4:30	65	11.14	883	47	316
LZMW1B-1397	1397	8/14/2007	6:15	65	11.18	920	53	328
LZMW1B-1457	1457	8/14/2007	9:15	82	11.17	904	72	320
LZMW1B-1517	1517	8/14/2007	11:47	55	11.32	1060	87	424
LZMW1B-1577	1577	8/14/2007	14:00	72	11.31	1120	95	400
LZMW1B-1637	1637	8/15/2007	13:05	167	10.85	1110	149	564
LZMW1B-1697	1697	8/15/2007	16:10	160	10.71	1050	157	548
LZMW1B-1757	1757	8/15/2007	19:15	180	10.58	1060	171	552
LZMW1B-1817	1817	8/15/2007	22:45	185	9.92	1100	165	844
LZMW1B-1847	1847	8/16/2007	0:20	220	9.37	1190	227	1730
LZMW1B-1877	1877	8/16/2007	3:07	250	9.34	1380	238	1460
LZMW1B-1907	1907	8/16/2007	4:50	360	9.06	1650	193	1130

Notes:
The groundwater samples were analyzed by Sanders Laboratories, Inc.

3.5.2.3. DIW-1 Airlift Samples

Airlift water quality results (**Tables 3-10** and **3-11)** were obtained from the DIW-1 below an approximate depth of 1,240 feet after the switch to reverse-air drilling was made. For the reasons discussed in **Section 3.5.2.1**, specific airlift sample results are not considered to be very reliable as compared to packer test water samples. Very little formation water was generated from the pilot hole following installation of the intermediate casing (at an approximate depth of 1,180 feet below land surface) until approximately 1,800 feet bls where water quality results showed degradation occurring. TDS concentration increased sharply below 1,800 feet bls with a value of 25,800mg/L measured at 2,015 feet. Below this depth, TDS concentrations were above 25,000 mg/L to the bottom of the pilot hole except for the suspect sample of 2,095 feet.

Throughout the injection zone (2,370 to 3,200 feet), the conductivity, TDS and chloride concentrations averaged 55,427uS/cm, 31,853 mg/L and 19,967 mg/L respectively.

3.5.3. Packer Test Water Quality Samples

3.5.3.1. LZMW-1B Packer Water Quality

Water samples collected from packer tests completed on the LZMW-1B and the DIW-1 were submitted to PBS&J personnel for field testing in conjunction with duplicate samples submitted by the Contractor to Sanders Laboratories for analysis of ammonia, conductivity, total Kjeldahl nitrogen, TDS, chloride, sulfate and pH. **Tables 3-12** and **3-13** summarize the results from the LZMW-1B packer tests. The isolated zone during each packer test was thoroughly developed with a minimum of three borehole volumes pumped prior to initiating the test, thus resulting in discharge water samples that were more representative of the isolated formation.

The discharge sample collected at the end of Packer Test 1 indicated that the TDS concentration was 34,400 mg/L for the interval between approximately 1,788 and 1,907 feet below land surface. Packer Test 2 was conducted across the interval approximately between 1,693 and 1,753 feet below land surface and contained TDS concentrations of 15,400 mg/L.

Packer Test 3 was performed across the interval between approximately 1,613 and 1,673 feet below land surface and contained a TDS concentration of 3,460 mg/L. On the basis of Packer Tests 2 and 3, the base of the USDW was estimated at approximately 1,700 feet.

Packer Test 4 was conducted in order to confirm a proposed monitoring zone for the UZMW-1. Packer tests were not conducted in UZMW-1 due to the use of mud rotary drilling during the construction of the well. Packer Test 4 was performed across the

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Florida Governmental Utility Authority
Lehigh Acres WWTP Class I Deep Injection Well
Deep Injection Well DIW-1

TABLE 3-10
AIRLIFT WATER QUALITY FIELD RESULTS - DIW-1

FIELD RESULTS						
Date	Time	Depth (ft bls)	Conductivity (µS/cm)	TDS (mg/L)	Temp (°C)	Sal (‰)
12/13/2007	18:30	1,240	944	472	28.8	0.50
12/14/2007	0:30	1,300	735	368	27.0	0.40
12/14/2007	13:12	1,360	822	411	29.8	0.40
12/14/2007	15:30	1,420	765	382	29.3	0.40
12/14/2007	21:00	1,480	801	400	24.6	0.40
12/15/2007	2:00	1,540	782	391	25.2	0.40
12/15/2007	6:00	1,600	837	419	25.8	0.40
12/15/2007	9:04	1,660	802	401	26.6	0.40
12/15/2007	14:02	1,720	978	489	26.9	0.50
12/15/2007	21:45	1,780	1,229	614	25.5	0.60
12/16/2007	4:10	1,810	7,220	3,610	30.6	4.00
12/16/2007	5:00	1,810	8,950	4,470	31.0	5.00
1/8/2008	9:44	1,830	4,320	2,160	24.2	2.30
1/8/2008	16:22	1,890	6,120	3,060	26.3	3.30
1/9/2008	0:46	1,950	7,880	3,940	30.4	4.30
1/12/2008	6:30	2,015	41,000	20,500	22.8	26.20
1/13/2008	15:32	2,095	22,400	11,180	27.1	13.50
1/14/2008	16:59	2,135	43,300	21,700	27.9	27.90
1/15/2008	2:25	2,157	51,200	25,600	29.9	33.60
1/16/2008	16:19	2,217	50,600	25,300	26.9	33.20
1/16/2008	22:15	2,255	51,800	25,900	28.9	34.10
1/17/2008	11:49	2,315	52,300	26,100	26.4	34.40
1/19/2008	0:20	2,377	50,900	25,500	27.9	33.40
1/19/2008	14:27	2,437	51,000	25,500	29.2	33.50
1/20/2008	8:14	2,497	52,600	26,300	22.3	34.60
1/20/2008	11:56	2,557	53,200	26,600	26.0	35.10
1/20/2008	17:08	2,617	52,800	26,400	23.5	34.80
1/20/2008	23:40	2,677	52,800	26,400	25.4	34.80
1/21/2008	16:20	2,737	53,100	26,500	20.3	34.90
1/22/2008	16:40	2,797	53,000	26,500	26.4	35.00

Florida Governmental Utility Authority
Lehigh Acres WWTP Class I Deep Injection Well
Deep Injection Well DIW-1

TABLE 3-10
AIRLIFT WATER QUALITY FIELD RESULTS - DIW-1

FIELD RESULTS						
Date	**Time**	**Depth (ft bls)**	**Conductivity (µS/cm)**	**TDS (mg/L)**	**Temp (°C)**	**Sal (‰)**
1/24/2008	22:00	2,877	53,000	26,500	29.4	34.90
1/25/2008	7:30	2,917	54,100	27,100	25.8	35.80
1/25/2008	21:30	2,977	54,100	27,100	30.9	35.80
1/26/2008	14:15	3,037	54,500	27,200	25.8	36.00
1/28/2008	2:00	3,097	54,600	27,300	30.3	36.20
1/29/2008	1:00	3,157	56,800	28,400	36.7	10.20
1/29/2008	18:00	3,198	57,700	28,800	38.5	29.30

Notes:
Samples were refrigerated following the sample collection.

Florida Governmental Utility Authority
Lehigh Acres WWTP Class I Deep Injection Well
Deep Injection Well Airlift Samples Collected During Specific Capacity Tests

TABLE 3-11
AIRLIFT WATER QUALITY LABORATORY RESULTS - DIW-1

LABORATORY RESULTS								
Site	Depth (ft)	Date	Time	Chloride (mg/L)	pH (s.u.)	Specific Conductivity (µmhos/cm)	Sulfate (mg/L)	Total Dissolved Solids (mg/L)
DIW1-1240	1,240	12/13/2007	18:30	90	7.83	1040	620	1060
DIW1-1300	1,300	12/14/2007	0:30	95	8.11	702	426	860
DIW1-1360	1,360	12/14/2007	13:12	85	8.00	724	425	640
DIW1-1420	1,420	12/14/2007	15:30	80	7.95	703	474	780
DIW1-1480	1,480	12/14/2007	21:00	60	8.07	729	156	1060
DIW1-1540	1,540	12/15/2007	2:00	95	8.23	716	466	1100
DIW1-1600	1,600	12/15/2007	6:00	100	8.18	712	450	960
DIW1-1660	1,660	12/15/2007	9:04	115	8.24	733	517	900
DIW1-1720	1,720	12/15/2007	13:50	125	8.09	931	460	700
DIW1-1780	1,780	12/15/2007	21:45	175	8.09	1090	212	840
DIWI-1810	1,810	12/16/2007	4:10	2,150	7.36	6550	532	3,820
DIW1-1830	1,830	1/8/2008	9:44	1,000	11.25	3,970	316	2,290
DIW1-1890	1,890	1/8/2008	16:22	1,650	10.58	6,180	502	3,430
DIWI-1950	1,950	1/9/2008	0:46	2,500	9.24	8,030	562	4,440
DIW1-2015	2,015	1/12/2008	6:30	15,200	7.97	42,000	2510	25800
DIW1-2095	2,095	1/13/2008	15:32	7800	8.00	22000	1350	11000
DIW1-2135	2,135	1/14/2008	16:59	16200	7.79	43800	2410	26600
DIW1-2157	2,157	1/15/2008	2:25	19500	7.68	51700	3070	27800
DIW1-2217	2,217	1/16/2008	16:19	18700	7.63	53400	3210	29400
DIW1-2255	2,255	1/16/2008	22:15	19500	7.61	56500	3150	30800
DIW1-2317	2,315	1/18/2008	11:49	20000	7.62	56500	3150	30300
DIW1-2377	2,377	1/19/2008	12:20	20000	7.56	56500	3860	32800
DIW1-2437	2,437	1/19/2008	14:27	19000	7.56	56800	3100	30700
DIW1-2497	2,497	1/20/2008	8:14	19000	7.50	57100	3070	30800
DIW1-2557	2,557	1/20/2008	11:56	19500	7.44	56300	3400	30600
DIW1-2617	2,617	1/20/2008	17:08	23000	7.45	56500	3540	31400
DIW1-2677	2,677	1/20/2008	23:40	20500	7.48	55000	3410	31300
DIW1-2737	2,737	1/21/2008	16:20	20000	7.36	53400	2990	31700
DIW1-2797	2,797	1/22/2008	16:40	18500	7.65	53800	3400	30300
DIW1-2857	2,877	1/24/2008	22:00	20500	7.65	52900	3100	31400
DIW1-2917	2,917	1/25/2008	7:30	20500	7.56	54000	3100	30900
DIW1-2977	2,977	1/25/2008	21:30	18000	7.65	53900	3450	32600
DIW1-3037	3,037	1/26/2008	14:15	20500	7.71	55000	3100	31800
DIW1-3097	3,097	1/27/2008	2:00	20000	7.62	55100	2980	32500
DIW1-3157	3,157	1/29/2008	1:00	20000	7.59	57100	3040	33800
DIW1-3197	3,197	1/29/2008	18:02	20500	7.57	58000	3060	35200

Notes:
The groundwater samples were analyzed by Sanders Laboratories, Inc.

TABLE 3-12
PACKER TEST FIELD WATER QUALITY RESULTS - LZMW-1B

Date	Test #	Interval (ft bls)	Conductivity (µS/cm)	TDS (mg/L)	Salinity (SIU)	Temp (C)
8/18/2007	1	1788-1907	46500	29000	30.3	32.4
8/19/2007	2	1753-1693	21300	12320	12.8	32.0
8/20/2007	3	1673-1613	6250	3310	3.4	31.4
8/21/2007	4	1583-1523	3480	1793	1.8	33.0

Florida Governmental Utility Authority
Lehigh Acres WWTP Class I Deep Injection Well
Lower Zone Monitoring Well LZMW-1B

TABLE 3-13
PACKER TEST LABORATORY WATER QUALITY RESULTS - LZMW-1B

Date	Test #	Interval (ft bls)	Ammonia (mg/L as N)	Chloride (mg/L)	Conductivity (µS/cm)	Total N (mg/L of N)	pH (SU)	Sulfate (mg/L)	TDS (mg/L)
8/18/2007	1	1788-1907	0.37	20,000	46,800	1.14	7.27	2,290	34,400
8/19/2007	2	1753-1693	0.71	8,750	21,500	1.00	7.37	609	15,400
8/20/2007	3	1673-1613	0.46	2,130	5,360	0.60	8.05	426	3,460
8/21/2007	4	1583-1523	0.39	1,230	4,050	0.53	7.96	466	2,330

interval from approximately 1,523 to 1,583 feet with a TDS concentration 2,330 mg/L, demonstrating that the proposed monitoring interval for UZMW-1 was located above the base of the USDW. A copy of the laboratory report for the LZMW-1B packer tests is included in **Appendix J**.

3.5.3.2. DIW-1 Packer Water Quality

Tables 3-14 and **3-15** summarize the laboratory water quality results from the DIW-1 packer tests, of which the first three tests were performed in the formations (approximately 1,885 to 2,088 feet, comprising the confining unit) above the injection zone and the fourth test (approximately 2,130 to 2,230 feet) included more permeable units overlying the top of the injection zone. Packer test results indicate a degrading formation water quality with increasing depth. TDS concentrations are 28,900 mg/L from the first packer test and increase to 30,700 mg/L from the fourth packer test. Water quality data from the packer tests confirm that the formation water quality in the injection zone is significantly different (poorer) than the formation water quality in the lower monitoring zone and this difference likely reflects the good confining characteristics of the rock vertically separating the two zones. A copy of the laboratory report for the DIW-1 packer tests is included in **Appendix K**.

3.5.4. Background Water Quality Conditions

Following installation of the final casing at the monitor wells and the final casing at the injection well, background water quality conditions were established for LZMW-1B, DIW-1, and UZMW-1. The open borehole interval at each well was pumped as part of well development until the discharge water was free and clear of sediment and a minimum of three well volumes had been removed from each well. Immediately following the completion of the well development procedures, a submersible pump was utilized by Sanders Laboratories personnel in order to draw a representative discharge water sample from each well. Each representative water sample was transferred to labeled sample bottles and transported by laboratory personnel to Sanders Laboratories for analyses. The LZMW-1B and UZMW-1 were sampled on September 27, 2007, and DIW-1 was sampled on March 25, 2008.

All background water samples were analyzed for Primary and Secondary Drinking Water Standards. **Table 3-16** presents a comparison of the background water samples with the maximum contaminant limits (MCLs) of the drinking water standards. The Primary standard exceedance at all three wells was Sodium. Antimony, Nickel, Radium 226, and Gross Alpha at DIW-1; Barium at UZMW-1; Tetrachloroethene (TCE) at LZMW-1B; and Lead at both UZMW-1 and LZMW-1B. Secondary standard exceedances in all three wells were detected for chloride, sulfate, total dissolved solids, manganese and iron; color in LZMW-1B; and aluminum and foaming agents in UZMW-

TABLE 3-14
PACKER TEST FIELD WATER QUALITY RESULTS - DIW-1

Date	Test #	Interval (ft bls)	Conductivity (µS/cm)	TDS (mg/L)	Salinity (SIU)	Temp (C)
2/3/2008	1	1940-1970	49400	24700	32.3	26
2/4/2008	2	1885-1915	45000	22500	29.1	29.0
2/5/2008	3	1990-2088	52400	26200	34.5	29.4
2/5/2008	4	2130-2230	53900	26900	35.6	30.8

TABLE 3-15
PACKER TEST LABORATORY WATER QUALITY RESULTS - DIW-1

Date	Test #	Interval (ft bls)	Ammonia (mg/L as N)	Chloride (mg/L)	Conductivity (µS/cm)	Total N (mg/L of N)	pH (SU)	Sulfate (mg/L)	TDS (mg/L)
2/3/2008	1	1940-1970	0.09	18,500	51,100	0.30	7.40	2,600	28,900
2/4/2008	2	1885-1915	0.08	16,600	45,600	0.36	7.34	2,800	25,100
2/5/2008	3	1990-2088	0.10	19,200	56,700	0.31	7.29	2,400	30,300
2/5/2008	4	2130-2230	0.23	18,500	53,600	0.37	7.25	3420	30,700

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Analyses conducted by Sanders Laboratories, Inc.

TABLE 3-16
PRIMARY and SECONDARY DRINKING WATER ANALYSES of BACKGROUND WATER SAMPLES

Primary Drinking Water Standards: Inorganics				
Parameter	**MCL**	**UZMW-1 09/27/07**	**LZMW-1B 09/27/07**	**DIW-1 3/36/08**
Antimony	0.006	<0.002	<0.002	**0.006**
Arsenic	0.05	0.003	0.003	<0.002
Barium	2.0	**2.65**	0.852	0.039
Beryllium	0.004	<0.0005	<0.0001	<0.0001
Cadmium	0.005	<0.001	<0.001	<0.001
Chromium	0.10	0.004	<0.001	<0.01
Cyanide	0.20	<0.005	<0.005	<0.005
Fluoride	4.0	2.6	0.9	0.88
Lead	0.015	**0.021**	**0.034**	0.008
Mercury	0.002	<0.001	<0.001	<0.001
Nickel	0.1	0.002	<0.001	**0.01**
Nitrate (as N)	10.0	<0.01	<0.01	<0.01
Nitrite (as N)	1.0	<0.01	<0.01	0.02
Selenium	0.05	<0.002	<0.002	<0.002
Sodium	160	**613**	**8,040**	**12,000**
Thallium	0.002	<0.001	<0.001	<0.0012
Primary Drinking Water Standards: Organics				
Parameter	**MCL**	**UZMW-1B 09/27/07**	**LZMW-1 09/27/07**	**DIW-1 3/36/08**
1,1,1-Trichloroethane	0.2	<0.0003	<0.0003	<0.00021
1,1,2-Trichloroethane	0.005	<0.0003	<0.0003	<0.00044
1,1-Dichloroethene	0.007	<0.0005	<0.0005	<0.00023
1,2,4-Trichlorobenzene	0.07	<0.0005	<0.0005	<0.00041
1,2-Dichloropropane	0.005	<0.0003	<0.0003	<0.00021
2,4,5-TP (Silvex)	0.05	<0.00025	<0.00025	<0.00019
2,4-D	0.07	<0.001	<0.001	<0.00022
Alachlor	0.002	<0.0002	<0.0002	<0.00064
Atrazine	0.003	<0.00006	<0.00006	<0.00051
Benzene	0.001	<0.0005	<0.0005	<0.00020
Benzo(a)pyrene	0.0002	<0.0001	<0.0001	<0.000073
Carbofuran	0.04	<0.0005	<0.0005	<0.00041
Carbon Tetrachloride	0.003	<0.0003	<0.0003	<0.00024
Chlordane	0.002	<0.00005	<0.00005	<0.000012
Cis-1,2-Dichloroethene	0.07	<0.0002	<0.0002	<0.00021
Dalapon	0.2	<0.001	<0.001	<0.0023
Di(2-ethylhexyl)adipate	0.4	0.0005	<0.0003	<0.00071
Di(2-ethylhexyl)phthalate	0.006	<0.001	<0.001	<0.00089
Dibromochloropropane	0.0002	<0.000005	<0.000005	<0.0000034
Dichloromethane (Methylene Chloride)	0.005	<0.0005	<0.0005	<0.00023
Dinoseb	0.007	<0.0005	<0.0005	<0.00023
Diquat	0.02	<0.001	<0.001	<0.0019

TABLE 3-16
PRIMARY and SECONDARY DRINKING WATER ANALYSES of
BACKGROUND WATER SAMPLES

Endothall	0.1	<0.02	<0.02	<0.0028
Endrin	0.002	<0.0001	<0.0001	<0.000097
Ethylbenzene	0.7	<0.0005	<0.0005	<0.00021
Ethylene Dibromide	0.00002	<0.000005	<0.000005	***NA
Glyphosate (Roundup)	0.7	<0.01	<0.01	<0.013
Heptachlor	0.0004	<0.00008	<0.00008	<0.0000035
Heptachlor Epoxide	0.0002	<0.0001	<0.0001	<0.000026
Hexachlorobenzene	0.0001	<0.00005	<0.00005	<0.00032
Hexachlorocyclopentadiene	0.05	<0.0002	<0.0002	<0.00025
Lindane	0.0002	<0.00006	<0.00006	<0.00019
Methoxychlor	0.04	<0.00005	<0.00005	<0.000042
Monochlorobenzene	0.1	<0.0005	<0.0005	***NA
Oxamyl (Vydate)	0.2	<0.0005	<0.0005	<0.00013
p-Dichlorobenzene (1,4-Dichlorobenzene)	0.075	<0.0005	<0.0005	<0.00023
Pentachlorophenol	0.001	<0.0001	<0.0001	<0.00039
Picloram	0.5	<0.00075	<0.00075	<0.00023
Polychlorinated Biphenyl (PCB)	0.0005	<0.0002	<0.0002	<0.00013
Simazine	0.004	<0.00007	<0.00007	<0.00066
Styrene	0.1	<0.0005	<0.0005	<0.00021
Tetrachloroethene	0.003	<0.0002	**0.0063**	<0.00024
Toxaphene	0.003	<0.0005	<0.0005	<0.00058
Trans-1,2-Dichloroethene	0.1	<0.0005	<0.0005	<0.00035
Trichloroethene	0.003	<0.0002	<0.0002	<0.00036
Vinyl Chloride	0.001	<0.0005	<0.0005	<0.00032
Xylenes (Total)	0.1	<0.0005	<0.0005	<0.00046
Primary Drinking Water Standards: Radionuclides				
Parameter	**MCL**	**UZMW-1B 09/27/07**	**LZMW-1 09/27/07**	**DIW-1 3/36/08**
Radium 226	5pCi/l	1.4+/-0.2	4.7+/-2.0	**7.1+/- 0.4**
Radium 228	5pCi/l	0.5 +/-0.2	0.6+/-0.2	0.5 +/-0.2
Gross Alpha	15pCi/l	7.3+/-2.2	0.6+/-0.3	**100+/-0.5**
Primary Drinking Water Standards: Microbiological				
Parameter	**MCL**	**UZMW-1B 09/27/07**	**LZMW-1 09/27/07**	**DIW-1 3/36/08**
Total Coliform	absence	**U**	**U**	**U**
Primary Drinking Water Standards: Disinfection Byproducts				
Parameter	**MCL**	**UZMW-1B 09/27/07**	**LZMW-1 09/27/07**	**DIW-1 3/36/08**
Total Trihalomethanes (TTHM)	0.08	<0.0002	<0.0002	0.0013
Haloacetic Acids Five (HAA5)	0.06	0.0001	0.0001	<0.00018
Chlorite		0.05	2.2	***NA
Secondary Drinking Water Standards				
Parameter	**MCL**	**UZMW-1B 09/27/07**	**LZMW-1 09/27/07**	**DIW-1 3/36/08**
Aluminum	0.2	**1.27**	0.118	<0.009
Chloride	250	**900**	**14,600**	**19,000**
Copper	1.0	<0.001	0.001	0.003

TABLE 3-16
PRIMARY and SECONDARY DRINKING WATER ANALYSES of
BACKGROUND WATER SAMPLES

Color	15 PCU	10	10	**15**
Foaming Agents	0.5	**0.6**	0.18	0.16
Iron	0.3	**1.75**	**0.472**	**3.05**
Manganese	0.05	**0.06**	**0.377**	**0.059**
Odor	3 TON	1	1	1
pH (at Collection Point)	6.5 - 8.5	7.18	6.96	***NA
Silver	0.1	0.006	<0.001	<0.001
Sulfate	250	**524**	**2,130**	**3,100**
Total Dissolved Solids (TDS)	500	**2,380**	**28,100**	**31,700**
Zinc	5.0	0.03	0.014	0.045
Minimum Criteria for Sewage Effluent				
Parameter	**MCL**	**UZMW-1B 09/27/07**	**LZMW-1 09/27/07**	**DIW-1 3/36/08**
Toluene		<0.0005	0.0012	<0.00022
1,2-Dichloroethane	0.003	<0.0002	<0.0002	<0.00029
o-Dichlorobenzene (1,2-Dichlorobenzene)	0.6	<0.0005	<0.0005	<0.00021
Ammonia-N		0.3	0.19	0.34
Nitrogen, Organic		<0.01	0.4	0.84
Nitrogen, Total		0.40	0.59	0.02
Nitrogen, Total Kjeldahl		0.40	0.59	0.89
Ortho-phosphate-P		0.029	0.017	0.017
Phosphorus, Total		0.172	0.088	0.061
Additional Parameters				
Parameters	**MCL**	**UZMW-1B 09/27/07**	**LZMW-1 09/27/07**	**DIW-1 3/36/08**
Disolved Oxygen (D.O.)		2.09	2.19	***NA
Carbonate Alkalinity		***NA	***NA	***NA
Chloroform		<0.0002	<0.0002	<0.00025
Uranium		NA	NA	0.2
Cryptosporidium		NA	NA	***NA
Giardia lamblia		NA	NA	***NA
E-Coli		NA	NA	***NA
Enterococcus, MF		NA	NA	***NA
Fecal Coliform, MF		NA	NA	***NA

Notes

1. Maximum Contaiminant Level (MCL) per Rules 62-550.310 and 62-550.320, FAC.
2. Concentrations expressed in milligrams/liter (mg/l) unless otherwise indicated
3. NA = not analyzed

* represents total coliform concentration in colony forming units
** represents Maximum Residual Disinfectant Level (MRDL)
*** represents no analysis performed by the lab

Abbreviations

BDL : Below Detection Limits. All detection limits below MCL's.
MFL: Million Fibers/Liter > 10 um.
NTU: Turbidity Units
PCU: Color Units
TON: Threshhold Odor Number
pCi/l: Picacurries/liter
TNTC: Too Numerous To Count
TS: Thief Sample
U: Tested for but Undecteced

1. The TCE detection in the water sample from LZMW-1B is at a low concentration and is likely related to drilling activities or sampling error. All of these exceedences, except TCE, are naturally occurring and reflect the degrading ambient groundwater. All the wells will be re-tested for background water quality before initiating the operational testing phase. All of the chemical analyses are included in the laboratory reports that are attached as **Appendix O**.

3.6. Geophysical Logging

A geophysical logging program was conducted throughout the construction of the injection well system. The logging program included collection of geophysical data for use in the interpretation of the hydrogeologic conditions beneath the site, identifying the depth of the USDW, and to aid in the estimation and verification of the construction details of the wells. YBI provided all geophysical logging services during construction activities.

3.6.1. LZMW-1B Logging Runs

The geophysical logging series conducted on the LZMW-1B consisted of 8 individual logging events that were performed during the course of well construction. Geophysical logging was completed on all pilot and reamed portions of the borehole in addition to selected stages of well construction. Logging operations in the 12.25-inch pilot hole were conducted primarily to verify hydrogeologic conditions and determine casing setting depths and packer test intervals. Logs conducted in the reamed portion of the borehole were primarily run to verify gauge of the borehole and estimate cement quantities. A summary of all geophysical logging of LZMW-1B is presented in **Table 3-17**. Copies of individual logs for LZMW-1B are included in **Appendix P**.

The first logging event (***LZMW-1B Run 1***) of the LZMW-1B followed the completion of the mud drilled, 12.25-inch pilot hole to 1,150 feet. Logging included a combination gamma ray and X-Y caliper logs, a borehole compensated sonic (BHC) and dual induction log. The gamma ray log clearly shows the base of the Hawthorne Group at about 670 feet by a reduction in the gamma counts, which is representative of the lower contact with the Suwannee Limestone. Two separate sand layers were encountered at approximately 780 feet bls and 1,080 feet bls, respectively. The caliper/gamma log shows little indication of the sand zone at 780 feet bls in the mudded borehole. The sand zone at 1,080 feet bls is marked by a gamma peak and slight opening of the hole diameter. The sonic log indicates that the most competent rock in the section is encountered below 900 feet. The dual induction log indicated a gradual decrease in fluid resistivity, which is attributed to the degrading formation water quality. Based on a review of the logs and the incidence of the heaving sand layers at 780 and 1,080 feet

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Lower Zone Monitoring Well

TABLE 3-17
GEOPHYSICAL LOGGING RUNS

LZMW-1B									
DATE		7-Aug-07	11-Aug-07	16-Aug-07	1-Sep-07	3-Sep-07	4-Sep-07	5-Sep-07	5-Sep-07
LOGGING RUNS		RUN-1	RUN-2	RUN-3	RUN-4	RUN-5-1	RUN-5-2	RUN-5-4	RUN-6
BOREHOLE		12.25-inch pilot	24-inch reamed	12.25-inch pilot	14-inch reamed	6-inch cased	6-inch cased	6-inch cased	6-inch cased
INTERVAL LOGGED	BEGIN (FT BLS)	0	0	0	0	0	0	0	0
	END (FT BLS)	1150	1150	1907	1905	1780	1780	1780	1780
LOGS CONDUCTED	GAMMA	X	X	X	X				
	CALIPER	X	X	X	X				
	DUAL INDUCTION	X		X					
	FLUID CONDUCTIVITY			X					
	LONG/SHORT RESISTIVITY			X					
	TEMPERATURE			X		X	X	X	
	FLOW METER			X					
	SONIC	X		X					
	LOG DERIVED TDS			X					
	CEMENT BOND LOG								X
	TELEVIEWER			X					
COMMENTS		Geologic confirmation of pilot	Indication of casing placement	Confirmation of pilot hole	Indication of casing placement	Confirmation of Cement Top	Confirmation of Cement Top	Confirmation of Cement Top	Confirmation of Cemented Annulus

bls, the 24-inch diameter Surface casing depth was selected at 1,150 feet in competent rock with in the upper portion of the Ocala Limestone.

LZMW-1B Run 2 was completed after the reaming operation for the installation of Surface casing and included a combination gamma ray and X-Y caliper logs to a depth of 1150 feet. These logs were used to verify borehole dimensions that may affect casing installation and to estimate cement quantities for grouting. The gamma ray log was essentially the same as that of LZMW-1B Run 1. The caliper log showed multiple washouts of the borehole while penetrating though the Upper Hawthorne Formation, from the base of the pit casing down to 240 feet. This washout is indicative of soft strata that were easily removed by the drill bit during the drilling process. The length of the borehole is relatively gauged (24 to 26-inch) below 240 feet, which indicates more competent strata, with the exception of the sand zones occurring at 780 and 1,080 feet bls. In the deeper sections of the borehole the caliper log shows the hole becoming more round and the gamma spikes decrease to a very low concentration of gamma ray radiation, all indicating more competent formation characteristics. Based upon these observations, the casing depth of 1,150 feet was confirmed.

LZMW-1B Run 3 was run on the 12.25-inch pilot hole from 0 to 1,907 feet. The logs included static X-Y caliper, gamma ray, BHC-sonic with log derived TDS, temperature, dual induction, lateral resistivity (LL3), spontaneous potential (SP), and televiewer. Under dynamic conditions the flowmeter, temperature, and fluid conductivity logs were conducted. These logs were utilized for confirmation of the pilot hole and the native formation conditions as well as later for indication of packer placement with in the pilot hole. Further these logs were used in conjunction with the packer test data to identify the depth of the USDW and select an upper monitoring zone of LZMW-1B.

An analysis of the sonic and resistivity logs by YBI was used to create the log derived TDS values for the logged interval. This analysis used porosity values derived from the sonic log to determine the formation factor F using Archie's second equation:

$$F = \frac{a}{\phi^m}$$

Where: a = a constant derived from core data

m = a constant derived from core data

ϕ = Porosity from sonic log

The resistivity of the formation water was derived using another Archie equation:

$$Rw = \frac{Ro}{F}$$

Where: Rw = resistivity of the formation water

Ro = resistivity value from deep induction log

F = Formation factor

Based on this analysis, the depth where the formation water becomes consistently greater than 10,000 mg/L TDS was determined to be approximately 1,700 feet. The geophysical logs and water quality data from packer tests were submitted to the TAC along with recommendations for the 6-inch final casing setting depth. Following review of the submittals and correspondence with the TAC, a 6-inch casing depth of approximately 1,800 feet was accepted by the TAC. The TAC also concurred with the identification of the base of the USDW at approximately 1,700 feet.

The combination gamma ray and X-Y caliper log was in part to verify an appropriate setting depth for the packer test of intervals. The borehole is gauge (14-inch hole) between approximately 1,523 and 1,788 feet, which is marked by both competent micritic limestone and weathered limestone. A borehole diameter between 13 and 15 inches at an approximate depth of 1,785 feet was selected for the depth to install the single inflatable packer (17-inch) proceeding packer test one. The X-Y caliper log was referenced throughout the decision making process for additional straddle packer placements utilized during packer tests 2 through 4

LZMW-1B Run 4 consists of a combination gamma ray and X-Y caliper log run to a depth of approximately 1,907 feet in preparation for installation and grouting of the 6-inch final casing to an approximate depth of 1,796 feet. It was used to estimate cement quantities and to identify potential problem areas in the reamed portion of borehole.

LZMW-1B Run 5 - Pass 1 consists of a temperature log run to verify cement coverage associated with the 6-inch casing. Pass 1 of the log was run to a depth of 1,780 feet after cementing stage 1 and shows the top of the cement at about 1,710 feet. The physical tag of the cement top was at 1,718 feet indicating a good correlation. The remaining portion of the casing was grouted to land surface in four additional cementing stages.

LZMW-1B Run 5 - Pass 2 consists of a temperature log run to verify cement coverage associated with the 6-inch casing. Pass 2 of the log was run to a depth of 1,780 feet after

cementing stage 2 and shows the top of the cement at about 1,225 feet. The physical tag of the cement top was at 1,263 feet indicating a good correlation.

LZMW-1B Run 5 - Pass 3 consists of a temperature log run to verify cement coverage associated with the 6-inch casing. Pass 3 of the log was run to a depth of 1,780 feet after cementing stage 3 and shows the top of the cement at about 860 feet. The physical tag of the cement top was at 781 feet indicating a good correlation.

LZMW-1B Run 5 - Pass 4 consists of a temperature log run to verify cement coverage associated with the 6-inch casing. Pass 4 of the log was run to a depth of 1,780 feet after cementing stage 4 and shows the top of the cement at about 342 feet. The physical tag of the cement top was at 188 feet indicating a poor correlation which could be attributed to the calibration of the tool and an inverse temperature gradient inside the well. The remaining portion of the casing was grouted to land surface in the fifth cementing stage.

LZMW-1B Run 6 consists of a cement bond log of the 6-inch FRP casing. The log shows excellent casing bond and dense cement throughout the entire length of cemented casing from 1,786 feet to the top of cement (at the time of log run) at a depth of 188 feet bls.

3.6.2. UZMW-1 Logging Runs

A total of six individual logging events were performed during the construction of UZMW-1 (**Table 3-18**). Copies of the geophysical logs are presented in **Appendix Q**. The first logging event (***UZMW-1 Run 1***) followed the completion of the mud drilled, 12.25-inch pilot hole to 750 feet. Logging included a combination gamma ray and X-Y caliper logs, BHC and dual induction. The UZMW-1 logs show very similar responses to the corresponding logs run for the LZMW-1B confirming the similar lithology and water quality encountered at the respective boreholes. Based on a review of the logs, the 16-inch diameter intermediate casing depth was selected at 680 feet in a competent rock upper portion of the Suwannee Limestone.

UZMW-1 Run 2 was completed after the reaming operation for the installation of surface casing and included a combination gamma ray and X-Y caliper logs to a depth of 698 feet. These logs were used to verify uniform borehole width that may affect casing installation and to estimate cement quantities for grouting. The gamma ray log was essentially the same as that of UZMW-1 Run 1. The caliper log showed multiple small washouts of the borehole from the base of the pit casing down to 300 feet. This washout is indicative of soft strata that were easily removed by the drill bit during the drilling process. The borehole is relatively gauge (23 to 24-inch) below 300 feet, which indicates more competent strata that is less likely to washout during drilling. Based upon this observation, the casing depth of 680 feet was confirmed.

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Upper Zone Monitoring Well

TABLE 3-18
GEOPHYSICAL LOGGING RUNS

UZMW-1									
DATE		5-Jun-07	9-Jun-07	10-Jun-07	18-Sep-07	20-Sep-07	21-Sep-07	22-Sep-07	23-Sep-07
LOGGING RUNS		RUN-1	RUN -2	RUN -3	RUN -5	RUN -6	RUN-7-1	RUN -7-2	RUN -7-3
BOREHOLE		12.25-inch pilot	24-inch reamed	16-inch cased	12.25-inch pilot	14-inch reamed	6-inch cased	6-inch cased	6-inch cased
INTERVAL LOGGED	BEGIN (FT BLS)	0	0	0	0	0	0	0	0
	END (FT BLS)	750	698	680	1578	1578	1490	1490	1490
LOGS CONDUCTED	GAMMA	X	X		X	X			
	CALIPER	X	X		X	X			
	DUAL INDUCTION	X			X				
	FLUID CONDUCTIVITY								
	LONG/SHORT RESISTIVITY								
	TEMPERATURE			X	X		X	X	X
	FLOW METER								
	SONIC	X			X				
	LOG DERIVED TDS				X				
	SECTOR BOND LOG								
	VIDEO								
COMMENTS		Geologic confirmation of pilot	Indication of casing placement	Cement Temperature Log	Confirmation of pilot hole	Indication of casing placement	Cement Temperature Log	Cement Temperature Log	Cement Temperature Log

UZMW-1 Run 3 included a temperature log run to verify cement coverage associated with the 16-inch casing. Temperature log was run to a depth of 680 feet after cementing stage 1 and shows the top of the cement at about 257 feet. The physical tag of the cement top was also at 257 feet indicating a good correlation. The cement was brought to land surface during cementing stage 2.

UZMW-1 Run 4 was run on the entire borehole, including the 16-inch casing from land surface to 680 feet, then continuing into the 12.25-inch pilot hole from 680 to 1,578 feet The logs included X-Y caliper, gamma ray, BHC-sonic, dual induction, lateral resistivity (LL3), spontaneous potential (SP) and log derived TDS. These logs were used in conjunction with the packer test data from LZMW-1B to confirm that the proposed monitoring zone (1,497 to 1,578 feet) of the UZMW-1 was above the base of the USDW and had sufficient hydraulic capacity to function as the upper monitoring zone. Based on the submitted test data, TAC approved the interval 1,496 to 1,578 feet (upper portion of the Avon Park) as the monitoring zone for the UZMW-1.

UZMW-1 Run 5 consists of a combination gamma ray and X-Y caliper log run to a depth of 1,578 feet in preparation for installation and grouting of the 6-inch final casing to 1,497 feet. It was used to estimate cement quantities and to identify potential problem areas in the reamed portion of borehole.

UZMW-1 Run 6 consists of two temperature logs run to verify cement coverage associated with the 6-inch casing. Temperature stage log #1 was run to a depth of 1,490 feet after cementing stage 2 and shows the top of the cement at about 1,315 feet which coincided with the physical tag of 1,330 feet in the annulus. Temperature log of the second stage was run to a depth of approximately 1,490 feet after cementing the third stage and indicated that the top of the cement was located at about 1,072 feet. The physical tag of the cement top was at 1,103 feet indicating a good correlation. Temperature log of the third stage was run to a depth of 1,490 feet after the fourth cementing stage and indicated the top of the cement at about 270 feet. The physical tag of the cement top was at 272 feet indicating a good correlation. The remaining portion of the casing was grouted to land surface in the fifth cementing stage.

3.6.3. DIW-1 Logging Runs

A total of 11 individual logging events were performed during the construction of DIW-1 **Table 3-19**. Copies of geophysical logs run on DIW-1 are presented in **Appendix R**. **Figures 3-29** and **3-30** depict the DIW-1 geophysical logging setup and the XY Caliper/ Gamma Ray Logging tool utilized in the logging of all the wells on site.

DIW-1 Run 1 is a combination gamma ray and X-Y caliper log and a dual induction log run inside the 12.25-inch pilot hole to a depth of 1,201 feet to verify the geologic characteristics of the formation exposed to in borehole.

Florida Governmental Utility Authority
Lehigh Acres WWTP Class I Deep Injection Well
Deep Injection Well

TABLE 3-19
GEOPHYSICAL LOGGING RUNS

DIW-1							
DATE		24-Nov-07	6-Dec-07	8-Dec-07	8-Dec-07	9-Dec-07	16-Dec-07
LOGGING RUNS		RUN-1	RUN -2	RUN -3-1	RUN-3-2	RUN-3-3	RUN-4
BOREHOLE		12.25-inch pilot	52-inch reamed	42-inch cased	42-inch cased	42-inch cased	12.25-inch pilot
INTERVAL LOGGED	BEGIN (FT BLS)	0	57	57	57	57	1185
	END (FT BLS)	1201	1185	1185	1185	1185	1810
LOGS CONDUCTED	GAMMA	X	X				X
	CALIPER	X	X				X
	DUAL INDUCTION	X					X
	FLUID CONDUCTIVITY						
	LONG/SHORT RESISTIVITY						
	TEMPERATURE			X	X	X	X
	FLOW METER						
	SONIC						X
	CEMENT BOND LOG						
	VIDEO						
	TELEVIEWER						
	RTS						X
COMMENTS		Geologic confirmation of pilot	Indication of casing placement	Confirmation of Cement Top	Confirmation of Cement Top	Confirmation of Cement Top	Confirmation of pilot hole / Indication of casing placement

Florida Governmental Utility Authority
Lehigh Acres WWTP Class I Deep Injection
Deep Injection Well

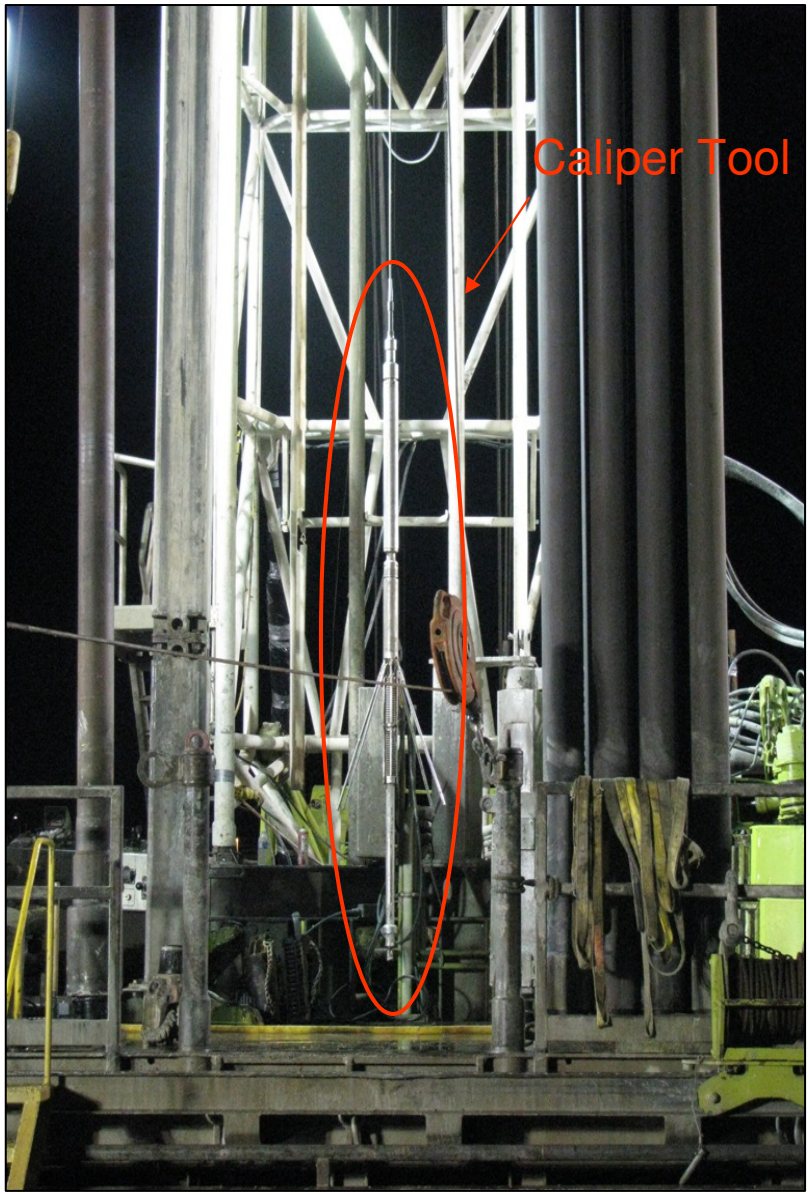
TABLE 3-19
GEOPHYSICAL LOGGING RUNS

		DIW-1					
DATE		31-Dec-07	1-Jan-08	3-Jan-08	6-Jan-08	1-Feb-08	8-Mar-08
LOGGING RUNS		RUN-5	RUN-6	RUN-7		RUN-8	RUN-9
BOREHOLE		40.5-inch reamed	40.5-inch reamed	34-inch cased	34-inch cased	12.25 inch pilot	Reamed Hole
INTERVAL LOGGED	BEGIN (FT BLS)	1080	1080	0	100	1800	1800
	END (FT BLS)	1805	1805	1795	1795	3200	3200
LOGS CONDUCTED	GAMMA	X	X			X	X
	CALIPER	X	X			X	X
	DUAL INDUCTION					X	
	FLUID CONDUCTIVITY						
	LONG/SHORT RESISTIVITY						
	TEMPERATURE			X		X	
	FLOW METER						
	SONIC					X	
	CEMENT BOND LOG				X		
	VIDEO					X	
	TELEVIEWER						
	RTS						
COMMENTS		Indication of casing placement	Indication of casing placement	Confirmation of Cement Top	Confirmation of Cement Bond Integrity	Confirmation of pilot hole geology and indication of packer placement	Indication of casing placement and grout volume

Florida Governmental Utility Authority
Lehigh Acres WWTP Class I Deep Injection
Deep Injection Well

TABLE 3-19
GEOPHYSICAL LOGGING RUNS

		DIW-1		
DATE		13-Mar-08 - 19-Mar-08	20-Mar-08	1-Apr-08
LOGGING RUNS		RUN-10-1 - 10-12	RUN-11	RUN-12
BOREHOLE		24-inch cased	22-inch reamed	MIT-08
INTERVAL LOGGED	BEGIN (FT BLS)	0	2370	2370
	END (FT BLS)	3200	3200	3200
LOGS CONDUCTED	GAMMA			X
	CALIPER			
	DUAL INDUCTION			
	FLUID CONDUCTIVITY			
	LONG/SHORT RESISTIVITY			
	TEMPERATURE	X		X
	FLOW METER			
	SONIC			
	CEMENT BOND LOG		X	
	VIDEO			
	TELEVIEWER			
	RTS			X
COMMENTS		Confirmation of Cement Top	Confirmation of Cement Bond Integrity	Confirmation of Casing Integrity



GEOPHYSICAL LOGGING

Figure 3-29

X-Y CALIPER & GAMMA RAY
GEOPHYSICAL LOGGING TOOL

Figure 3-30

DIW-1 Run 2 is a combination gamma ray and X-Y caliper log run inside the 52-inch reamed hole to a depth of 1,185 feet utilized for indication and confirmation of casing seating depth as well as verify borehole dimensions and estimate the cement quantity required to cement the 42-inch surface casing.

DIW-1 Run 3-1 is a temperature log run inside the 42-inch surface casing to a depth of 1185 feet after the first stage cementing. The log clearly shows a cement top temperature signature at 730 feet, the top of the cement was physically tagged at a depth of 726 feet. Three additional cementing stages were necessary to bring the cement surrounding the well casing to land surface.

DIW-1 Run 3-2 is the temperature log run inside the 42-inch surface casing to a depth of 1185 feet after the second stage cementing. The log clearly shows a cement top temperature signature at 328 feet, the top of the cement was physically tagged at a depth of 310 feet.

DIW-1 Run 3-3 is a temperature log run inside the 42-inch surface casing to a depth of 1185 feet after the third stage cementing. The log clearly shows a cement top temperature signature at 100 feet, the top of the cement was physically tagged at a depth of 126 feet.

DIW-1 Run 4 was run on the 12.25-inch pilot hole from 1,185 to 1,810 feet. The logs included X-Y caliper, gamma ray, BHC-sonic, temperature, dual induction, LL3, SP, Log Derived TDS, and a televiewer log were used to select the depth of the 34-inch intermediate casing. The induction log shows a decrease in the medium and deep resistivity below 1,640 feet as the base of the USDW (located at approximately 1,700 feet based on the log derived TDS) is approached and passed. The sonic log clearly shows the location of harder dolomite formations between 1,750 and 1,765 feet while the caliper log shows a mostly gauge hole throughout the logged interval. Based on the log data, a depth of 1,800 feet was selected for the intermediate casing setting depth, which was approved by TAC.

DIW-1 Run 5 was run on the 40.5-inch reamed hole from 1,080 to 1,805 feet prior to installing the 34-inch intermediate casing. The log shows a mostly gauge hole with an obstruction occurring at approximately 1,765 feet. The borehole will be reamed and logged again.

DIW-1 Run 6 was run on the 40.5-inch reamed hole from 1,080 to 1,805 feet prior to installing the 34-inch intermediate casing. The log, showing a mostly gauge hole below 1,260 feet, was used to verify the casing seating depth and estimate the cement quantity required to cement the 34-inch intermediate casing to land surface.

DIW-1 Run 7 is a temperature log run inside the 34-inch intermediate casing to a depth of 1795 feet after the fifth and last stage of cementing. The log clearly shows a

temperature transition indicating the top of cement at all the stages. There was close correlation between the physical tags and the temperature logs to ensure a valid temperature log.

DIW-1 Run 7-CBL consists of a cement bond log of the 34-inch casing. The log shows excellent casing bond and dense cement throughout the entire length of cemented casing from 1,795 feet to the top of cement (at the time of log run) at a depth of 100 feet bls.

DIW-1 Run 8 was run on the 12.25-inch pilot hole from 1,800 to 3,200 feet in order to verify pilot hole geology and determine the appropriate settings for targeted packer tests. The logs included X-Y caliper, gamma ray, BHC sonic/VDL, temperature, dual induction, LL3, SP, log derived TDS and video. The VDL portion of the sonic log clearly shows hard rock between 1,800 and 2,100 feet overlying the fractured formation of the injection zone below 2,150 feet. The induction log shows an increase in the medium and deep resistivity below 2,140 feet which correlates to increased permeability of the dolomite and limestone formation within and immediately above the top of the injection zone which coincides with the Boulder Zone of the Oldsmar Formation. The caliper log shows a mostly gauge hole beginning at 1,800 feet which opens up below 2,150 feet into major voids and cavities at 2,150, 2,450, 2,800 and 2,950 feet. Based on the caliper log, packer depths were selected for testing at 1,940-1,970, 1,885-1,915, 1,990-2,088 and 2,130-2,230 feet. The temperature log indicated a subtle deflection in the temperature profile at a depth of 2,115 and 2,145 feet. The top of the injection zone was selected at a depth of 2,370 feet which is within the Oldsmar Formation. Based on packer test, geophysical, video and lithologic data, PBS&J recommended to TAC a final casing depth of approximately 2,370 feet. After their review, TAC concurred and approved the final casing depth of 2,370 feet, making the injection zone between 2370 and 3,200 feet. The last parameter of this geophysical logging suite was a video log of the reamed borehole from land surface to the bottom at 3,200 feet bls. In the video, the casing welds are apparent and secure, the bottom of the intermediate casing is well confined in cement and tight within the borehole. Formation contacts visible on the video include alternating dark brown microcrystalline dolomite, with micritic Limestone. The top of the Oldsmar formation at 2,160 feet bls is visible and dramatic. Many open voids, and cavernous areas are visible with large boulders between 2,370 and 3,100 feet bls. The bottom of the borehole is a lower permeable zone of the Oldsmar Formation, recognizable by the lighter colored dolomitized limestone, and the lack of void spaces. The borehole is open from top to bottom, plumb and round.

DIW-1 Run 9 is a combination gamma ray and X-Y caliper log run in the 28.5-inch reamed hole from 1,800 to 2,360 feet and in the 26-inch reamed hole from 2,360 to 2,370 feet, and then in the reamed borehole from 2,370 to 3,200 feet. The log showed that the borehole varied in diameter from about 21 inches to about 36 inches from the base of the intermediate casing down to 1,808 feet. The borehole diameter was used to estimate the cement quantity required to grout the 24-inch final casing.

DIW-1 Run 10 consists of a composite of twelve temperature logs completed during cementing of the 24-inch final casing. The initial temperature log (#1) completed after the first cementing stage shows the top of the cement at a depth of 2,326 feet. The physical tag of the cement top was at 2,328 feet. The temperature log (#2) completed after the second cementing stage indicates the top of the cement was at 2,270 feet, which was confirmed with a physical tag at the same depth. The temperature log (#3) completed after the third cementing stage indicated a cement top at 2,149 feet, which was confirmed with a physical tag at the same depth. In general, there was an excellent correlation between the temperature top determinations and the physical tags. The temperature log (#4) completed after the fourth cementing stage shows the top of the cement at a depth of 2,140 feet. The physical tag of the cement top was at 2,140 feet. The temperature log (#5) completed after the fifth cementing stage indicates the top of the cement was at 2,130 feet, which was confirmed with a physical tag at 2,148 feet. The temperature log (#6) completed after the sixth cementing stage indicated a cement top at 2,106 feet, which was confirmed with a physical tag at the same depth. The temperature log (#7) completed after the seventh cementing stage shows the top of the cement at a depth of 1,968 feet. The physical tag of the cement top was at 1,974 feet. The temperature log (#8) completed after the eighth cementing stage indicates the top of the cement was at 1,823 feet, which was confirmed with a physical tag at 1,986 feet. The temperature log (#9) completed after the ninth cementing stage indicated a cement top at 1,502 feet, which was confirmed with a physical tag at the same depth. The temperature log (#10) completed after the tenth cementing stage shows the top of the cement at a depth of 1,094 feet. The physical tag of the cement top was at 1,083 feet. The temperature log (#11) completed after the eleventh cementing stage indicates the top of the cement was at 758 feet, which was confirmed with a physical tag at 776 feet. The temperature log (#12) completed after the twelfth cementing stage indicated a cement top at 326 feet, which was confirmed with a physical tag at the same depth. The remainder of the pilot hole was grouted to land surface in cementing stage 13.

DIW-1 Run 11 consists of a cement bond log of the 24-inch casing. The log shows excellent casing bond and dense cement throughout the entire length of cemented casing from 2,370 feet to the top of cement (at the time of log run) at a depth of 326 feet bls.

DIW-1 Run 11 is a temperature and gamma ray survey run just inside the 24-inch final casing at a depth of 2,365 feet for the purpose of conducting the Radio-Active Tracer test. Several passes were made to achieve background gamma ray and temperature levels inside the casing from land surface to 2,370 feet bls. Gamma ray logs were also conducted during the RTS test and immediately after to show any significant signs of vertical migration of the simulated injectate.

3.7. Injection Test

As part of the FDEP well construction permit and approved testing program, a short-term injection test was designed to determine the specific capacity and to assess the performance of the injection well. The injection test was approved for a testing duration of 12 hours at an injection rate ranging from approximately 1,200 to 2,500 gallons per minute (gpm) using reclaimed water from the FGUA reuse system. The reclaimed water was withdrawn from the end of the chlorine contact chamber and pumped directly into the injection well using a temporary pump and intake/piping system.

Setup for the injection test consisted of temporary pressure transducers and permanent pressure gauges installed at the UZMW-1, and LZMW-1B, wellhead and down hole in the injection well, see **Figures 3-31** and **3-32**. All aboveground pressure transducers were connected to In-Situ Hermit 3000 data loggers and the down hole transducers were self-contained memory gauges. The data loggers were set to record all measurements in psi (pounds per square inch) and the down hole gauges recorded atmospheric pressure as psi. A backup transducer was installed at the DIW-1 measuring point. The injection wellhead transducers were installed 10 inches above the 24-inch landing flange (approximately 3.2 feet above land surface). The UZMW-1 transducer was installed at the 6-inch landing flange (approximately 3 feet above land surface) and the LZMW-1B was installed 15 feet below the 6-inch flange (approximately 12 below land surface).

A down hole memory pressure gauge was installed at 2,390 feet below land surface at the injection well. The purpose of the down hole transducer was to monitor formation pressure changes during the injection test and assess what impact friction induced pressure losses had on the injection pressures.

Flow rate and volume to the injection well were monitored using a calibrated flowmeter with a totalizer dial, in-line with the injection test piping assembly (**Figure 3-33**). Water levels (well pressures) were monitored pre and post injection testing. Background monitoring was conducted two days prior to the injection test to establish regional or barometric trends on water levels prior to conducting the injection test. All Injection Test data will be included on a compact disk in **Appendix S**.

3.7.1. Pre-Injection Test

A pre-injection test was conducted on April 15, 2008 to determine if the reuse service pumps at the WWTP were capable of providing a minimum of 1,200 gpm of water to the injection well. This test began at approximately 15:00 hours and ended at about 16:00 hours. The injection rate of this pre-injection test ranged from 1,200 to 1,600 gpm. The test results showed that all equipment was operating properly and conducting a

INJECTION TEST SETUP

Figure 3-31

Figure 3-32 **INJECTION TEST SETUP - PUMPS**

FLOWMETER

Figure 3-33

longer 12-hour test at approximately 1,200 to 1,800 gpm was feasible. The 12-hour injection test was then scheduled for 0800 hours on April 17.

3.7.2. 12-Hour Injection Test

The 12-hour injection test was started at 0805 hours on April 19, with an approximate injection rate of 1,250 gpm. The weather was clear and warm, dominated by high pressure conditions throughout the test period. Throughout the 12-hour injection test, hourly manual readings of the flow meter were recorded by PBS&J personnel in addition to the digital recorded information from data loggers supplied by YBI. For the first 8 hours of the test, the injection rate was 1,225 gpm. At approximately 8 hours into the injection test, the flow rate was increased to approximately 1,800 gpm, the WWTP was unable to sustain this rate of output and after 26 minutes, the injection rate was decreased to 1,650 gpm for the remaining 3.5 hours of the test. The average injection rate for the 12-hour test was 1,438 gpm and the total value of reclaimed water injected during the test was approximately 945,500 gallons.

3.7.3. Injection Test Evaluation

Data collected by transducers during the injection test includes raw pressure values observed and the subsequent pressure changes resulting from injection. **Figure 3-34** and **3-35** presents raw pressure data as measured at the injection wellhead. Raw pressure data from the injection wellhead and the monitor wells were converted to water levels in feet and referenced to NGVD. The raw pressure data output from the injection test is presented in **Appendix O.**

Background water level data collected in all three wells. **Figure 3-36** shows that water levels remained relatively stable with only minor variations resulting from barometric and tidal influences. Immediately prior to the start of injection, the static water level at the injection well was 19.8 psi. Within a minute after injection started, the injection well water level spiked to 21.5 psi and then decreased sharply to approximately 18.5 psi. Injection water level began a gradual increase for the duration of the injection period, eventually recording an internal high value of 19.3 psi, coinciding with the increase in injection rate to 1,800 gpm. Following injection, the water level at the injection wellhead decreased to below static levels of 18.73 psi. The difference between pre and post static water levels is attributed to the density differentials in the background formation water and the density of the water injected (freshwater). The overall water level change attributed to injection activities is estimated to be 1 psi (2.3 feet).

The transducers (both primary and backup) installed at the LZMW-1B and UZMW-1 indicated that water levels (pressures) in both wells did not show any appreciable change during the injection test (**Figures 3-37** and **3-38**). Tidal data (**Figure 3-39**) from the week of the test shows the occurrence of tides in the vicinity of Fort Myers ranging

Lehigh Acres DIW-1 Injection Test

Full Test - DIW-1

Lehigh Acres, FL - April 17, 2008

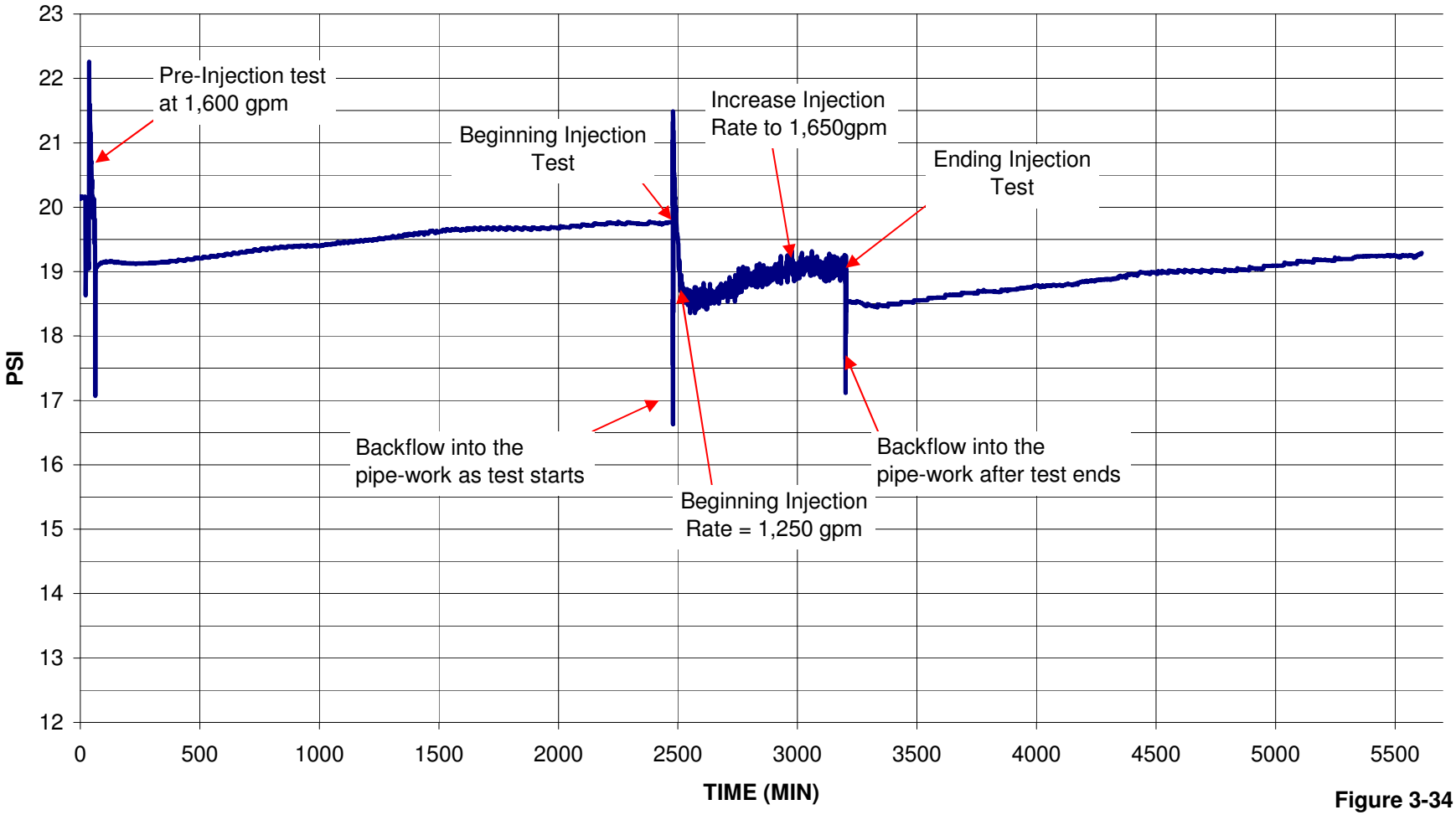


Figure 3-34

Lehigh Acres DIW-1 Injection Test
DIW-1
Lehigh Acres, FL April 17, 2008

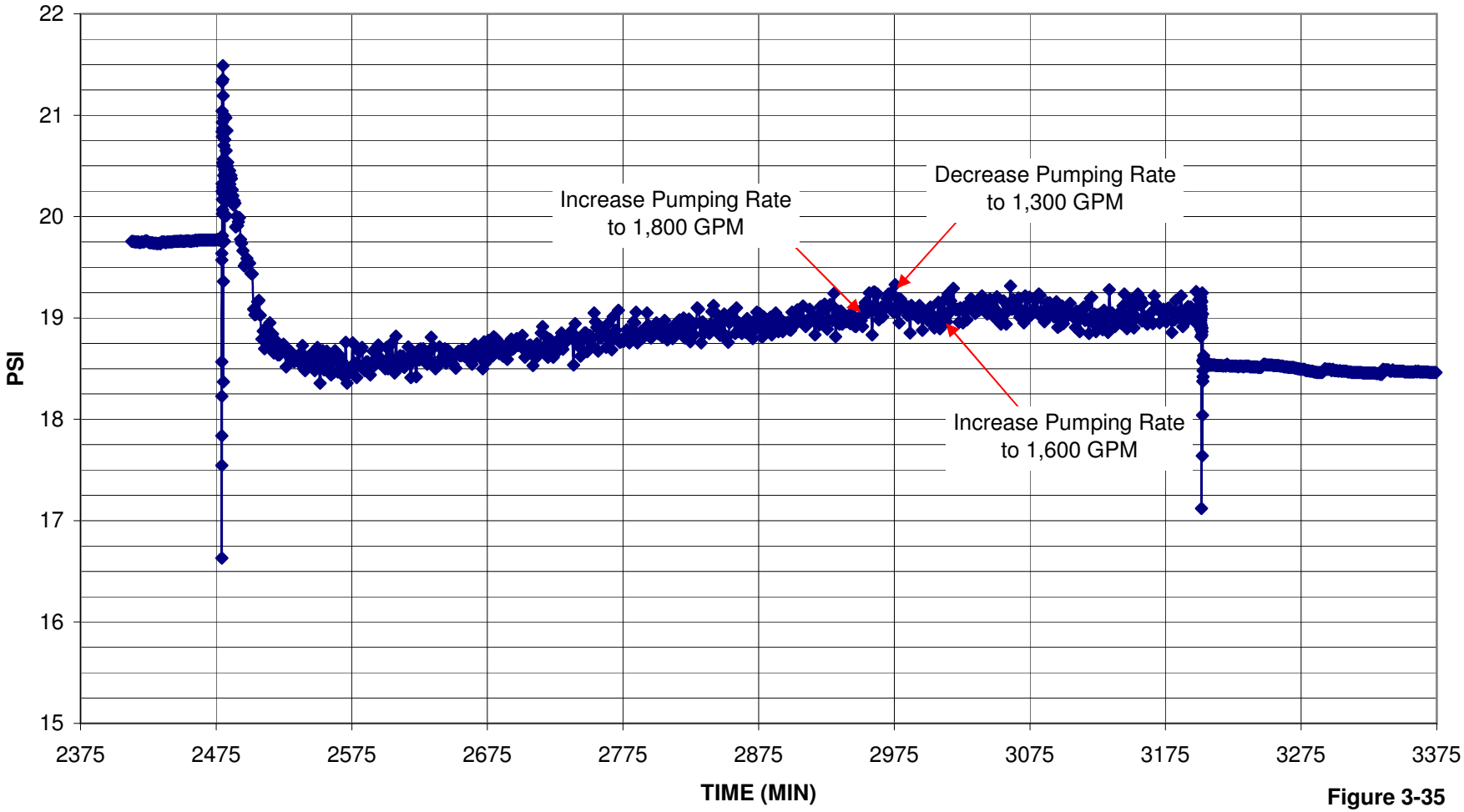


Figure 3-35

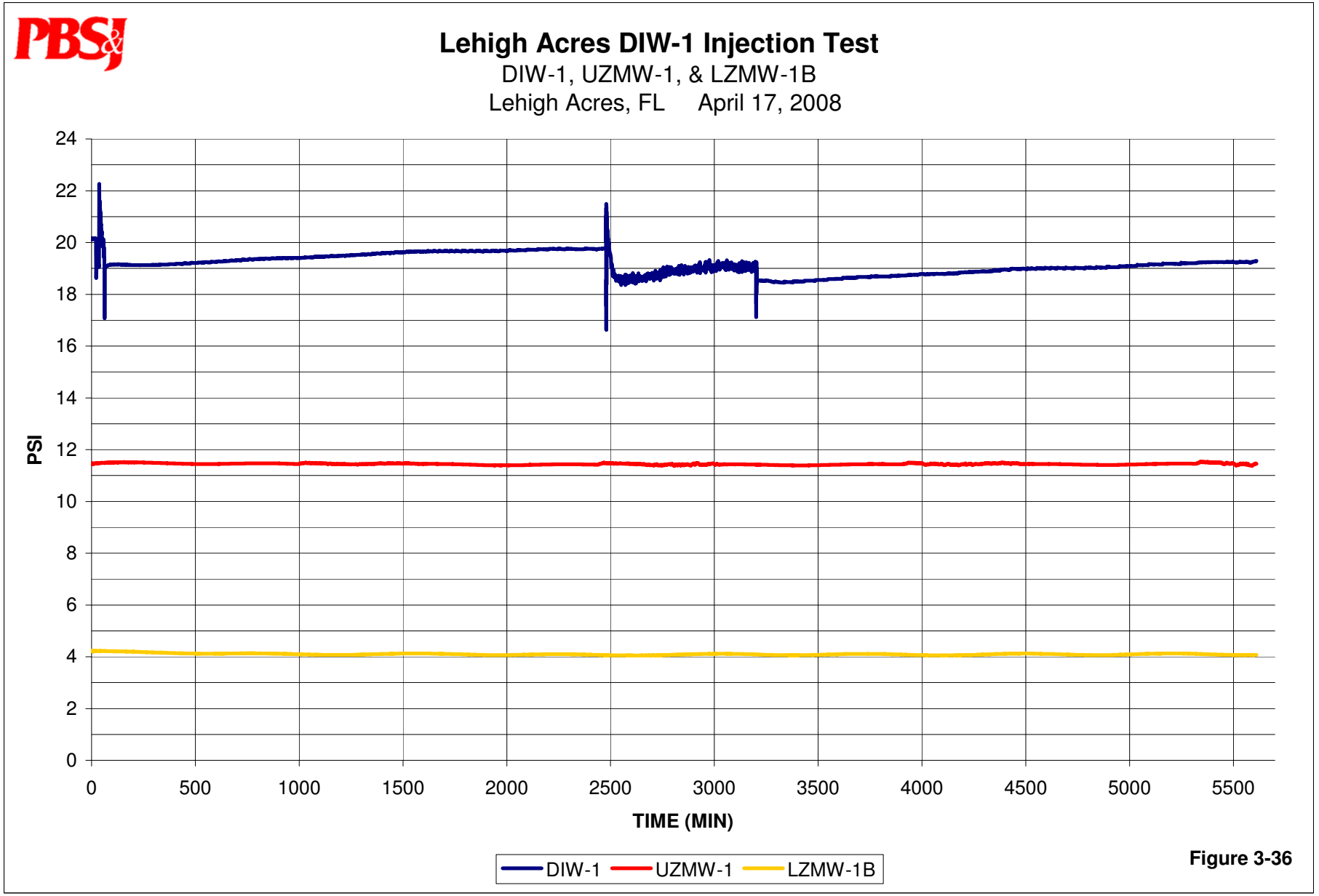

Lehigh Acres DIW-1 Injection Test
DIW-1, UZMW-1, & LZMW-1B
Lehigh Acres, FL April 17, 2008
PSI
0
2
4
6
8
10
12
14
16
18
20
22
24
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
TIME (MIN)
DIW-1
UZMW-1
LZMW-1B

Figure 3-36

Lehigh Acres DIW-1 Injection Test

Full Test - LZMW-1B

Lehigh Acres, FL - April 17, 2008

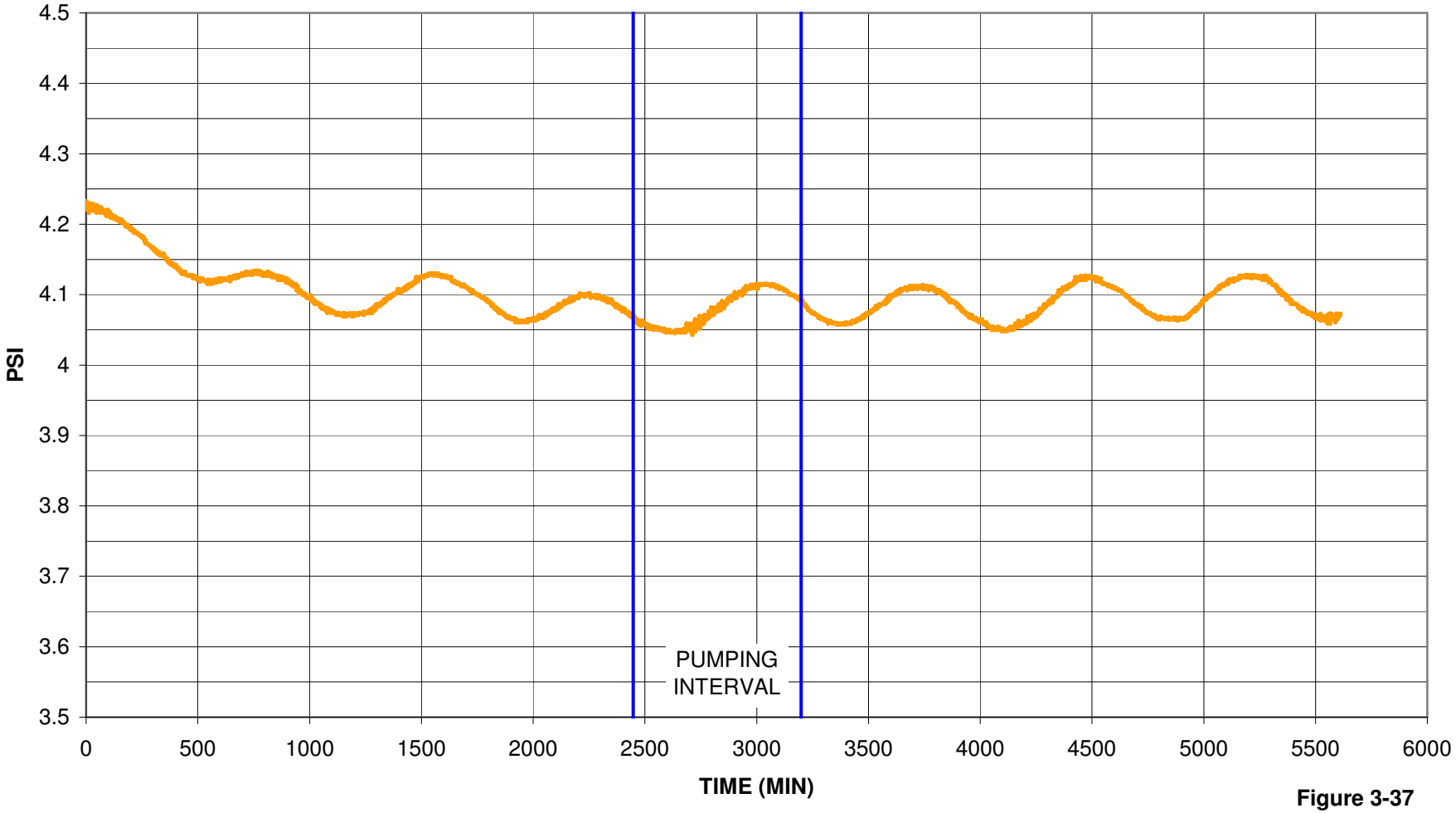


Figure 3-37

Lehigh Acres DIW-1 Injection Test

Full Test - UZMW-1

Lehigh Acres, FL - April 17,2008

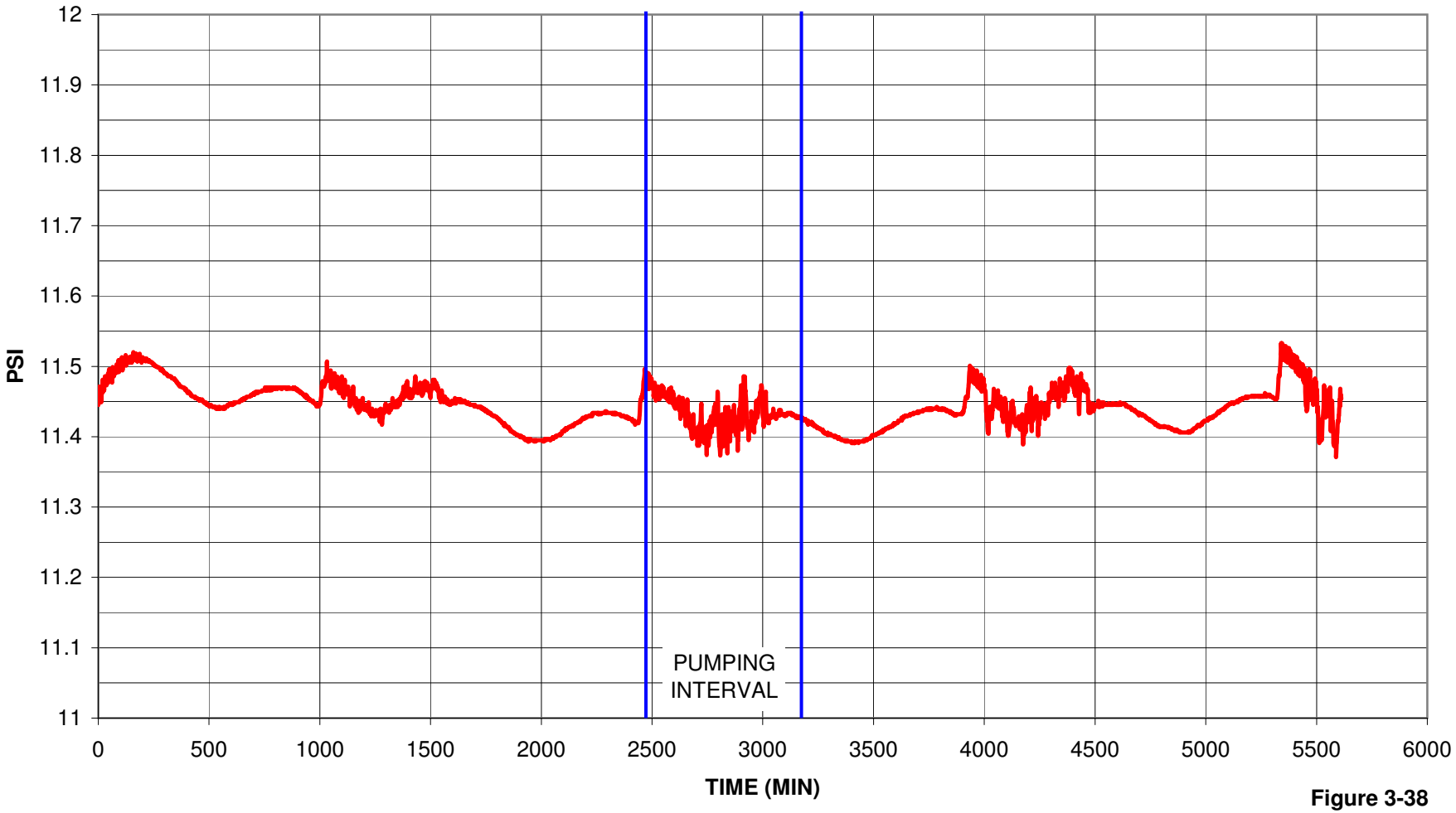


Figure 3-38

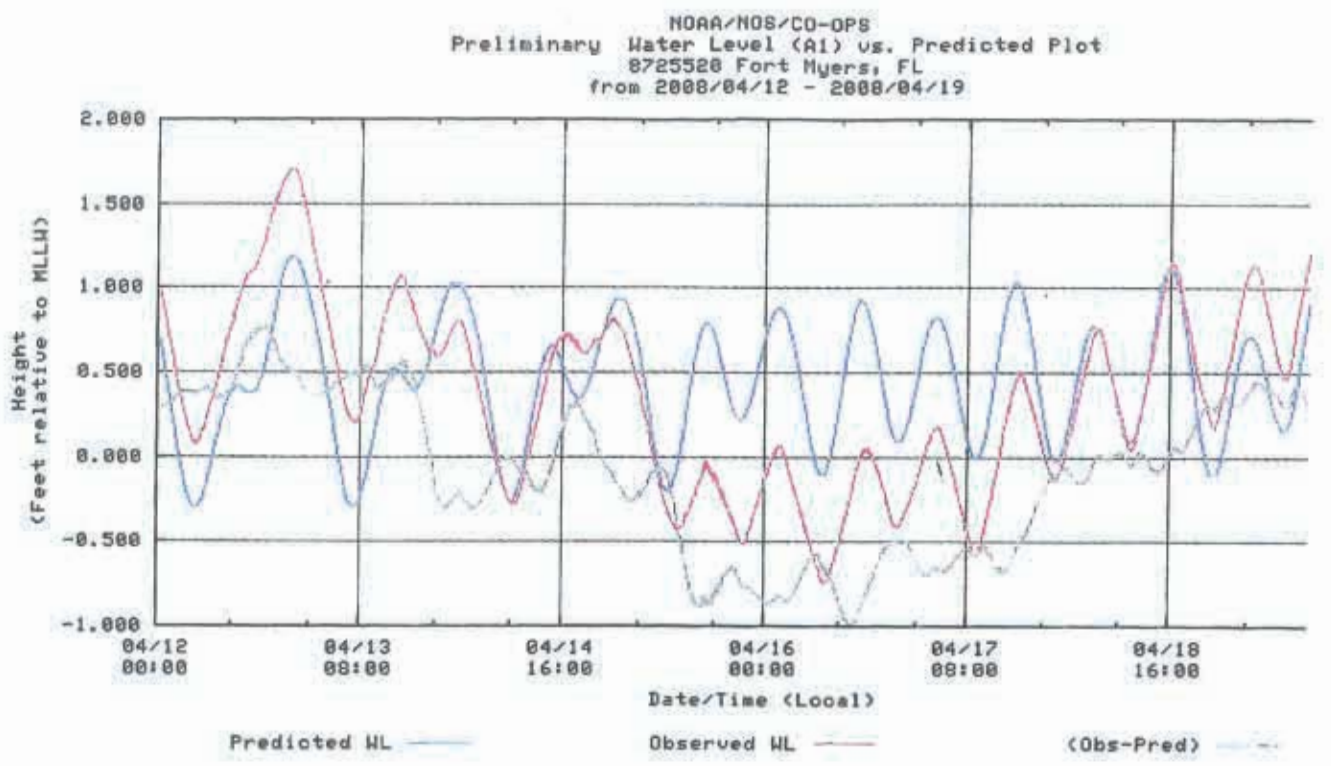

NOAA/NOS/CO-OPS
Preliminary Water Level (A1) vs. Predicted Plot
8725520 Fort Myers, FL
from 2008/04/12 - 2008/04/19
Height (Feet relative to MLLW)
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
04/12 00:00
04/13 08:00
04/14 16:00
04/16 00:00
04/17 08:00
04/18 16:00
Date/Time (Local)
Predicted WL
Observed WL
(Obs-Pred)

Figure 3-39

in amplitude of -0.6 to 1.6 feet at the coast; the location of the injection well is 14 miles inland, however minor tidal influence are apparent on the UZMW-1 and LZMW-1B Injection Test data.

The primary down-hole pressure transducer (2,390 feet) showed a pressure response in the formation that was similar to the pressures measured at the injection wellhead (**Figure 3-40**). Data collected during the injection test indicate that the down-hole formation injection-pressure change was on the order of 2 psi (4.6 feet), as compared to the 1.0 psi (2.3 feet) measured at the wellhead. This data suggests that friction losses in the injection well system were low while injecting reclaimed water at approximately 1,438 gpm. The specific infectivity of the well was estimated to be 719 gpm per psi (313 gpm/per foot) at the injection wellhead. This value is indicative of a highly transmissive injection zone.

3.8. Vertical Travel Time Calculations

The vertical travel time of a freshwater injectate plume was calculated between the top of the injection zone (2,370 feet) and the base of the USDW (1,700 feet). **Table 3-20** summarizes the calculation for vertical travel time using the Darcy equation and incorporating injection well core permeability and porosity data, injection pressure, fresh water head differences, and buoyancy factors. Vertical upward flow migration is dependent upon the static head differences between the injection zone and overlying units, the pressure directly caused by injection, and the buoyancy of the fresher injectate in a saline injection zone. The static head within the lower monitoring zone, which is near the location of the base of the USDW, was selected as the lower reference point some 463 feet above the injection zone.

Water levels (heads) and injection pressures were obtained during the injection test and post monitoring period conducted at the DIW-1 site on April 15 and April 17. For the analysis, static injection well and LZMW-1 heads were referenced to feet from land surface. The injection well water level (68.91 feet NGVD) measured 12 hours after the end of the injection test was selected as the static equivalent fresh water head because reclaimed water used during the injection test had filled the injection zone near the well and the entire length of the final casing. The LZMW-1 water level (19.90 feet NGVD) measured at the same point in time was selected as the static equivalent fresh water head because the TDS concentration of this well (2,380 mg/l) suggests that the measured water level is not significantly affected by salt water density differences.

Using the static head differential, an aquifer pressure increase of 4.6 feet during injection and a buoyancy pressure displacement of 1.88 feet, the total differential pressure between the top of the injection zone and the lower monitoring zone is calculated to be 55.14 feet. The vertical head gradient between the two zones, which are separated by 792 feet, is then 0.035 feet per foot. Incorporating the vertical permeability

Lehigh Acres DIW-1 Injection Test

DIW-1 - Wellhead and Formation Data

Lehigh Acres, FL April 17, 2008

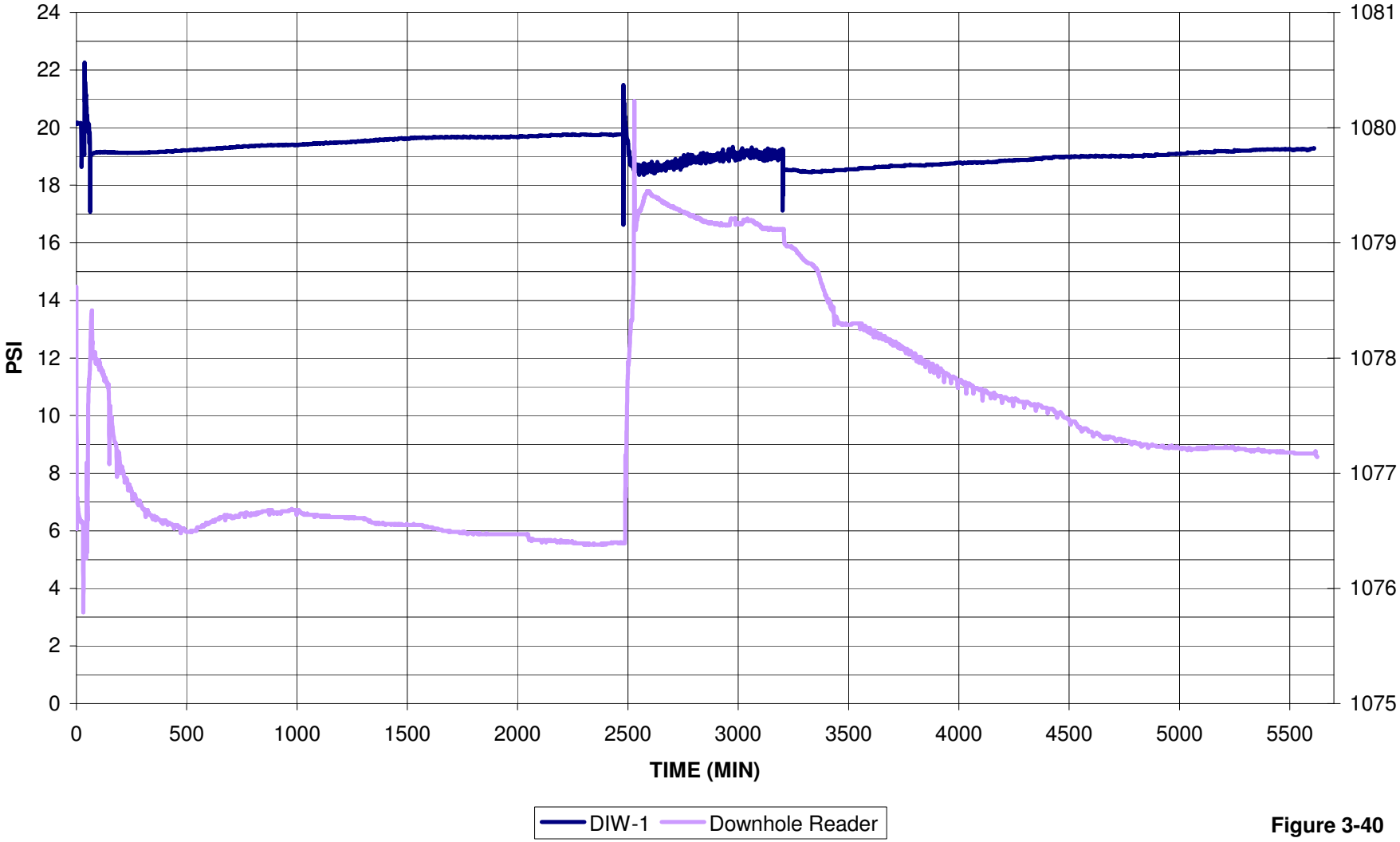


Figure 3-40

TABLE 3-20
SUMMARY OF VERTICAL TIMES

Vertical travel distance to LZMW, beyond the base of USDW (1700 feet bls): D= Distance = 2370'- 1700' = 670 feet	Dist = 670 feet
Geometric averages of vertical permeability (Kv) and apparent Porosity (N) (From Core Lab data – Table 3-2)	
a. Kv (avg) = Geometric average of vertical permeability	Kv avg = 0.0325 feet/day
b. N (avg) = Geometric average apparent porosity.	N avg = 0.247 dimensionless
Pressure difference between 10,000 mg/l TDS and injection plume: (Note pad elevation of ~22.5 feet; all elevations referenced from NGVD)	
a. Natural Pressure (Head) Difference (Hd): Injection Well head (Iwh) – UZMW head (Mwh)	
Equiv fresh water head on injection well:	Iwh = 68.9 feet
Equiv fresh water head on LZMW:	Mwh = 20.24 feet
Difference between adjusted heads:	Hd = 48.66 feet
b. Aquifer (Formation) Pressure Increase during injection (Api):	Api = 4.6 feet
c. Buoyancy Pressure (Bp): Displacement distance (plume height) of injectate multiplied by Difference in specific gravity. Assume worst case of a SG difference of 0.025 (sea water – fresh water). Assume plume height of 75 feet.	
0.025 * 75 = Bp	Bp = 1.88 feet
d. Total Differential Pressure = Hd+Api+Bp=Tp	Tp = 55.14
4. Vertical travel time (Tv) based on Darcy Equation: T_v.=D/V_x where D distance and V_x is darcian velocity (Vd) or Linear Velocity (VI)	
a. Vd=Kv*lv, Where lv is the vertical head gradient lv = Tp/D = 40.6/844	lv = 0.082 feet/feet
:.Vd = Kv*lv	Vd = 0.002665 ft/day
b. Linear Velocity (VI) = Darcian Velocity (Vd)/ Apparant Porosity (N)	VI = 0.0108 ft/day
c. Travel time = separation from interface to injectate/VI, where interface is at a depth of 1700 feet and injectate originates from 2370 feet; thus separation (s) = 670 feet	
Tt = s/VI = 670 feet/0.0108 feet/day	Tt = 62,037 days
Travel time (Tt) to 10,000 TDS interface	Tt ~ 170 years

(0.03258 feet per day based on core data) and porosity (0.247 dimensionless) of the formation along with the head gradient into Darcy's equation yields a linear travel time of 0.0108 feet per day. It then follows that the estimated travel time for a fresh water injectate from the top of the injection zone to the base of the USDW (distance of 670 feet) is on the order of 170 years.

4.0 Piping and Wellhead Configuration

The piping, pumps and controls associated with the Lehigh Acres DIW-1 system have not been constructed as of the date of this report. The final design of the deep injection well system has been completed as illustrated in the design drawings presented as **Figures 4-1** through **4-5**. It is anticipated that construction of the deep injection well system will commence in July of 2008 and will be completed by early 2009. Following construction of the deep injection well system piping, pumps and controls, a set of complete As-Builts and an operations and maintenance (O&M) manual will be prepared and submitted to FDEP as part of the permanent record. The O&M manual will include specifics about the start-up, operations and monitoring of the deep injection well system and a formal request by FGUA to initiate operationally testing.

GENERAL NOTES

1. ALL DISTURBED AREAS SHALL BE SEEDED AND MULCHED EXCEPT ALL STRUCTURES SHALL BE SODDED 10 FEET ON ALL SIDES
2. UNDERGROUND FACILITIES, STRUCTURES AND UTILITY HAVE BEEN PLOTTED FROM THE BEST AVAILABLE SURVEYS AND RECORDS. THEIR LOCATIONS MUST BE CONSIDERED APPROXIMATE ONLY. THERE MAY BE OTHERS, THE EXISTENCE OF WHICH IS NOT PRESENTLY KNOWN. IT IS THE CONTRACTOR'S RESPONSIBILITY TO DETERMINE EXACT LOCATION PRIOR TO CONSTRUCTION. THE CONTRACTOR SHALL USE METAL DETECTOR, PROBE AND OTHER NON-DESTRUCTIVE METHODS TO LOCATE ALL EXISTING LINES PRIOR AND DURING EXCAVATION. THE CONTRACTOR SHALL NOTIFY THE UTILITY COMPANIES IN THE AREA BEFORE BEGINNING CONSTRUCTION, AT LEAST 48 HOURS IN ADVANCE. CALL FLORIDA SUNSHINE STATE ONE CALL CENTER (1-800-432-4770).
3. A LATERAL SEPARATION OF TEN FEET OUT-TO-OUT SHALL BE MAINTAINED BETWEEN THE WATER MAIN AND ANY SANITARY SEWER MAINS. IN CASE OF CROSSING, A VERTICAL SEPARATION OF NOT LESS THAN 18-INCHES SHALL BE MAINTAINED. A MINIMUM LATERAL SEPARATION OF 5 FEET OUT-TO-OUT SHALL BE MAINTAINED BETWEEN REUSE, NON-POTABLE AND REJECT WATER MAINS
4. CONNECTIONS TO EXISTING FACILITIES SHALL BE MADE IN THE PRESENCE OF THE UTILITY OWNERS, PLANT OPERATORS AND THE ENGINEER. THE CONTRACTOR SHALL GIVE AT LEAST TWO WEEKS NOTICE TO ALL PARTIES CONCERNED PRIOR TO BEGINNING WORK.
5. THE CONTRACTOR SHALL COORDINATE CONSTRUCTION ACTIVITIES WITH THE WASTEWATER TREATMENT PLANT (WWTP) OPERATOR ON A DAILY BASIS TO MINIMIZE INTERFERENCE WITH WWTP OPERATIONS AND OPERATOR ACTIVITIES. THE CONTRACTOR SHALL MAINTAIN ROAD ACCESS AT ALL TIMES FOR VEHICLES AND OTHER CONTRACTORS. THE CONTRACTOR SHALL PROVIDE A 10 DAY ADVANCED NOTICE OF CRITICAL PIPING CONNECTIONS.
6. ALL BURIED PIPE SHALL HAVE A MINIMUM OF 3-FEET COVER.
7. ALL BURIED PIPE SHALL BE RESTRAINED WITH RESTRAINED MECHANICAL JOINT, (RMJ) MEGALUG SERIES 1100 OR EQUAL.
8. FLANGE ADAPTERS SHALL BE EBAA SERIES 2100 MEGAFLANGE-FLANGE ADAPTERS OR EQUAL.
9. ALL FLANGE CONNECTIONS SHALL USE TYPE 316 STAINLESS STEEL NUTS AND BOLTS.
10. NEW WORK UNDER THIS CONTRACT ON EXISTING SITE DRAWINGS IS SHOWN IN HEAVY LINE WEIGHTS.
11. ALL FORCEMAIN SHUT-DOWNS SHALL BE COMPLETED BETWEEN 11 PM AND 6 AM.
12. THE CONTRACTOR SHALL PROVIDE ALL DEWATERING EQUIPMENT NECESSARY TO KEEP EXCAVATIONS DRY AND SHALL PROVIDE ALL SHEETING, SHORING, AND BRACING NECESSARY TO PROTECT ADJACENT STRUCTURES, UTILITIES, EXISTING PAVEMENT, OR TO MINIMIZE TRENCH WIDTH.
13. THE CONTRACTOR SHALL CONTACT THE OWNERS CONSTRUCTION MANAGER IMMEDIATELY REGARDING ANY CONFLICTS ARISING DURING CONSTRUCTION FROM ANY IMPROVEMENTS SHOWN ON THE DRAWINGS.
14. THE CONTRACTOR SHALL ADHERE TO ALL CONDITIONS AND REQUIREMENTS OF ALL PERMITS WHICH HAVE BEEN OBTAINED.
15. THE CONTRACTOR SHALL PROVIDE AND INSTALL HAY BALES AND/OR SILT SCREENS AROUND THE PROPOSED CONSTRUCTION ACTIVITY, AS NECESSARY, TO PREVENT THE TRANSPORT OF SEDIMENT DOWNSTREAM INTO STREETS, STORM SEWERS, OPEN DITCHES, LAKES, DETENTION PONDS, ETC., AND SHALL PERFORM ALL NECESSARY INSPECTIONS, ALL IN ACCORDANCE WITH THE SPECIFICATIONS-PREVENTION, CONTROL AND ABATEMENT OF EROSION AND WATER POLLUTION.
16. THE CONTRACTOR SHALL KEEP ROADS OPEN FOR TRAFFIC AND MAINTAIN CONTINUOUS ACCESS TO STRUCTURES ADJACENT TO THE WORK.
17. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ANY DAMAGES TO EXISTING UTILITIES CAUSED BY CONSTRUCTION OPERATIONS.
18. ALL MAINS SHALL BE TESTED AND FLUSHED IN ACCORDANCE WITH THE SPECIFICATIONS PRIOR TO CONNECTING TO EXISTING MAINS. ALL MAINS TO BE ABANDONED IN PLACE SHALL BE DRAINED, FLUSHED, AND DISINFECTED.

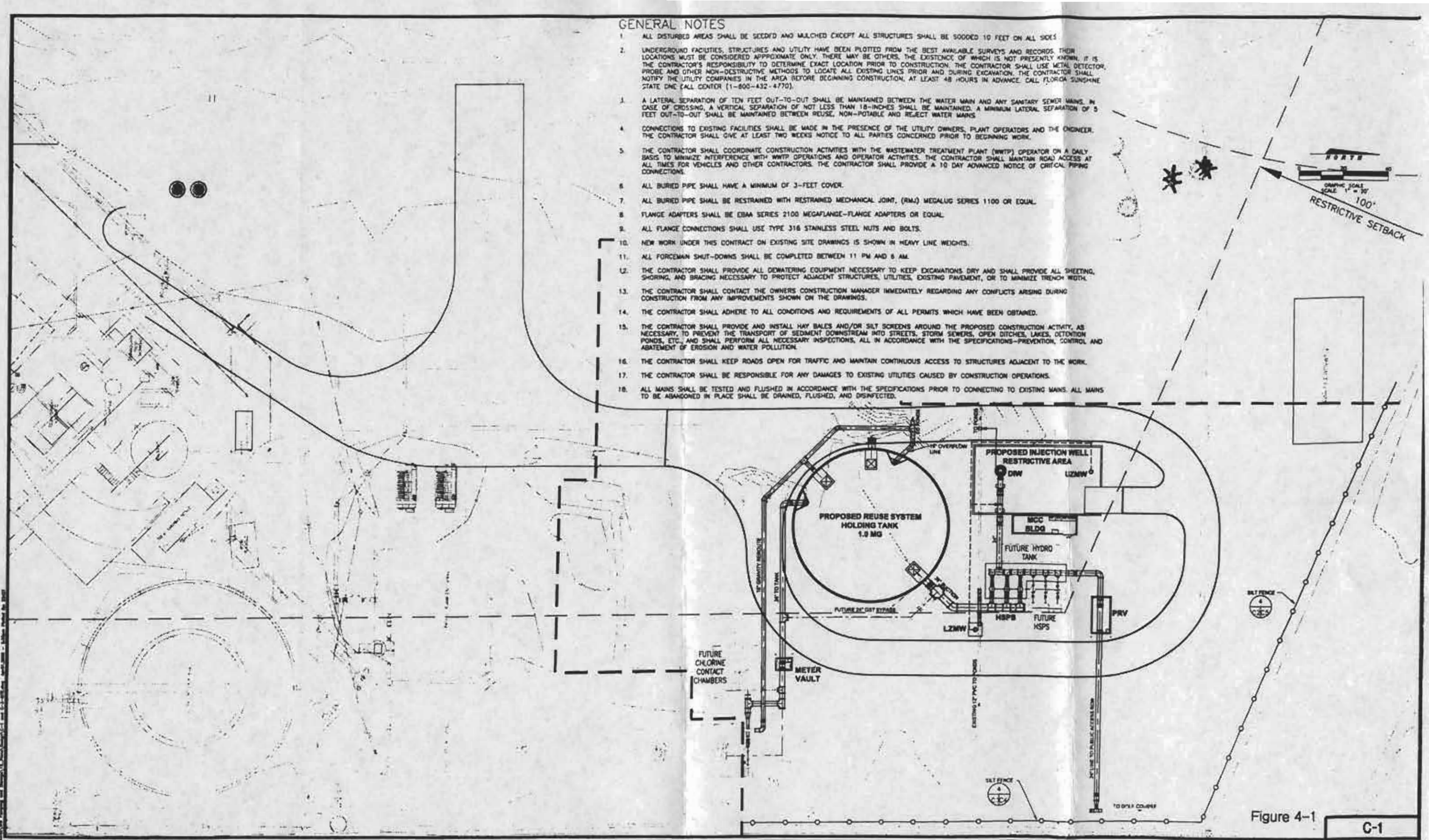


Figure 4-1

C-1

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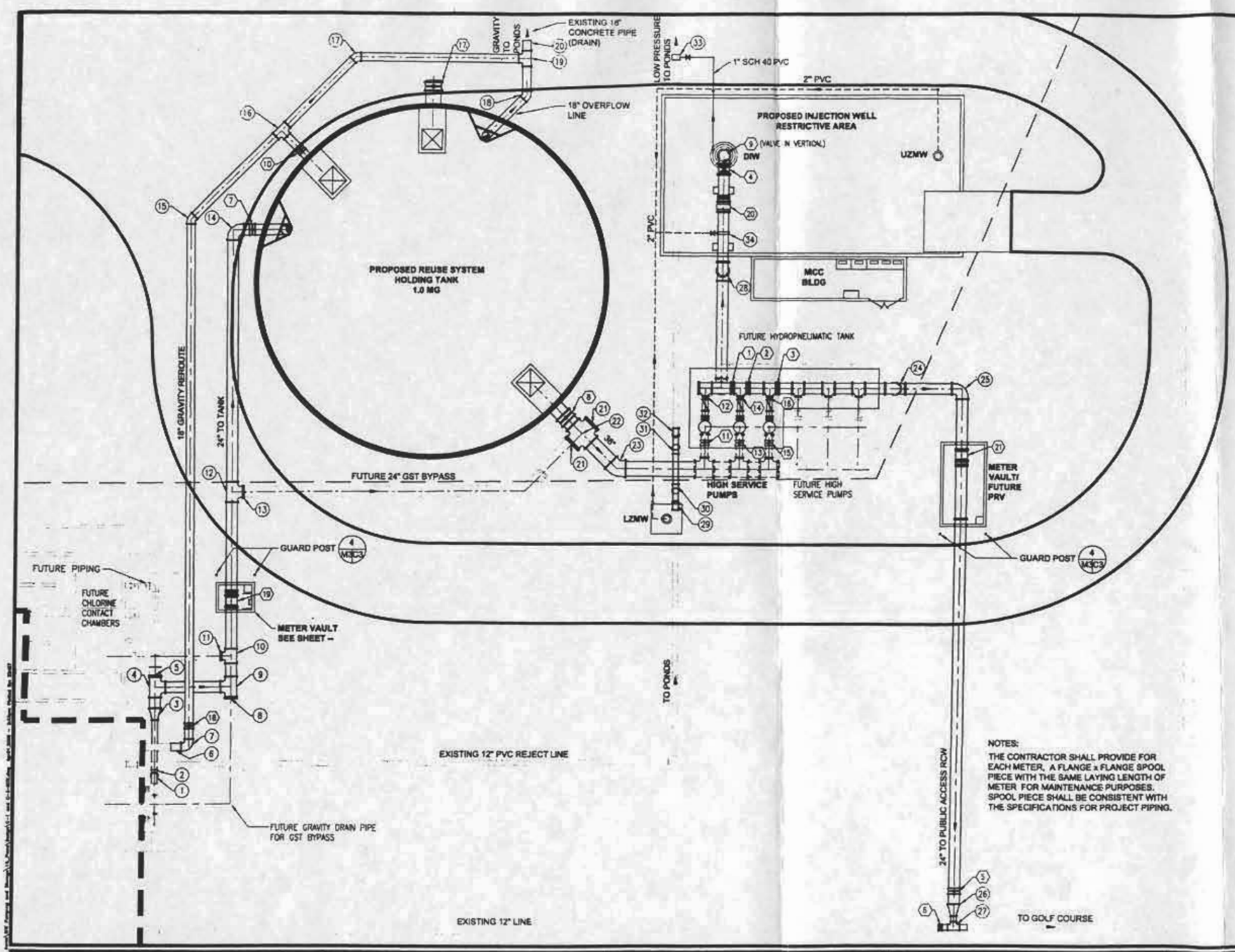
CLIENT	PROJECT	TASK
FLORIDA GOVERNMENTAL UTILITY AUTHORITY	LEHIGH ACRES WWTF RECLAIMED WATER STORAGE AND PUMPING STATION	OVERALL SITE PLAN

ORIGINAL
REVISIONS:
1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12.

Name: , BRADLEY S McMAHEN, P.E.
Florida P.E. No.: FL67966
Address: PBS&J
482 SOUTH KELLER ROAD
ORLANDO, FL 32810
Signature Date

JOB NO. 007120091
DRAWN PW
DESIGN BM
CHECKED –
Q.C. –

SHEET 5



NOTES:

THE CONTRACTOR SHALL PROVIDE FOR EACH METER, A FLANGE x FLANGE SPOOL PIECE WITH THE SAME LAYING LENGTH OF METER FOR MAINTENANCE PURPOSES. SPOOL PIECE SHALL BE CONSISTENT WITH THE SPECIFICATIONS FOR PROJECT PIPING.

(1) METER AND VALVE SCHEDULE

NO.	VALVE ID	DESCRIPTION	LOCATION
1	MOV-1	24" BUTTERFLY VALVE (FLG)	HIGH SERVICE PUMPS
2	MOV-2	24" BUTTERFLY VALVE (FLG)	HIGH SERVICE PUMPS
3	MOV-3	24" BUTTERFLY VALVE (FLG)	HIGH SERVICE PUMPS
4	MOV-4	24" GATE VALVE (FLG)	DEEP INJECTION WELL
5	MV-1	24" BUTTERFLY VALVE (MJ)	TO GOLF COURSE
6	MV-2	12" BUTTERFLY VALVE (MJ)	TO GOLF COURSE
7	MV-3	24" BUTTERFLY VALVE (MJ)	TANK INFLUENT
8	MV-4	24" BUTTERFLY VALVE (MJ)	TANK EFFLUENT
9	MV-5	24" GATE VALVE (FLG)	DEEP INJECTION WELL
10	MV-6	18" BUTTERFLY VALVE (MJ)	TANK DRAIN TO PONDS
11	MV-7	18" BUTTERFLY VALVE (MJ)	HIGH SERVICE PUMP - SUCTION
12	MV-8	12" BUTTERFLY VALVE (FLG)	HIGH SERVICE PUMP - DISCHARGE
13	MV-9	18" BUTTERFLY VALVE (MJ)	HIGH SERVICE PUMP - SUCTION
14	MV-10	12" BUTTERFLY VALVE (FLG)	HIGH SERVICE PUMP - DISCHARGE
15	MV-11	18" BUTTERFLY VALVE (MJ)	HIGH SERVICE PUMP - SUCTION
16	MV-12	12" BUTTERFLY VALVE (FLG)	HIGH SERVICE PUMP - DISCHARGE
17	MV-13	36" BUTTERFLY VALVE (MJ)	TANK EFFLUENT - FUTURE
18	MV-14	18" BUTTERFLY VALVE (MJ)	GRAVITY REROUTE TO POND
19	FM-1	24" MAGNETIC FLOW METER (FLG)	TANK INFLUENT METER VAULT
20	FM-2	24" MAGNETIC FLOW METER (FLG)	DEEP INJECTION WELL METER
21	FM-3	24" MAGNETIC FLOW METER (FLG)	PRIMETER VAULT TO GOLF COURSE

(1) FITTING SCHEDULE

NO.	DESCRIPTION	NORTHING	EASTING
1	12" 90° BEND (F.E. x M.J.)	11281.69	13404.25
2	12" 90° BEND (M.J.)	11281.69	13404.25
3	24" x 12" REDUCER (M.J.)	11281.18	13391.80
4	24" x 24" TEE (M.J.)	11280.68	13398.52
5	24" M.J. PLUG (M.J.)	11280.74	13387.29
6	18" TRANSITION SLEEVE TO CONC. PIPE	11286.91	13398.24
7	18" 90° BEND (M.J.)	11286.34	13398.24
8	24" M.J. PLUG (M.J.)	-	-
9	24" x 24" TEE (M.J.)	11286.24	13385.69
10	24" x 18" TEE (M.J.)	11286.08	13379.68
11	18" M.J. PLUG (M.J.)	-	-
12	24" x24" TEE (M.J.)	11294.61	13348.98
13	24" M.J. PLUG (M.J.)	-	-
14	24" 90° BEND (M.J.)	11292.42	13294.18
15	18" 45° BEND (M.J.)	11283.80	13292.44
16	18" x 18" TEE (M.J.)	11301.63	13274.27
17	18" 45° BEND (M.J.)	13315.46	13258.89
18	18" 45° BEND (M.J.)	11349.88	13296.43
19	18" x 18" TEE (M.J.)	11348.08	13297.94
20	18" TRANSITION SLEEVE TO CONC. PIPE	11349.49	13256.32
21	36" M.J. PLUG (M.J.)	-	-
22	36" x 36" CROSS (M.J. x M.J.)	11365.77	13332.34
23	36" 45° BEND (M.J.)	11371.09	13338.15
24	24" 90° BEND (M.J.)	11428.71	13321.20
25	24" 90° BEND (M.J.)	11436.88	13320.80
26	24" x 12" REDUCER (M.J.)	11441.81	13426.47
27	12" CUT IN TEE OR TAPPING SLEEVE	11442.06	13436.93
28	24" 90° BEND (M.J.)	11360.22	13296.67
29	12" 45° BEND (M.J.)	11363.06	13345.79
30	12" 45° BEND (M.J.)	11362.96	13343.06
31	12" 45° BEND (M.J.)	11362.86	13334.96
32	12" 45° BEND (M.J.)	11362.50	13331.83
33	TAPPING SADDLE, BALL VALVE AND BOX	-	-
34	TAPPING SADDLE, BALL VALVE	-	-

Figure 4-2

C3

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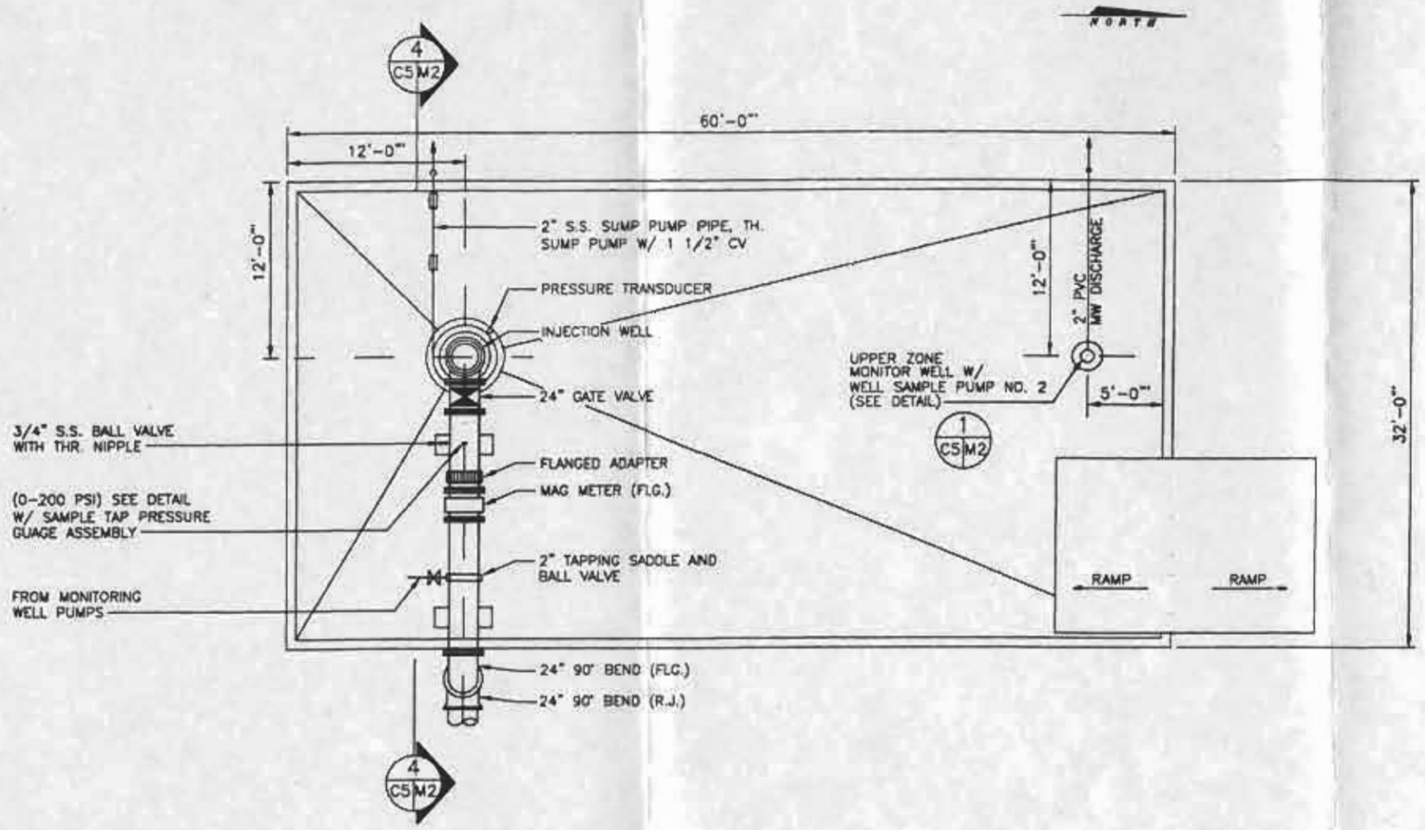
CLIENT	PROJECT	TASK
FLORIDA GOVERNMENTAL UTILITY AUTHORITY	LEHIGH ACRES WWTF RECLAIMED WATER STORAGE AND PUMPING STATION	YARD PIPING PLAN

ORIGINAL
REVISIONS:
1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12.

Name: , BRADLEY S McMAHEN, P.E.
Florida P.E. No.: FL62366
Address: PBS&J 482 SOUTH KELLER ROAD ORLANDO, FL 32810
Signature Date

JOB NO. 007120091
DRAWN PW
DESIGN BM
CHECKED
Q.C.

SHEET 7



PLAN
SCALE: 3/16" = 1' (1 C5 C5)

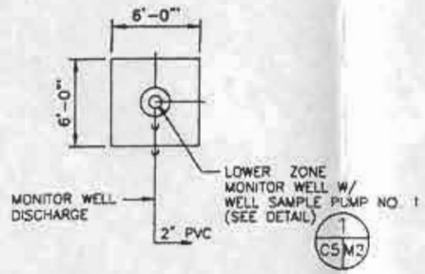


Figure 4-3

C5

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1001 S.W. 107th Ave., Miami, FL 33172-2507
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CLIENT	PROJECT	TASK
FLORIDA GOVERNMENTAL UTILITY AUTHORITY	LEHIGH ACRES WWTF RECLAIMED WATER STORAGE AND PUMPING STATION	DEEP INJECTION WELL PLAN

ORIGINAL
REVISIONS:
1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12.

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Florida P.E. No.: FL62988
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482 SOUTH KELLER ROAD
ORLANDO, FL 32810
Signature Date

JOB NO. 097120091
DRAWN PW
DESIGN BM
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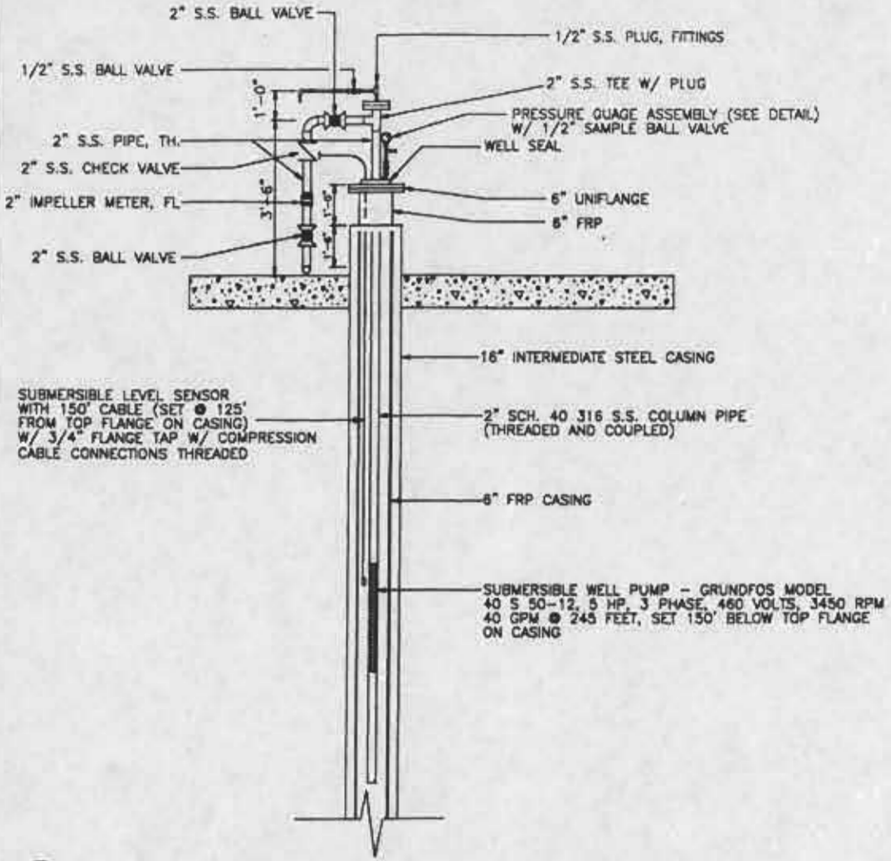
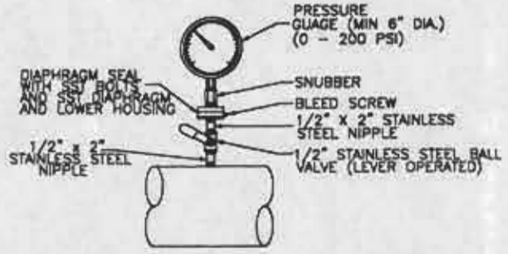
Q.C. —

SHEET 9



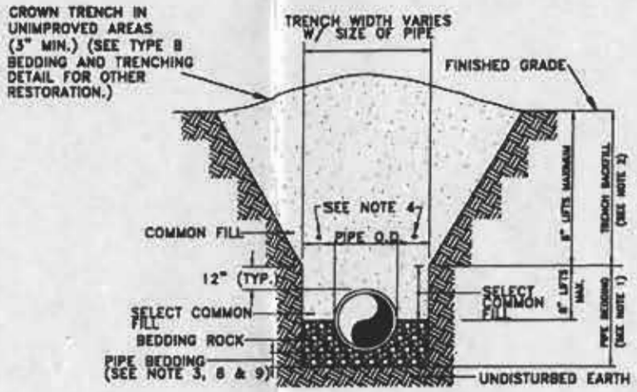
1 M2 C3 (UPPER & LOWER) MONITOR WELL WELLHEAD DETAIL
N.T.S.

NOTES: 1. SUBMERSIBLE LEVEL SENSORS : (ONE EACH MONITOR WELL)
DRUCK 1830 SERIES, TITANIUM
4-20mA OUTPUT
PRESSURE RANGE 0-200 psig
SCU-220 TERMINAL ENCLOSURE W/
INTEGRAL LOOP-POWERED AMPLIFIER
NEMA 4X
W/ MDK-LC LIGHTNING ARRESTER



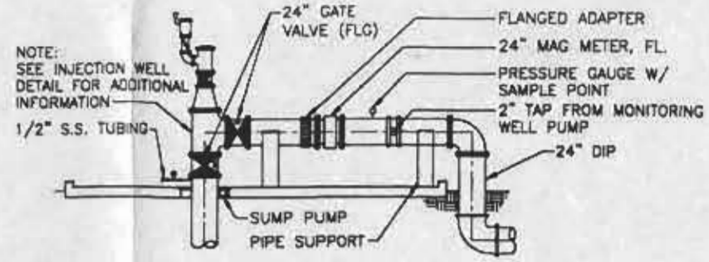
2 M2 M2 PRESSURE GAUGE
N.T.S.

NOTES:
1. ALL VALVES SHALL BE GEAR OPERATED W/ HANDWHEEL ACTUATORS
2. RYAN HERCO FRP SUPPORTS: STRUT TECH FRP CHANNELS W/ UNIVERSAL FIXED POLYURETHANE PIPE CLAMPS
3. BALL VALVES: (THREADED) KITZ TYPE 600, NO.52, 316 STAINLESS STEEL
4. PROPELLER METERS: WATER SPECIALTIES 150 PSI FL TUBE METER, MODEL ML-04-D, SOLID STATE ELECTRONICS, DIGITAL INDICATOR-TOTALIZER
5. PVC: SCHEDULE 80, SOLVENT WELD JOINTS, PAINTED
6. CHECK VALVES: (THREADED) KITZ CLASS 200, NO. 34, TYPE 316 STAINLESS STEEL
7. TAPPING SADDLE: MUELLER DR2A 1740IP NYLON COATED DUCTILE IRON W/ STAINLESS STEEL STRAPS OR EQUIV.
8. FCA - FLANGED ADAPTER: EBBA MODEL 2100 RESTRAINED MEGA FLANGE
9. SUMP PUMP: EBARA PRO-DRAINER, EPD-7, 3/4 HP-1 1/2", 304 SS, 1 PHASE, 115 VAC, AUTOMATIC FLOAT OPERATION, MODEL 40P707AU6.9S, 40 gpm @ 40 FT
10. PRESSURE TRANSMITTER: MODEL 1151 GP ALPHALINE PRESSURE TRANSMITTER 0-200 psig OR EQUAL

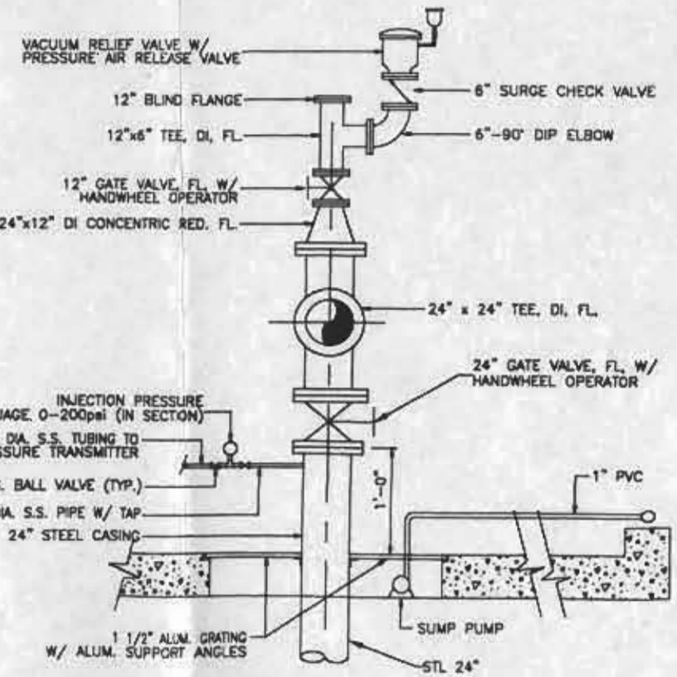


3 M2 C3 TRENCHING AND BEDDING DETAIL
N.T.S.

NOTES:
1. PIPE BEDDING: SELECT COMMON FILL COMPACTED TO 95% OF THE MAXIMUM DENSITY AS PER AASHTO T-180 ABOVE PIPE SPRING LINE; BEDDING ROCK BELOW PIPE SPRING LINE.
2. TRENCH BACKFILL: COMMON FILL COMPACTED TO 95% OF THE MAXIMUM DENSITY AS PER AASHTO T-180.
3. USE TYPE A BEDDING TO BE DETERMINED IN THE FIELD AS DIRECTED BY THE COUNTY.
4. (*): 15" MAX. FOR PIPE DIAMETER LESS THAN 24".
5. WATER SHALL NOT BE PERMITTED IN THE TRENCH DURING CONSTRUCTION.
6. ALL PIPE TO BE INSTALLED WITH BELL FACING UPSTREAM TO THE DIRECTION OF THE FLOW.
7. REFER TO THE SPECIFICATIONS FOR SHEETING & BRACING IN EXCAVATIONS..
8. CONTRACTOR SHALL UTILIZE TYPE A BEDDING, IF REQUIRED BY THE COUNTY. BEDDING DEPTH SHALL BE 4" MINIMUM FOR PIPE DIAMETER LESS THAN 15", AND 6" MINIMUM FOR PIPE DIAMETER 16" AND LARGER.
9. DEPTH FOR REMOVAL OF UNSUITABLE MATERIAL SHALL GOVERN DEPTH OF BEDDING ROCK BELOW THE PIPE. COUNTY SHALL DETERMINE IN THE FIELD REQUIRED REMOVAL OF UNSUITABLE MATERIAL TO REACH SUITABLE FOUNDATION.



4 M2 C5 DEEP INJECTION WELL WELLHEAD PROFILE
SCALE: N.T.S.



5 M2 C3 FINAL CAPPING DETAIL
N.T.S.

NOTE: ALL FLANGE PIPING SHALL BE WITH S.S. NUTS AND BOLTS

Figure 4-4

M-2

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FBPE Certificate of Authorization No.: 24

CLIENT	PROJECT	TASK
FLORIDA GOVERNMENTAL UTILITY AUTHORITY	LEHIGH ACRES WWTF RECLAIMED WATER STORAGE AND PUMPING STATION	DEEP INJECTION WELL AND MONITORING WELLS PIPING DETAILS

ORIGINAL
REVISIONS:
1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12.

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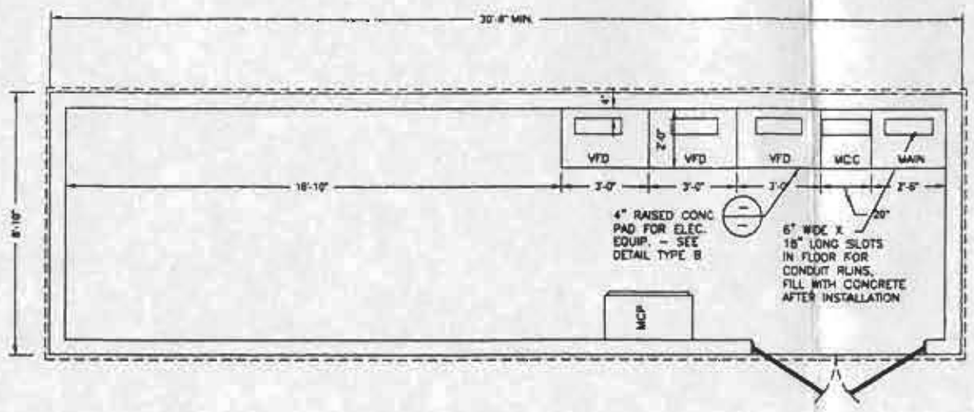
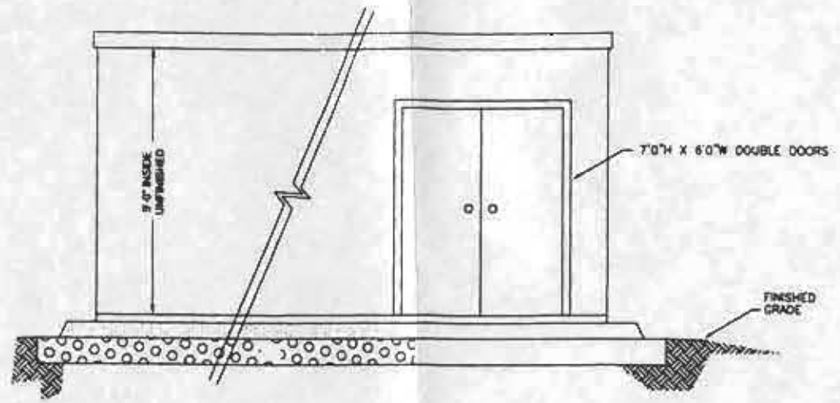
Florida P.E. No.: FL82988
Address: PBSJ 482 SOUTH KELLER ROAD ORLANDO, FL 32810
Signature Date

JOB NO. 00712009
DRAWN PW
DESIGN BM
CHECKED —
Q.C. —

SHEET 16



PLAN VIEW

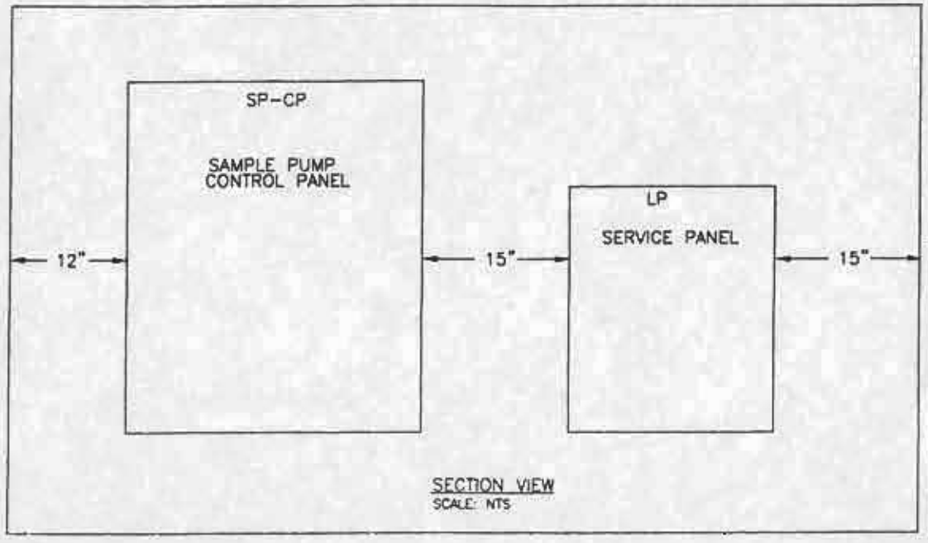


ELEVATION
NTS

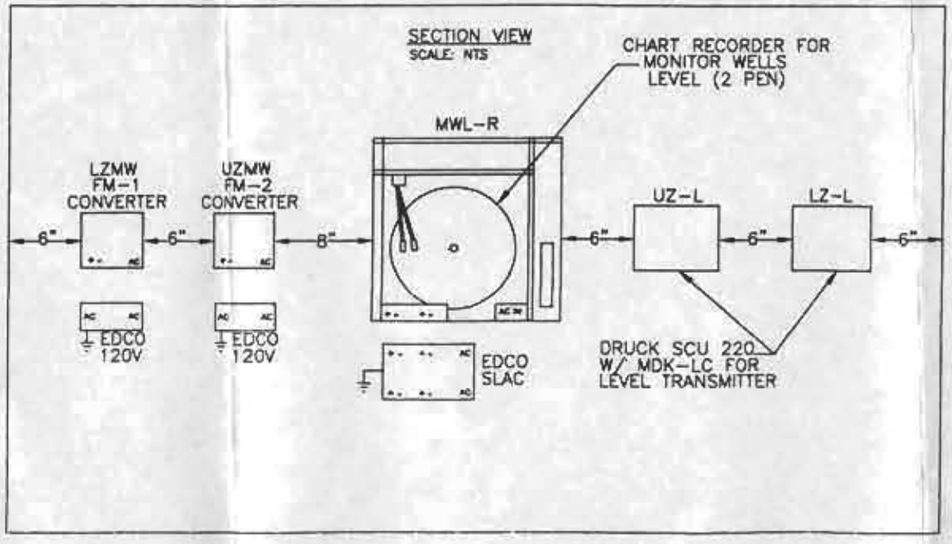
PRECAST ELECTRICAL BUILDING

SCALE: 3/8" = 1'-0"

1. CHART RECORDER
   PARTLOW VERSACHART 4 PEN COLOR RECORDER, CIRCULAR,
   115 VAC CHART TYPE: 7 DAY, (UL APPROVED)



SECTION VIEW
SCALE: NTS



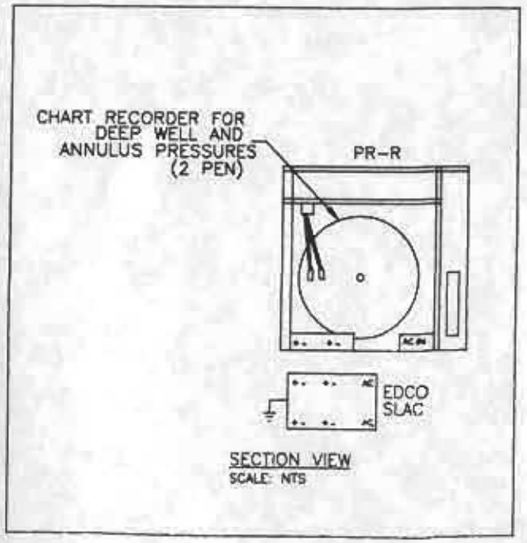


Figure 4-5

E-1

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C/O PBS&J
7205 N.W. 19th Ave., Bldg. 1, 33172-2367
FBPE Certificate of Authorization No.: 24

CLIENT	PROJECT	TASK
FLORIDA GOVERNMENTAL UTILITY AUTHORITY	LEHIGH ACRES WWTF RECLAIMED WATER STORAGE AND PUMPING STATION	PRECAST ELECTRICAL BUILDING PLAN

ORIGINAL
REVISIONS:
1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12.

Name: J. BRADLEY S McMAHEN, P.E.
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Address: PBS&J 482 SOUTH KELLER ROAD ORLANDO, FL 32810
Signature Date

JOB NO. 007120091
DRAWN PW
DESIGN BM
CHECKED
Q.C.

SHEET 18

5.0 Summary and Recommendations

5.1. Summary

A Class I Industrial deep injection well and two deep monitor wells were successfully constructed and tested at the Lehigh Acres site in Lehigh Acres, Lee County. DIW-1 was completed with a 24-inch steel casing to an approximate depth of 2,370 feet with an open hole section (injection zone) extending to an approximate depth of 3,200 feet. LZMW-1B was constructed with a monitoring zone interval of approximately 1,796 to 1,907 feet below land surface and UZMW-1 with a monitoring zone interval of approximately 1,496 to 1,578 feet below land surface. Four shallow water table monitoring wells were installed around the deep wells to monitor the Surficial Aquifer water quality during construction activities. All drilling operations were conducted under construction permits issued by the FDEP and the SFWMD.

A hydrogeologic testing program was approved by the FDEP and stipulated as part of the injection well construction permit. The testing program was performed on DIW-1 system during construction activities and included the following: formation sampling, rock coring, open hole packer hydraulic testing, water quality sampling, geophysical logging, and a short-term (12-hour) injection test.

Data collected from the hydrogeologic testing program were used to define the hydrogeologic framework beneath the Lehigh Acres site and aid in developing the final construction details for the deep wells. Formation sampling and geophysical logging were used to verify the geology of the site. Geophysical logging and water quality sampling (airlift and packer test) were used to determine the occurrence of the USDW, which was identified at approximately 1,700 feet.

Water quality samples also allowed a characterization of the background water quality conditions within the injection zone and monitoring intervals. Rock cores and packer tests were used to estimate the hydraulic characteristics of confining units overlying the injection zone. The geometric average of vertical permeability of the overlying geologic units tested was 0.0325 feet per day. Based on this vertical permeability, the estimated vertical travel time from the top of the injection zone (2,300 feet) to the base of the USDW (1,700 feet) is approximately 170 years.

A short-term (12-hour) injection test was performed on DIW-1 following completion of a successful MIT. An average flow rate of approximately 1,438 gpm, and a maximum flow rate of 1,650 gpm was sustained for the final 3.5 hours of the test with a maximum wellhead pressure change of 1.0 psi. A down-hole memory pressure transducer was utilized to directly measure pressure in the formation below the base of the casing. The formation pressure increase resulting from injection was 2.0 psi above static conditions.

This injection test demonstrated that a suitable injection zone exists between 2,370 and 3,200 feet.

5.2. Recommendations

Following construction of the piping, pumps and controls for the Lehigh Acres deep injection well system, an operational testing program will be performed in compliance with the injection well construction permit for DIW-1 and in support of the injection well operating permitting process. The proposed operational testing program will consist of injecting reclaimed water at a rate of up to 1,650 gpm (2.4 MGD) at a maximum wellhead pressure not to exceed 104 psi. Operational monitoring will consist of recording flows, injection wellhead pressures, monitor well pressures, and water quality sampling. The proposed monitoring parameters and frequencies stipulated in the FDEP well construction permit will be included in the Operation & Maintenance manual. Specific infectivity (SI) testing will be performed on a monthly basis throughout the duration of the operational testing period.

The operational testing period for DIW-1 will not exceed two years from the date of authorization. Data collected during operational testing will be submitted to the FDEP on a monthly basis as required by the operating permit. After a minimum testing period of one year, the test data will be reviewed and incorporated into a summary report for the FDEP, in support of the operating permit application.

6.0 References

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