Marco Lakes ASR Expansion Project ASR-8 Well Completion Report

May, 2005
Volume I

Prepared by:

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MARCO LAKES ASR- 8
EXPANISON PROJECT
WELL COMPLETION REPORT

Prepared for:

Marco Island Utilities
Marco Island, Florida

May 2005

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Project No. 01-04773.01

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EXECUTIVE SUMMARY

This report summarizes the construction of the fifth Aquifer Storage and Recovery (ASR) well, ASR-8, at Marco Island Utility's, Marco Lakes Facility. Ultimately, a total of nine ASR wells are proposed to be operational at this site. All wells constructed and proposed at this site will be completed to store water within the basal Hawthorn, upper Suwannee Formations. This storage zone is located between approximately 730 and 780 feet below land surface across the site.

ASR-8 was constructed using 17.4-inch O.D. CertainTeed, Certa-Lok SDR 17 PVC casing to conduct water between the surface and the ASR storage zone. The storage zone is intersected by ASR-8 from 730 to 773 feet below ground level. The wellhead is constructed using 316 stainless steel. Tests performed on the new ASR well indicate that the new well can operate at the design rate of 1000 gpm.

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1.0 INTRODUCTION

This Well Completion Report summarizes the construction of Well ASR-8 at Marco Island Utility's raw water facility at Marco Lakes (Figure 1-1). The drilling, construction, and testing activities conducted to complete ASR-8 are documented in this report.

Construction of ASR-8 was authorized by the Florida Department of Environmental Protection as a part of a permit to expand the existing ASR wellfield (Figure 1-2). Permission to construct eight (8) Class V Group Seven Aquifer Storage and Recovery injection wells at this site was granted by FDEP on April 22, 1999 through issuance of permit numbers 141218-001 through 008-UC (Appendix 1.1). Collier County also issued a permit for construction of ASR-8 and assigned the Florida Unique I.D. # CC10124A (Appendix 1.2).

The current expansion is designed to increase the ultimate storage capacity of the wellfield to approximately 600 MG. It is anticipated that the newly expanded wellfield will be able to deliver more than 450 million gallons of water for use at Marco Island on a seasonal basis assuming a 100 MG cycle storage volume per well.

2.0 HYDROGEOLOGY

2.1 Geology

The description of the geology at the project site is based on the analyses of drill cuttings, geophysical logs (Appendix 2.1), and hydrologic tests conducted during the construction of ASR-8. A lithologic log for ASR-8 is provided in Appendix 2.2. The borehole was terminated within the upper Suwannee Limestone at 773 feet below pad level (bpl). The general stratigraphic description of the site is summarized below and is provided as a hydrostratigraphic column in Figure 2-1. A northwest-southeast hydrogeologic cross-section based on correlated gamma logs from ASR-8 to ASR-2 is provided as Figure 2-2.

The geologic formations penetrated during drilling operations range in age from Holocene (8000 years ago to present) to Oligocene (33.7 to 23.8 million years ago). They consist of undifferentiated Quaternary deposits, the Tamiami Formation, the Peace River and Arcadia formations of the Hawthorn Group, and the Suwannee Limestone Formation. The ASR storage zone, which extends from 730 to 773 feet bpl at this well, occurs within carbonate rocks in the basal portion of the Arcadia Formation and the uppermost strata of the Suwannee Limestone.

Undifferentiated Quaternary Deposits

Undifferentiated sediments of Pleistocene to Holocene age (1.8 million years - present) range from less than 10 feet to over 30 feet thick across the site and form the uppermost strata encountered. These surficial deposits consist mainly of organics, clay, and limestone. A distinctive layer of consolidated limestone "caprock" was encountered in the uppermost section of surficial deposits from 7 to 12 feet below pad level. This limestone consists mainly of bivalve shells and shell fragments cemented in a matrix of recrystallized calcite.

Tamiami Formation

The Pliocene age Tamiami Formation (1.8 to 5.3 million years in age) unconformably underlies the undifferentiated surficial sediments. The Tamiami Formation extends from approximately 20 to 120 feet bpl at this site. The Tamiami can be subdivided into upper and lower limestone units (Pinecrest and Ochopee members), that are separated by a gray to green marl or marly limestone (Bonita Springs member). The limestones generally exhibit good to excellent moldic porosity, and become more sandy with depth. The combined thickness of the Tamiami Formation is approximately 100 feet.

Peace River Formation (Hawthorn Group)

The predominantly Miocene-age Hawthorn Group (5.3 to 23.8 million years in age) in south Florida is divided into an upper unit of mainly siliciclastic sediments, referred to as the Peace River Formation; and a lower unit consisting predominantly of carbonate rocks, termed the Arcadia Formation (Scott, 1988). The Peace River Formation extends from approximately 120 to 300 feet bpl at this site. This unit is composed mainly of upper and lower phosphatic clay/limestone sequences with an intermediate quartz sand layer. The uppermost layer at this site is a phosphatic clay whose base is defined by coarse phosphatic sands from 130 to 136 feet. A distinctive light brown siltstone from 136 to 144 feet separates the phosphatics from an intermediate sequence of quartz sand from 144 feet to 185 feet. The quartz sand layers in this unit are often very coarse and poorly sorted and contain abundant frosted and opaque grains. This unit is underlain by a thick sequence of phosphatic clays with interlayered limestones. Coarse stringers of discoidal quartz sand to pebbles are present in the clays from 207 to approximately 230 feet.

Arcadia Formation (Hawthorn Group)

The top of the Arcadia Formation is marked by a transition from a green clay to a phosphatic limestone at a depth of 300 feet bpl at this site. The base of the formation is picked at approximately 750 feet bpl across the site.

The Arcadia Formation consists of an interbedded sequence of phosphatic carbonate rocks and lime mud. Porosity of the limestones is variable; tending to be best developed where fossil shell has dissolved to form molds. The lower portion of the Arcadia Formation contains a sequence of dolosilt, clay, and marly limestone that form the confining beds above the ASR storage zone. The basal portion of the Arcadia Formation is included in the ASR storage zone, and consists of very pale orange limestone with excellent moldic porosity and low gamma activity. The thickness of the Arcadia Formation is approximately 450 feet.

Suwannee Limestone Formation

The Suwannee Limestone Formation is early to middle Oligocene in age (23.8-28 million years). The upper 23 feet of strata in the Suwannee are included in the ASR storage zone and consist predominantly of yellowish gray to very pale orange limestone packstone with good to excellent moldic porosity and low gamma activity.

2.2 Aquifer Designations

The strata penetrated are grouped into three principal systems; the surficial aquifer system, intermediate aquifer system, and the Floridan aquifer system. The aquifers and confining units identified at the site are illustrated in Figure 2-1. The surficial aquifer system includes the water table and lower Tamiami aquifers. The intermediate aquifer system includes a series of aquifers and confining units within the Hawthorn Group. The upper section of the Floridan aquifer includes the carbonate strata of the basal portion of

the Arcadia Formation and the upper portion of Suwannee Limestone and is the hydraulic unit identified as the storage interval at this site.

2.3 Storage and Confining Interval Description

The ASR storage interval occurs within permeable limestones present in the lower 20 feet of the Arcadia Formation and the upper 23 feet of the Suwannee Limestone (730 to 773 feet bls). Flow log data from the ASR-8 well (Figure 2-3) indicate that the fairly uniform flow comes from the zone between 745 and 773 feet. The flow log suggests that there is a single uniform flow unit from the bottom of the well at 773 feet to 745 feet bpl.

The confining beds overlying the storage zone consist of approximately 115 feet of phosphatic, low-permeability dolosilt and clay with interbeds of more permeable carbonates in the lower portion of the Arcadia Formation. Natural gamma activity is generally high within this interval.

2.4 Formation Water Quality

Fresh water resources in the region surrounding the site are generally limited to the water table aquifer and the upper portion of the lower Tamiami aquifer. Groundwater in deeper aquifers is brackish to saline.

Water samples were taken approximately every ten feet at ASR-8 during reverse-air drilling of the open hole from 730 to 773 feet. The samples were analyzed in the field for chloride concentration and conductivity (Table 2-4). Fluctuations in the chloride and conductivity results are believed to reflect the variability of the mixture between produced formation water and added fluids. Addition of lake water and drilling fluid at the surface while drilling out the cement plug at the base of the casing was required to prevent casing collapse. The results of two developmental water samples collected on the day following reverse air drilling are also included in the table. These samples more accurately reflect the true groundwater quality.

Formation water from the new well was later sampled after approximately 46 well volumes had been purged from the well during aquifer testing. These samples were analyzed for all primary and secondary drinking water parameters including unregulated chemicals by Harbor Branch Laboratories, Inc. A review of the chemical analyses results (Appendix 2.3) shows that the overall water quality within the injection zone indicates mixing of injected water from ASR-2 with the native formation water.

The base of the underground source of drinking water (USDW), defined in applicable state and federal regulations as 10,000 mg/l total dissolved solids, was not penetrated at the project site. The USDW was picked at a depth of 1,095 feet in well CO-2080, located about 2 miles south of the Marco Lakes (ViroGroup, 1996b). Native groundwater in the storage interval is brackish and most appropriately classified a G-II, groundwater with a TDS content between 3,000 and 10,000 mg/l (F.A.C. 62-520.410).

3.0 WELL CONSTRUCTION PROGRAM

The new ASR well was completed in the basal Arcadia/Upper Suwannee formations (ASR zone). Weekly summary reports were prepared for the FDEP and TAC during well construction (Appendix 3.1). Daily drilling reports were prepared by the contractor and were previously submitted with the weekly summary reports.

3.1 Site Preparation

Two site surveys were conducted by Metron, Inc. of Fort Myers, Florida to stake the well positions on the property and to establish reference elevations. A final survey will be conducted upon completion of this phase of the expansion. Removal of brush, ground foliage, and rocks was necessary at this site prior to the start of well construction.

3.1.1 Produced Water Discharge

Prior to beginning the reverse-air drilling phase of this well, a temporary discharge line was connected to an existing 8-inch diameter pipeline that outfalls at a point downstream of the Henderson Creek weir at the intersection of U.S. 41 and Henderson Creek (Figure 1-2).

Discharge below the weir at Henderson Creek was permitted under the State of Florida's Generic NPDES permit for the discharge of produced water from a non-contaminated site activity. All drilling solids were either hauled from the site for disposal as drilling mud or used as fill material for site restoration and preparation.

3.1.2 Temporary Drill Pad Construction

A temporary drilling pad 60 feet long by 20 feet wide, surrounded by a two-foot high berm, was constructed at the well site to contain water and drilling fluids at the wellhead and around the drilling rig. The well pad was graded to provide stability for the drilling rig. A 10-millimeter thick polyethylene liner was installed prior to installation of a gravel bed inside the pad. Plywood tracks were laid on the gravel bed inside the pad to distribute the weight of the drilling rig as it was moved into the pad area. Excess water and drilling fluid was pumped from the containment pad to fluid storage tanks as needed.

3.1.3 Pad Monitor Well Construction

The contractor received a permit from Collier County to construct two pad monitor wells prior to drilling ASR-8. The two wells are approximately 20 feet in depth (Figure 3-1), and were installed at the SE and NW corners of the drill pad prior to drilling to monitor for excess spills and leakage of salt water from the containment pad during drilling operations. The two 4-inch wells were drilled using the mud rotary method and were gravel packed, grouted, and developed. Construction details for the pad monitor wells are included in Table 3-1. Measurements of the static water levels were recorded and the pad monitor wells were purged and sampled weekly for the duration of the drilling and construction phase of the project. Field analyses performed for chlorides, conductivity, pH, and temperature are summarized in Tables 3-2 and 3-3.

3.2 ASR-8 Well Construction

Well construction at ASR-8 commenced on November 17, 2004 and the drilling rig was moved off the well on March 29, 2005. Final wellhead adjustments were completed May 16, 2005. A schematic of the final construction of ASR-8 is included as Figure 3-3.

3.2.1 Pit Casing Installation

Well construction began with the installation of a 26-inch O.D., steel pit casing set into a 35-inch nominal wellbore drilled to 50 feet below pad level (bpl). A single length of 26-inch, spiral welded, 3/8-inch wall, steel casing was set to a depth of 47 feet bpl and pressure grouted in place using neat portland, type II cement. Mill certificates for this pipe are included as Appendix 3-2.

3.2.2 Production Casing Installation

After installation of the pit casing, a 12½ -inch diameter bit was used to drill to a depth of 720 feet bpl by the mud rotary method to control artesian flow. Inclination surveys were completed in the pilot hole as well as the reamed hole every 90 feet and are listed in Table 3-4. Rates of bit penetration were measured at various intervals over most of the pilot hole depth and are included as Table 3-5. A drill pipe tally that includes the lengths of all units in the drill string was recorded for the drilling of the pilot hole (Table 3-6).

Pilot hole drilling was aborted at 720 feet bpl because the contractor was unable to adequately suppress artesian flow from the borehole. The pilot hole was filled with cement from 720 to 183 feet bpl by grouting through the drill string. Details of pilot hole cementing operations were recorded in a cementing log Table 3-7. Table 3-8 summarizes the volume of cement pumped and the tagged height for each stage.

The pilot borehole from 50 to 183 feet was reamed to a diameter of 25 inches. The 25-inch borehole was advanced through and beyond the cemented pilot hole and was terminated at 737 feet bpl. A tally of the pipe string used during the reaming phase of drilling is included as Table 3-9. The borehole was re-reamed and circulated with conditioned drilling fluid in preparation for setting casing. Natural gamma, XY-caliper, dual induction, and borehole compensated sonic logs were run in the reamed hole to assist in the final casing setting depth selection and estimation of annular borehole volume.

CertainTeed, Certa-Lok 17.4-inch O.D. SDR 17 PVC casing was run to the setting depth of 730 feet bpl. Table 3-10 provides a summary of the production casing installed. Specifications for the production casing string are included as Appendix 3.3. Neat cement grout was emplaced in the annulus during an initial pressure grout stage followed by two successive tremie grout stages. A total of 902 cubic feet of neat cement was used during the grouting operations. Details of cementing operations were recorded in a cementing log Table 3-11. Table 3-12 summarizes the volume of cement pumped and the annular height for each stage. Fluid temperature logs were performed after each of the three cement stages to estimate the annular grout level.

3.2.3 Casing Pressure Test

After the cement plug in the casing was partially drilled out from 695 to 723 feet bpl, the drilling mud was flushed from the casing and replaced with water. A volume of water approximating eight casing volumes was flushed through the casing to remove drilling solids. A one-hour pressure test of the casing was conducted with an initial pressure of 120.5 psi and a final pressure of 119 psi. The pressure inside the casing was recorded at 5-minute intervals and the official record was signed and witnessed by WRS and Southern Well Services (Appendix 3.4). The recorded pressure drop of 1.24% during the successful hour-long test was well below the 5% maximum limits specified in FAC 62-528.410. The accuracy of the pressure gauge was certified by prior testing against a pressure standard deadweight tester (Appendix 3.5). FDEP authorized the performance of this test without their presence.

3.2.4 Open-Hole Construction

Reverse-air drilling of the open hole portion of ASR-8 commenced on March 15, 2005 using a 15-inch bit. A tally was prepared of the lengths of all pieces of that drill string and is included as Table 3-13. Cuttings samples were collected at five-foot intervals and formation water samples were taken every ten feet and field analyzed for conductivity and chlorides. The borehole was advanced from the top of the cement plug inside the PVC

casing at 723 feet to a total depth of 773 feet bpl. Artesian flow was evidenced when the air supply was shut off below the base of the casing during this phase of drilling.

3.3 Well Development and Suppression

The well was developed for two hours by reverse-air through the drill string as the drill string was raised and lowered through the open hole section of the well. At the completion of development, produced water was clear of sediment. All water produced during reverse-air drilling and development was retained in storage tanks for settling before being discharged to Henderson Creek downstream of the weir. At the completion of development, the artesian flow of the well was suppressed using a salt solution to facilitate installation of a submersible pump for aquifer testing. After a step-drawdown test was completed, the well was once again suppressed in order to remove the submersible pump. The well was suppressed a third time in order to remove the drill through well header from the surface casing.

3.4 Final Geophysical Logging and Video Survey

MV Geophysical Surveys, Inc. performed a video survey and caliper/gamma log of the entire well and also the following open hole logs; flowmeter, fluid resistivity/temperature, dual induction, and borehole compensated sonic/variable density log.

3.5 Wellhead and Pad Completion

At the completion of well construction and testing, the well was killed using NaCl in preparation for wellhead installation. A 16-inch by 12-inch, flanged, schedule 40, 316 stainless steel tee with a 12-inch butterfly valve was connected to the well column with a stainless steel to Certa-Lok to flange adaptor (Appendix 3.3). The top of the 16-inch tee was temporarily completed with a blind flange. Two 2.5-inch and one 3-inch diameter stainless steel access ports with ball valves were provided on the wellhead assembly (Figure 3-4). The final well pad is to be at an elevation of 7.5 feet NGVD by others.

4.0 FLOW TESTS AND ANALYSES

On March 24, 2005, a step drawdown test was conducted on ASR-8. Pressure changes due to pumping were recorded at a frequency of one reading per minute during this test at a probe setting depth of 45 feet below top of casing. Drawdown and flow data from ASR-8 were compiled into -Appendix 4.1 for the four-hour step drawdown test.

The step drawdown test was primarily performed to establish the specific capacity of this interval for pump sizing. Table 4-1 summarizes the data obtained during this test. As indicated in Table 4-1, specific capacity values measured in ASR-8 were 35.8 gpm/ft at 205 gpm, 32 gpm/ft at 455 gpm, 27.6 gpm/ft at 787 gpm, and 25.6 gpm/ft 1098 gpm. A plot of drawdown vs. time is included as Figure 4-1. Figure 4-2 is a plot of specific capacity vs. discharge. It is estimated that the specific capacity of ASR-8 under production conditions will be approximately 25 gpm/ft.

5.0 REFERENCES

Scott, T.M., 1988, The lithostratigraphy of the Hawthorn Group (Miocene) of Florida: Fla. Geol. Survey Bul. No. 59, 148 p.

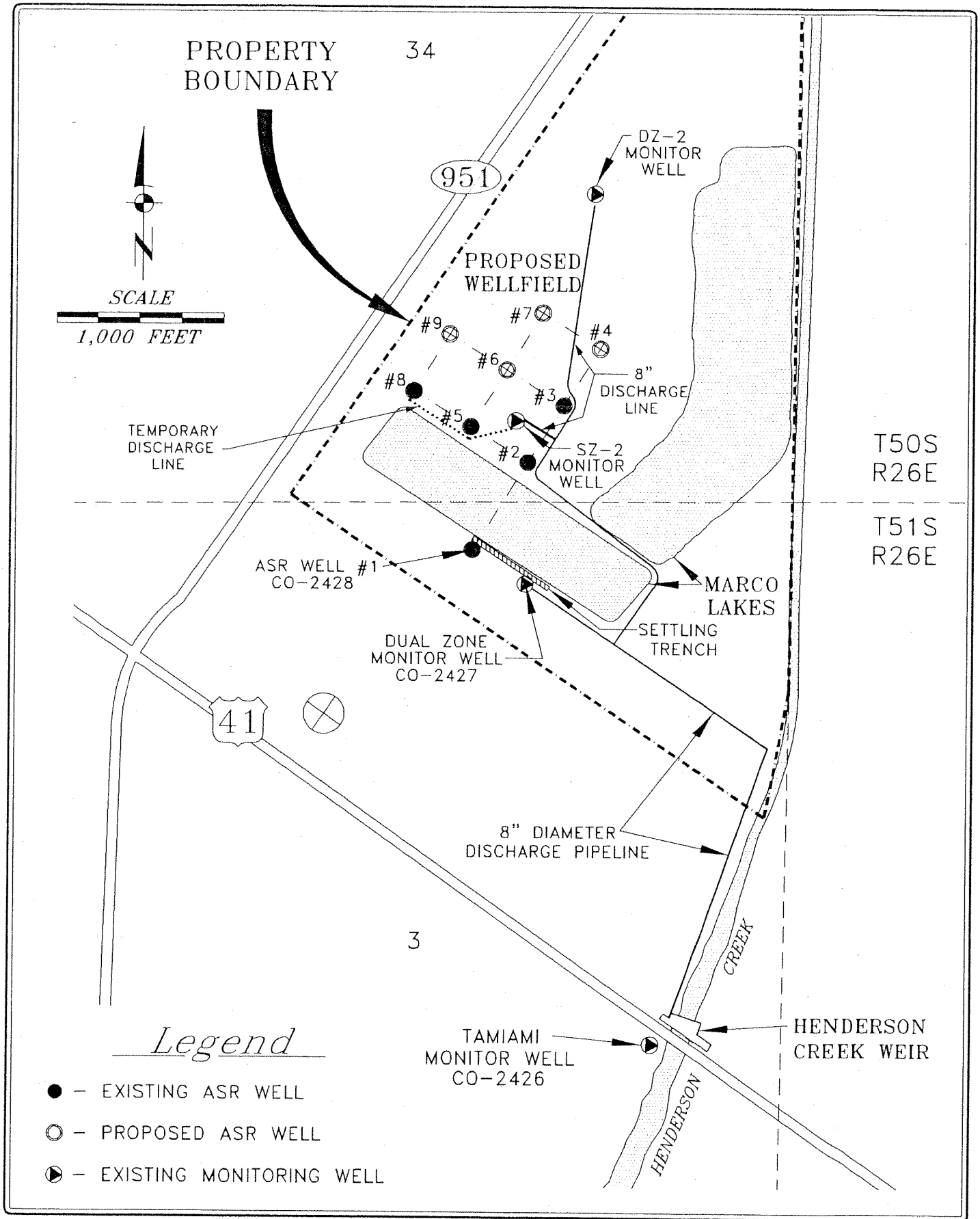
ViroGroup, Inc., 1996b, Marco Island R.O. Wellfield Expansion Project Well Construction Report: Report to Southern States Utilities (September 1996).

ViroGroup, Inc. 1998, Marco Lakes Aquifer Storage and Recovery Pilot Project-Final Report, Collier County, Florida: Report to Florida Water Services, Inc.

Water Resource Solutions, Inc. 2000, Marco Lakes ASR Expansion Project Well Completion Report: Report to Florida Water Services, Inc (April 2000).

Water Resource Solutions, Inc. 2005, Marco Lakes ASR Well No. 5 Completion Report: Report to Florida Water Services, Inc (December 2004).

FIGURES



Water Resource Solutions	PROJECT NAME: MARCO ISLAND UTILITIES	DWG. NUMBER: A-014773E3
	PROJECT NUMBER: 01-04773.02	DATE: 05/04/05

FIGURE 1-2. MARCO LAKES ASR EXPANSION SITE DETAIL.

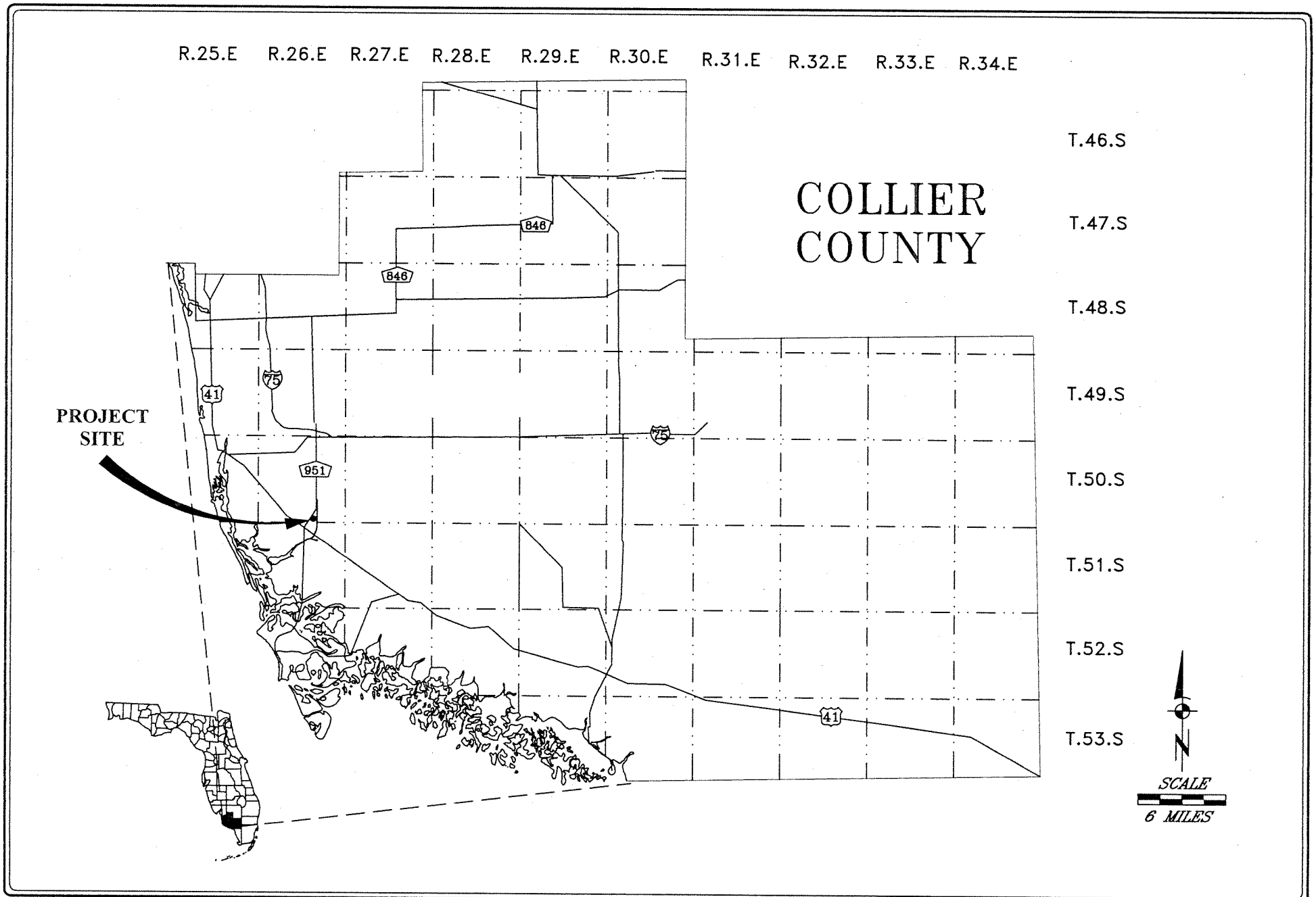


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FIGURE 1-1. GENERAL SITE LOCATION MAP.

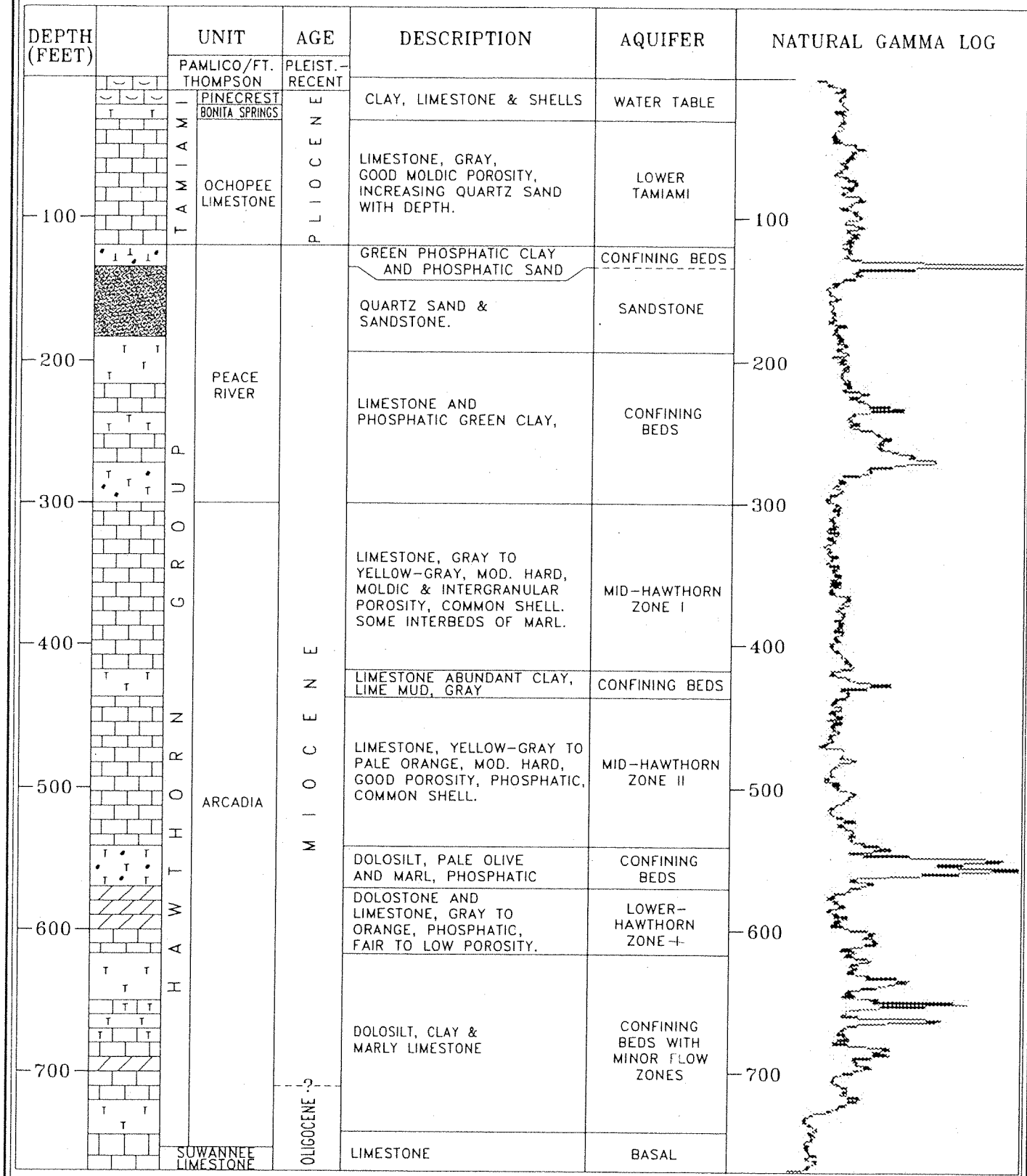

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FIGURE 2-1. HYDROSTRATIGRAPHIC COLUMN MARCO LAKES ASR-8.

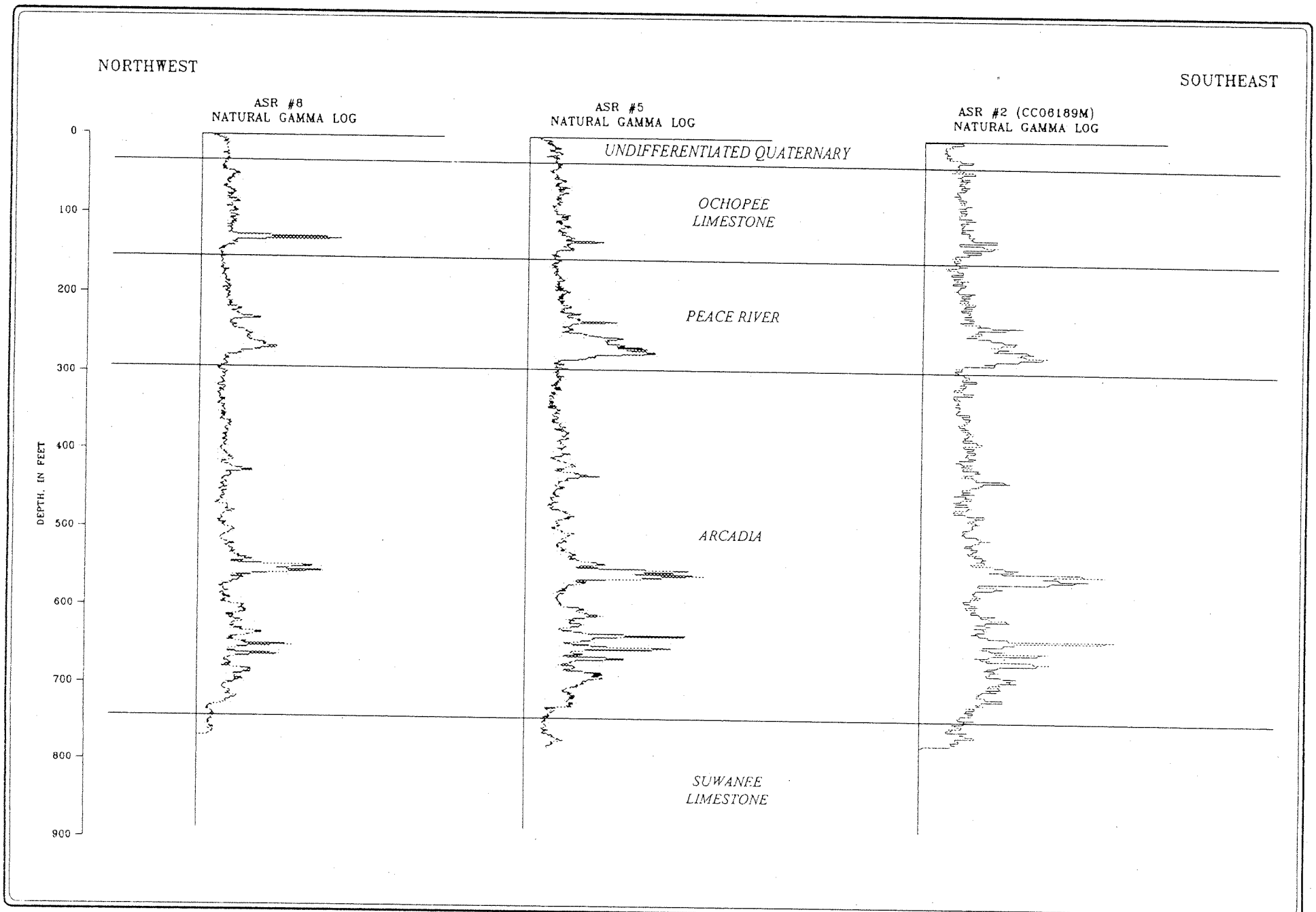

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FIGURE 2-2. NORTHWEST-SOUTHEAST GEOLOGIC CROSS-SECTION THROUGH SITE BASED ON GEOPHYSICAL LOGS.

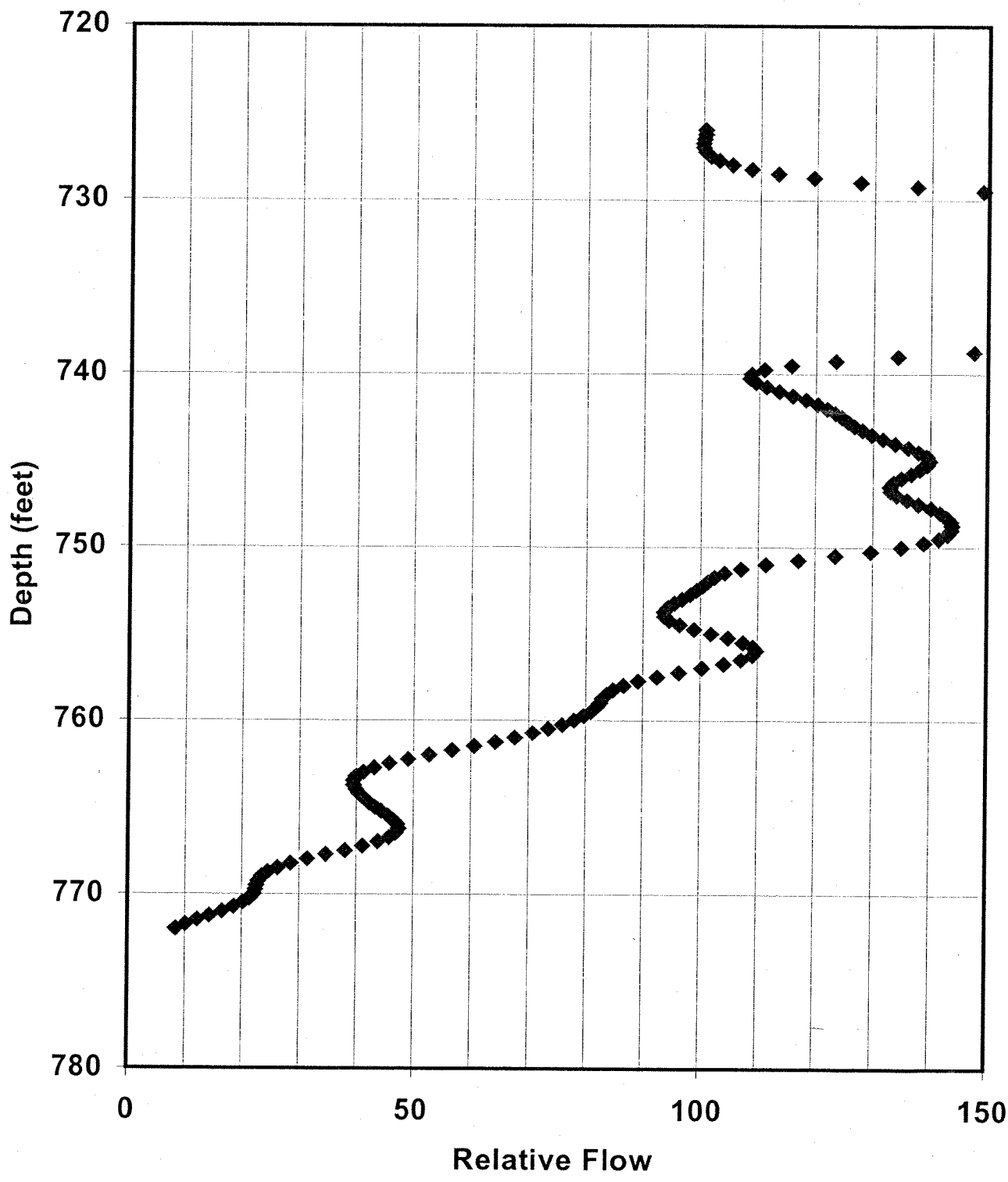

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Figure 2-3 Flow Log Diagram

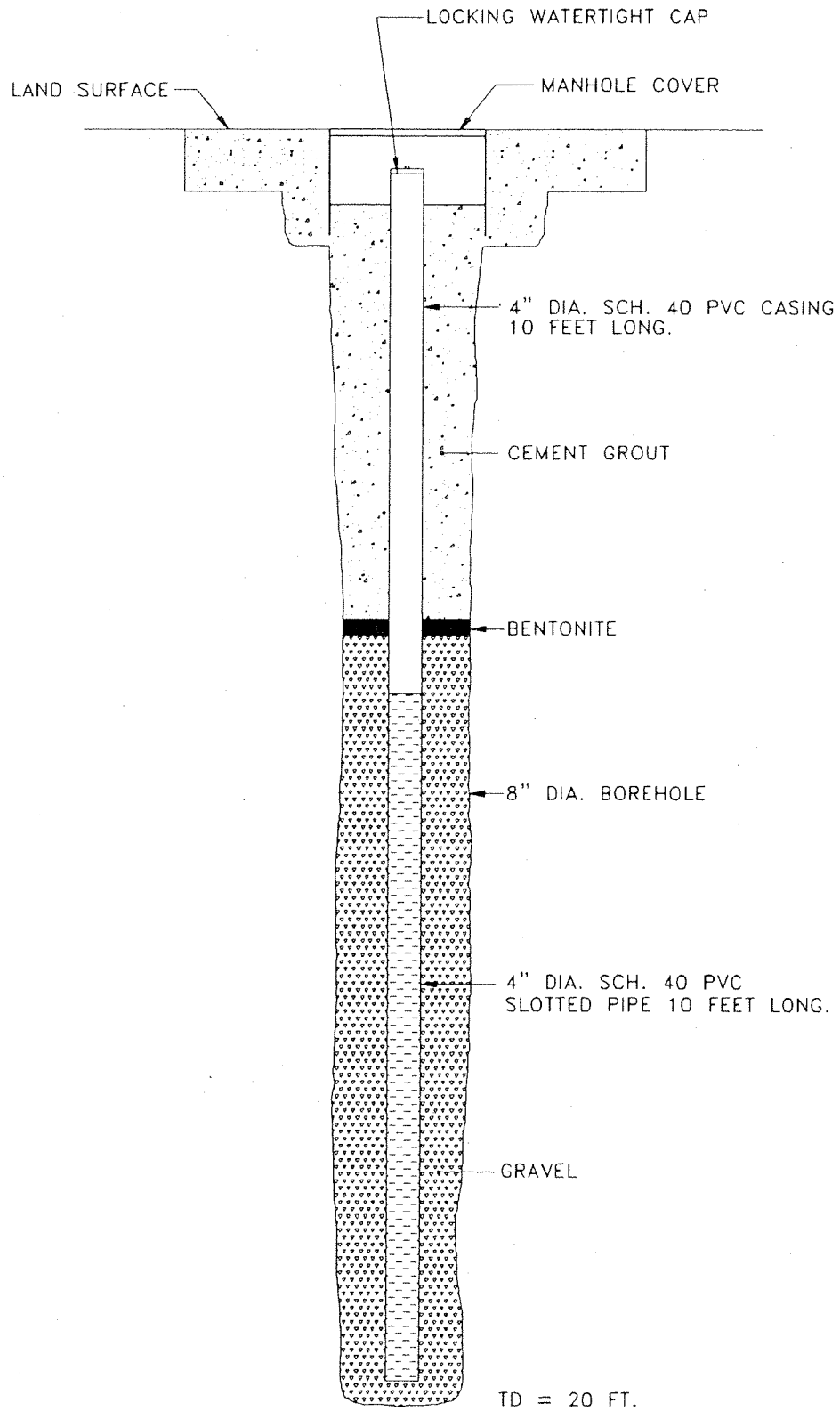

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FIGURE 3-1. PAD MONITOR WELL CONSTRUCTION SCHEMATIC.

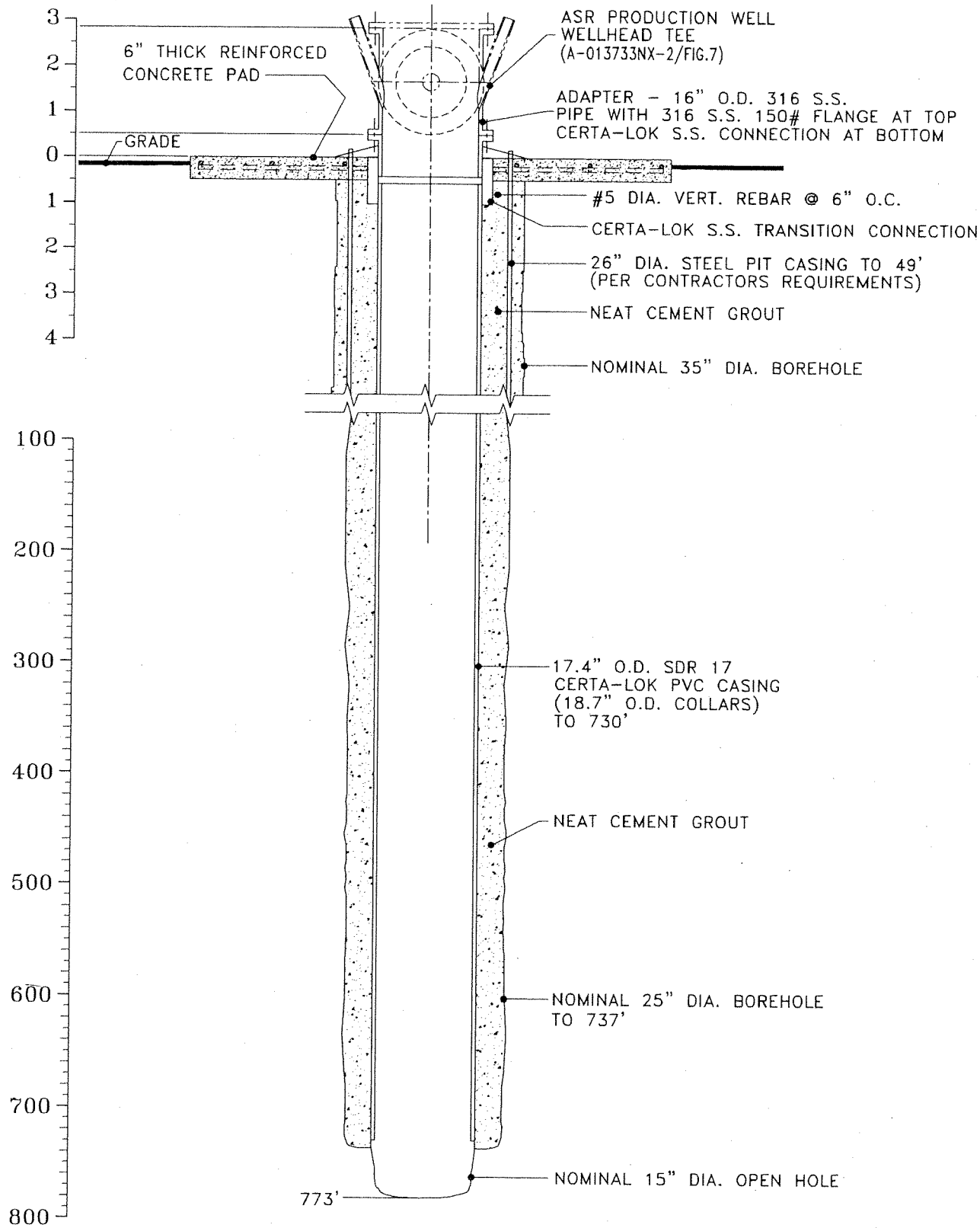

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FIGURE 3-2. ASR-8 WELL CONSTRUCTION SCHEMATIC.

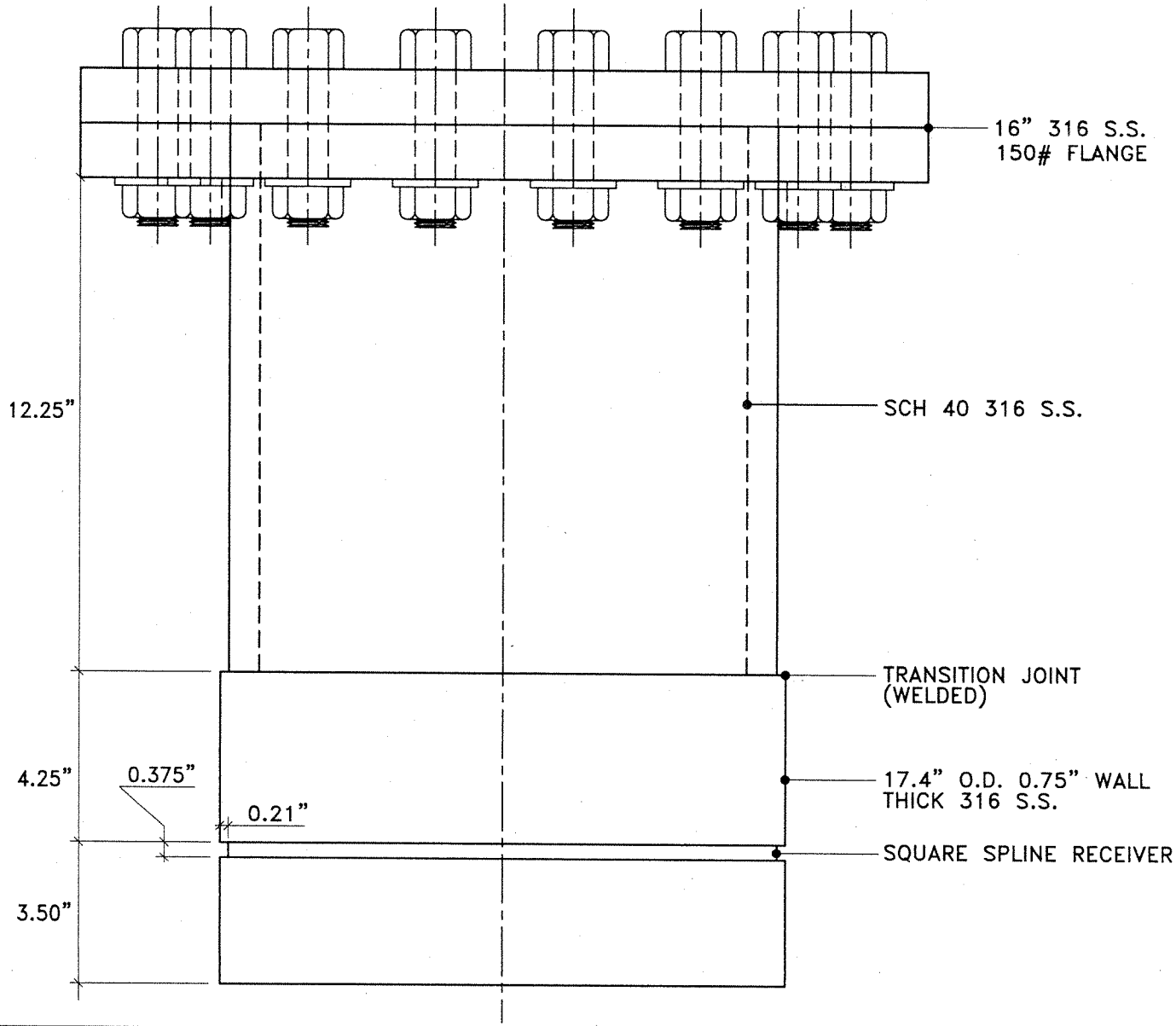

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FIGURE 3-3. SCHEMATIC OF CHANGE OVER ADAPTER.

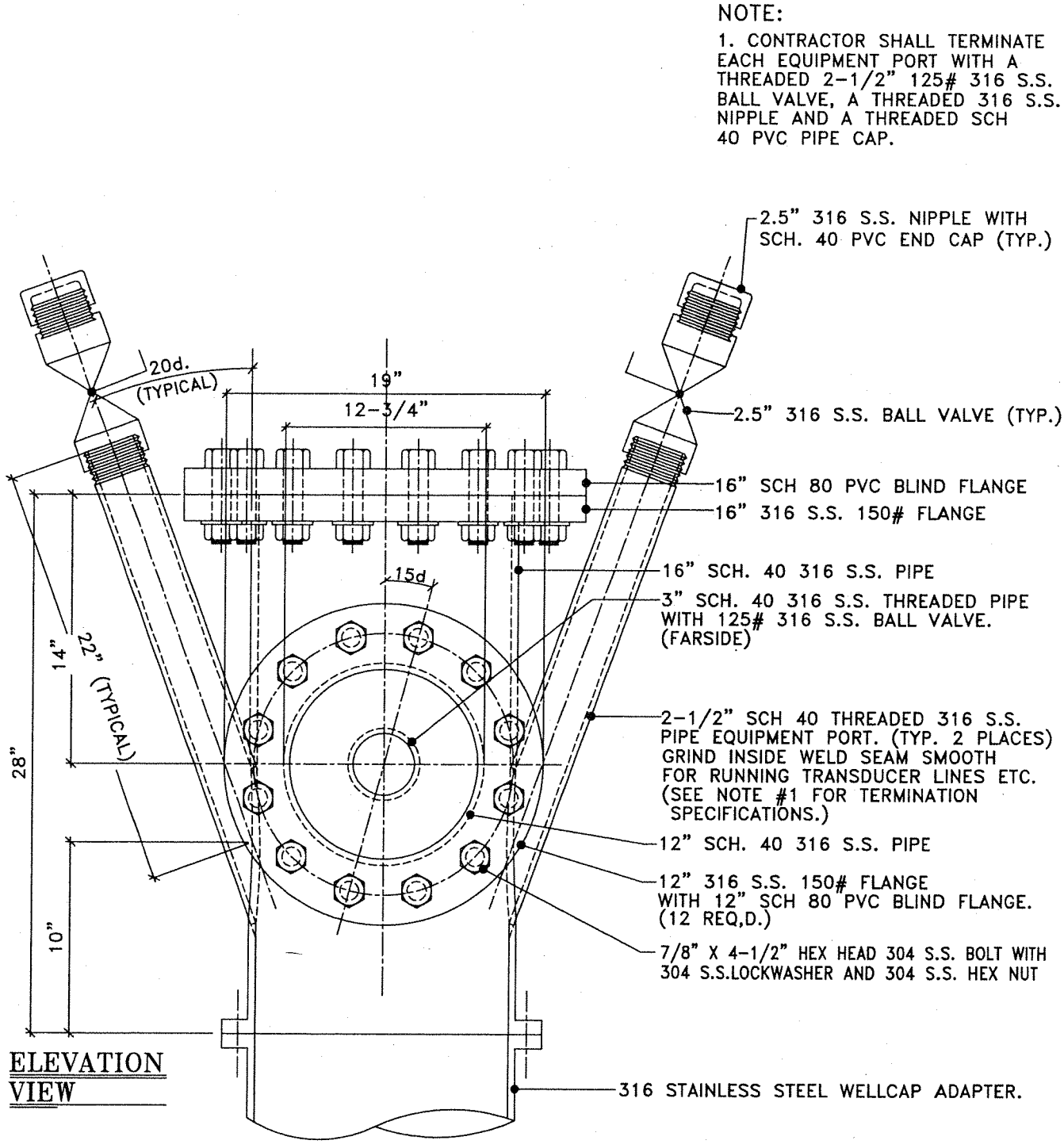

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FIGURE 3-4. ASR PRODUCTION WELLHEAD DIAGRAM.

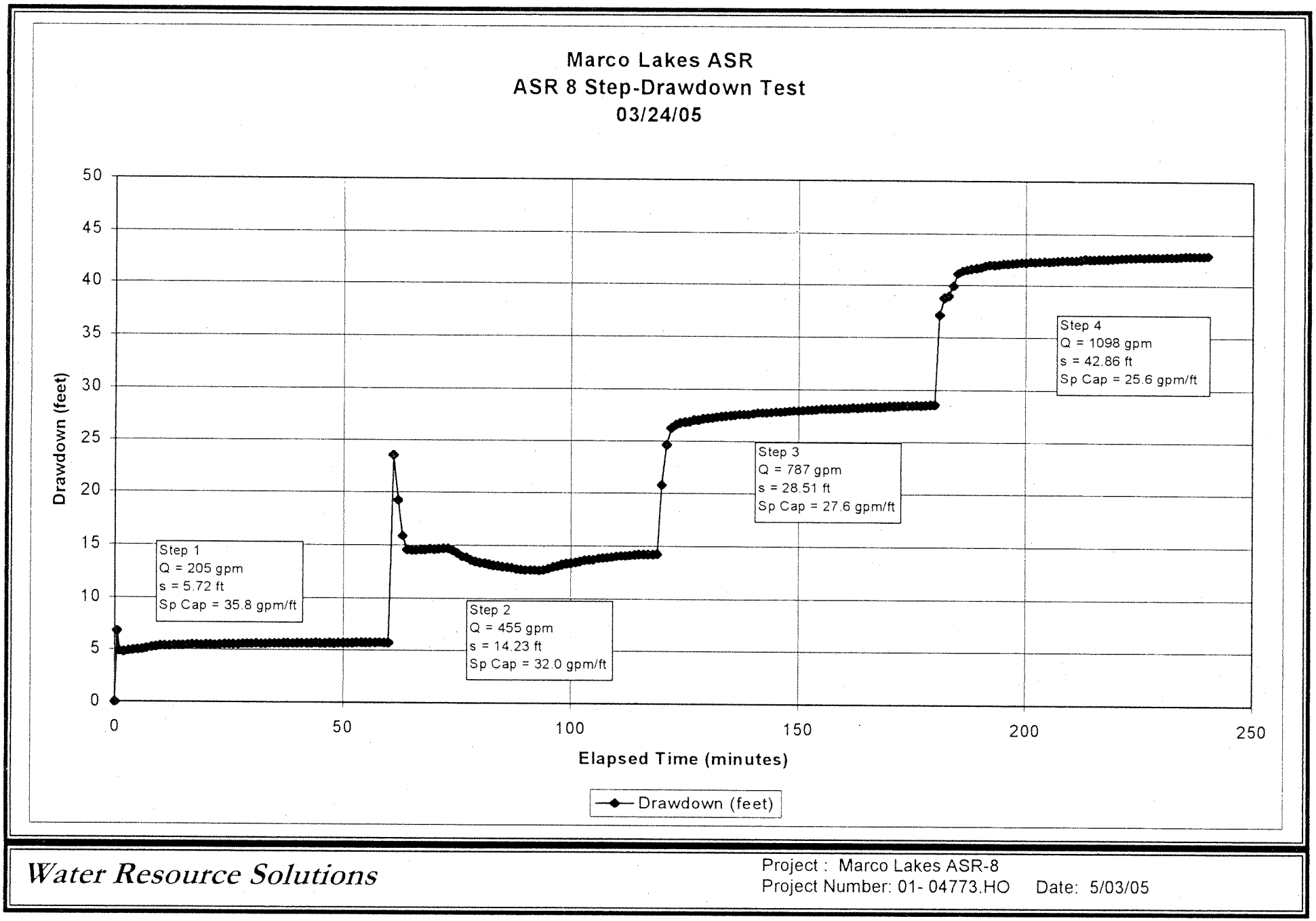

Figure 4-1 Step-Drawdown Test Hydrograph

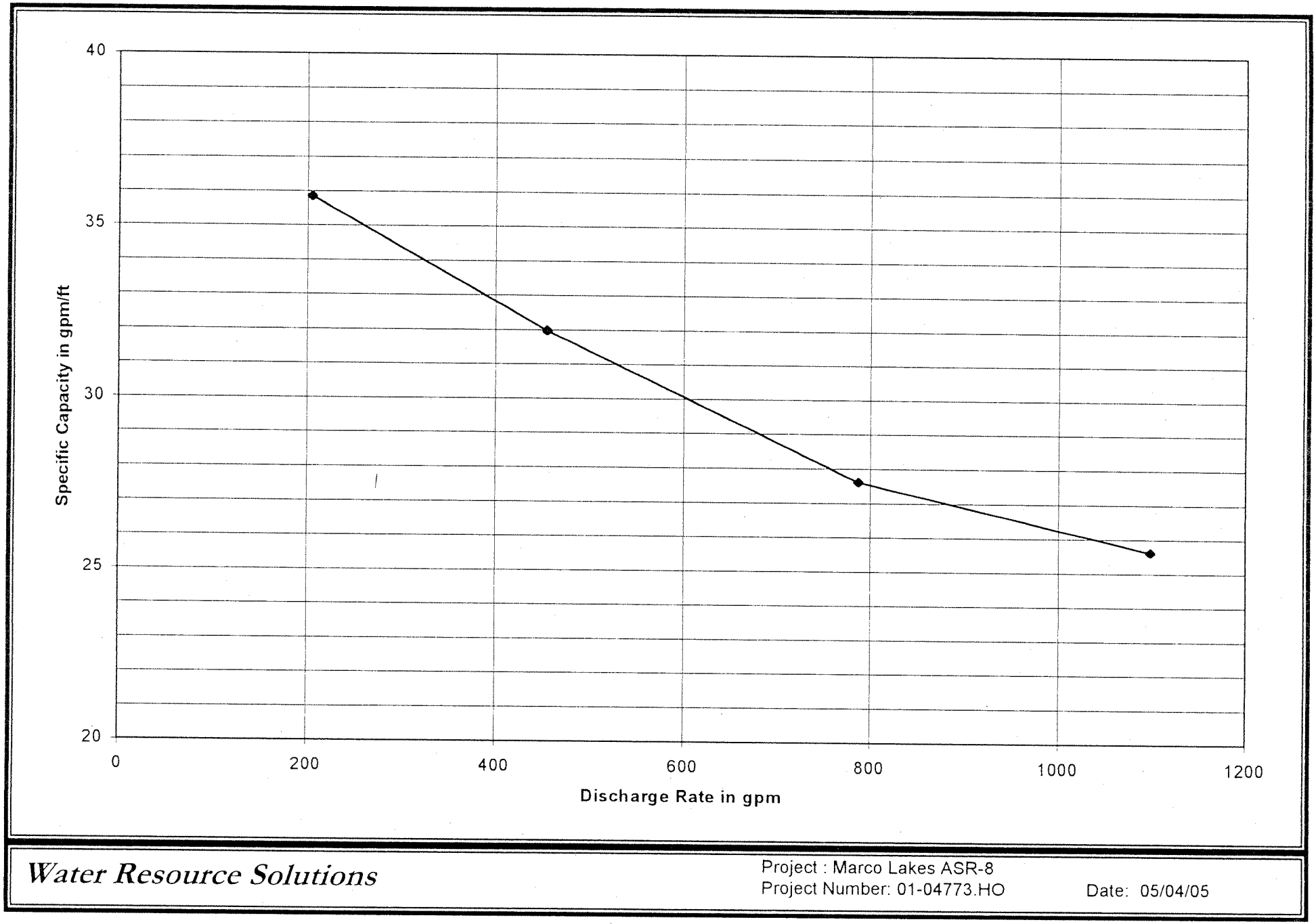

Figure 4-2. Specific Capacity vs. Discharge at ASR-8

Tables

Table 2-1

Formation Water Quality Analysis

Sample Date	Sample Time	Depth of 15-inch Bit (feet bpl)	CHLORIDE (mg/l)	CONDUCTIVITY (mS/cm)
03/15/05	16:15	740	320	5.43
03/15/05	16:20	750	360	3.60
03/15/05	16:52	752	300	5.73
03/15/05	17:35	760	480	3.50
03/15/05	18:00	773	460	4.69
03/16/05	10:46	760	560	3.04
03/16/05	12:04	730	620	3.06

Table 3-1

Pad Monitor Well Construction Details

WELL NUMBER:	MW #1 (12/01/04)	MW #2 (12/02/04)
LOCATION	SE CORNER	NW CORNER
ELEVATION OF TOC* (NGVD)	6.36	5.67
TOTAL DEPTH (FEET BELOW TOC)	20	20
DIAMETER (INCHES)	4 PVC	4 PVC
CASING LENGTH (FEET)	12.3	12.5
WIRE WRAP TYPE SCREEN LENGTH (FEET)	9.3	9.3
SCREEN SIZE	0.010-inch slot	0.010-inch slot
GRAVEL PACK DEPTH (FEET)	9 - 20	9 - 20
GRAVEL PACK TYPE	20/30 silica sand	20/30 silica sand
SEAL DEPTH (FEET)	8-9	8-9
SEAL TYPE	Bentonite Chips	Bentonite Chips
GROUT DEPTH (FEET)	0-8	0-8
GROUT TYPE	Portland cement & 6% bentonite	Portland cement & 6% bentonite

*TOC: indicates the "top of the casing" of the Surficial Aquifer Monitoring Well

Table 3-2

Pad Well No. 1 Weekly Monitoring Summary

Sample Date	Depth to Water Below Top of Casing (ft.)*	Elevation of Water Level (NGVD)	CHLORIDE (mg/l)	CONDUCTIVITY (µmhos/cm)	pH (standard units)	TEMPERATURE (°C)
12/2/04	6.45	1.88	26	688	7.06	26.4
12/9/04	6.62	1.71	26	680	6.86	26.1
12/16/04	6.24	2.09	22	658	6.86	26.3
12/22/04	7.11	1.22	20	652	6.84	26.3
12/30/04	7.09	1.24	20	667	6.76	24.4
1/6/05	7.23	1.1	22	651	6.87	25.8
1/13/05	7.37	0.96	20	634	6.83	25.6
1/20/05	7.22	1.11	33	641	6.87	23.5
1/27/05	7.2	1.13	32	649	6.88	24.9
2/3/05	7.29	1.04	38	646	6.83	24.7
2/10/05	7.38	0.95	40	644	6.83	24.6
2/17/05	7.53	0.8	40	646	6.89	24.9
2/24/05	7.73	0.6	40	650	7.35	No Data
3/3/05	7.76	0.57	40	648	6.85	24.0
3/10/05	7.31	1.02	42	648	6.82	24.2
3/17/05	7.1	1.23	46	625	6.90	24.1
3/24/05	6.53	1.8	38	663	7.03	24.9
3/31/05	6.57	1.76	64	685	6.76	24.3
4/07/05	6.66	1.67	76	715	6.77	24.4
4/14/05	6.48	1.65	106	808	6.81	24.0
4/21/05	4.78**	1.58	132	856	6.62	24.3
4/28/05	4.95	1.41	140	884	6.84	24.1
5/05/05	5.18	1.18	130	883	6.79	23.9
5/12/05	5.35	1.01	134	883	6.65	24.7

*Elevation = 8.33 Feet NGVD

** Casing was cut off to 6.36 feet NGVD on 4/18/05

Table 3-3

Pad Well No. 2 Weekly Monitoring Summary

Sample Date	Depth to Water Below Top of Casing (ft.)*	Elevation of Water Level (NGVD)	CHLORIDE (mg/l)	CONDUCTIVITY (µmhos/cm)	pH (standard units)	TEMPERATURE (°C)
12/2/04	5.76	2.01	24	628	7.47	25.7
12/9/04	5.93	1.84	20	602	6.98	25.4
12/16/04	6.14	1.63	20	581	6.98	25.1
12/22/04	6.34	1.43	18	585	7.01	25.3
12/30/04	6.36	1.41	18	569	7.19	25.1
1/6/05	6.51	1.26	18	569	7.03	25.5
1/13/05	6.64	1.13	18	553	6.92	24.6
1/20/05	6.54	1.23	26	568	7.04	24.4
1/27/05	6.5	1.27	28	576	7.03	24.6
2/3/05	6.56	1.21	35	580	6.99	25.8
2/10/05	6.36	1.41	32	589	6.95	25.1
2/17/05	6.8	0.97	36	598	6.98	26.2
2/24/05	7.01	0.76	32	599	7.35	No Data
3/3/05	6.99	0.78	32	615	6.90	24.8
3/10/05	6.86	0.91	36	622	6.86	25.1
3/17/05	6.39	1.38	32	605	6.98	25.1
3/24/05	5.8	1.97	38	663	7.03	24.9
3/31/05	5.85	1.92	22	610	6.86	25.3
4/07/05	5.93	1.84	38	622	6.89	25.0
4/14/05	5.81	1.96	42	621	6.81	25.2
4/21/05	3.93**	1.74	46	624	6.77	25.3
4/28/05	4.10	1.57	42	631	6.84	25.2
5/05/05	4.25	1.42	44	637	6.85	25.2
5/12/05	5.63	0.86	34	628	6.79	24.1

*Elevation = 7.77 Feet NGVD
** Casing was cut off to 5.67 feet NGVD on 4/18/05

Table 3-4

Inclination Survey Log

Date	Bit Diameter (inches)	Depth (feet bpl)	Inclination (degrees)
12/12/04	12.5	90	0.30
12/12/04	12.5	180	0.40
12/15/04	12.5	270	0.00
12/28/04	12.5	360	0.25
12/18/04	12.5	450	0.00
12/28/04	12.5	540	0.00
12/29/04	12.5	630	0.40
2/22/05	25.00	90	0.00
1/18/05	25.00	180	0.10
1/27/05	25.00	260	0.50
2/3/05	25.00	350	0.00
2/7/05	25.00	450	0.25
2/8/05	25.00	540	0.75
2/9/05	25.00	630	0.40
2/14/05	25.00	720	0.00

Table 3-5

Rate of Penetration Log for 12.5-Inch Pilot Hole

Date	Drill From (feet bpl)	Drill To (feet bpl)	Total Length (feet)	Minutes	Rate (feet/min.)
12/11/2004	67.23	97.5	30.27	23	1.32
12/12/2004	97.5	126.75	29.25	16	1.83
12/12/2004	126.75	156	29.25	30	0.98
12/12/2004	156	185.92	29.92	30	1.00
12/13/2004	185.92	216.65	30.73	18	1.71
12/13/2004	216.65	245.85	29.2	37	0.79
12/15/2004	245.85	276.85	31	17	1.82
12/16/2004	276.85	308.25	31.4	*NR	NR
12/16/2004	308.25	339.55	31.3	23	1.36
12/16/2004	339.55	371.25	31.7	37	0.86
12/16/2004	371.25	402.65	31.4	71	0.44
12/16/2004	402.65	433.25	30.6	17	1.80
12/16/2004	433.25	464.58	31.33	21	1.49
12/16/2004	464.58	496.12	31.54	17	1.86
12/28/2004	496.12	527.5	31.38	50	0.63
12/28/2004	527.5	559.23	31.73	48	0.66
12/29/2004	559.23	590.81	31.58	20	1.58
12/29/2004	590.81	622.3	31.49	48	0.66
12/29/2004	622.3	653.55	31.25	76	0.41
12/29/2004	653.55	684.25	30.7	113	0.27
12/30/2004	684.25	713	28.75	58	0.50

* NR Denotes Data Not Recorded

Table 3-6

Drill String Tally for 12.5-Inch Pilot Hole Drilling

Description	Unit Length (feet)	Total String Length (feet)	TD (ft) w/Kelly Down 35' BPL
Bit	1.00	1.00	36.00
Sub	1.13	2.13	37.13
Collar 1	29.00	31.13	66.13
C 2	30.27	61.40	96.40
C 3	30.13	91.53	126.53
C 4	29.25	120.78	155.78
Heavyweight 1	29.92	150.70	185.70
HW 2	30.95	181.65	216.65
HW 3	29.20	210.85	245.85
Drill Pipe 1	31.00	241.85	276.85
DP 2	31.50	273.35	308.35
DP 3	31.31	304.66	339.66
DP 4	31.34	336.00	371.00
DP 5	31.52	367.52	402.52
DP 6	31.39	398.91	433.91
DP 7	30.60	429.51	464.51
DP 8	31.35	460.86	495.86
DP 9	31.70	492.56	527.56
DP 10	31.76	524.32	559.32
DP 11	31.67	555.99	590.99
DP 12	31.57	587.56	622.56
DP 13	30.80	618.36	653.36
DP 14	31.35	649.71	684.71
DP 15	31.36	681.07	716.07
DP 16	30.75	711.18	Drilled to 720 feet

Table 3-7
Pilot Hole Cementing Log

Stage	Date	Time	Weight (ppg)	Volume Pumped (sks)	Comments
1	1/6/05	16:00			Finish tripping bit in to 681 feet bpl
1	1/6/05	16:17	15.8		Begin pumping cement
1	1/6/05	16:22	15.3	50	Stop pumping cement
1	1/6/05	16:24			Trip bit up to 650 feet bpl
1	1/6/05	16:29	15.2		Begin pumping cement
1	1/6/05	16:33		50	Stop pumping cement
1	1/6/05	16:38			Trip bit up to 618 feet bpl
1	1/6/05	16:40	15.1		Begin pumping cement
1	1/6/05	16:48		54	Finish pumping cement
1	1/6/05	16:50			Begin pumping 550 gallon freshwater chase
1	1/6/05	16:55			Finish pumping chase
1	1/6/05	17:02			Begin tripping bit up
1	1/6/05	17:50			Finish tripping bit up to 210 feet bpl
2	1/7/05	13:33			Tag cement at 688 ft. bpl
2	1/7/05	13:45			Trip bit up to 650 feet bpl
2	1/7/05	16:23	14.5		Begin pumping cement
2	1/7/05	16:26		35	Stop pumping cement
2	1/7/05	16:32			Trip bit up to 618 feet bpl
2	1/7/05	16:33			Begin pumping cement
2	1/7/05	16:36	14.6	35	Stop pumping cement
2	1/7/05	16:40			Trip bit up to 588 feet bpl
2	1/7/05	16:42			Begin pumping cement
2	1/7/05	16:46		35	Stop pumping cement
2	1/7/05	16:50			Trip bit up to 556 feet bpl
2	1/7/05	16:52			Begin pumping cement
2	1/7/05	16:58	14.6	47	Stop pumping cement
2	1/7/05	17:00			Trip bit to 463 feet bpl
2	1/7/05	17:10			Pump 300 gallon freshwater chase
2	1/7/05	17:15			Trip bit up to 210 feet bpl
2	1/7/05	17:30			Finish tripping bit up to 210 feet bpl
3	1/11/05	12:33			Tag cement at 417 ft. bpl
3	1/11/05	12:36			Trip bit up to 399 feet bpl
3	1/11/05	13:41			Begin pumping cement
3	1/11/05	13:43	14.5	25	Stop pumping cement
3	1/11/05	13:47			Trip bit up to 367 feet bpl
3	1/11/05	13:50			Begin pumping cement
3	1/11/05	13:53	14.4	25	Stop pumping cement
3	1/11/05	13:55			Trip bit up to 336 feet bpl
3	1/11/05	13:59			Begin pumping cement
3	1/11/05	14:03	14.7	25	Stop pumping cement
3	1/11/05	14:05			Trip bit to 305 feet bpl
3	1/11/05	14:10			Begin pumping cement
3	1/11/05	14:33	14.7	77	Stop pumping cement
3	1/11/05	14:37			Trip bit to 273 feet bpl
3	1/11/05	14:50			Pump 350 gallon freshwater chase
3	1/11/05	15:08			Trip bit up to 115 feet bpl
3	1/12/05	8:30			Tag at 183 feet bpl, Cementing done

Table 3-8
Pilot Hole Cement Stage and Volume Summary

Stage	Date	Cement additives	Yield (cf/sk)	Theoretical Fill			Actual Fill			Tag Depth (ft bpl)	Percent Filled (l/Fx100)	Cum. Total (cu ft)	Observer Init.
				Interval	Footage	Volume (cf)	Interval	Footage	Volume (cf)				
1	1/6/05	Neat	1.28	720 to 489	231	197	720 to 688	32	27	688	14%	27	AWM
2	1/7/05	Neat	1.28	688 to 459	229	195	688 to 417	271	231	417	118%	258	AWM
3	1/11/05	Neat	1.28	459 to 188	229	195	417 to 183	234	199	183	102%	422	AWM

Table 3-9
Drill String Tally for 25-Inch Reamed Hole Drilling

Description	Unit Length (feet)	Total String Length (feet)	TD (ft) w/Kelly Down 35' BPL
14.75-Inch Bit	1.20	1.20	
25-Inch Hole Opener	5.7	6.9	
25-Inch Stabilizer	4.59	11.49	
Sub	2.10	13.59	
8-Inch Collar 1	29.00	42.59	
25-Inch Stabilizer	7.03	49.62	84.62
C 2	29.22	78.84	113.84
C 3	30.73	109.57	144.57
C 4	30.30	139.87	174.87
Sub	2.0	141.87	176.87
Heavyweight 1	29.92	171.79	206.79
HW 2	30.95	202.74	237.74
HW 3	29.30	232.04	267.04
Drill Pipe 1	31.33	263.37	298.37
DP 2	31.32	294.69	329.69
DP 3	31.53	326.22	361.22
DP 4	31.39	357.61	392.61
DP 5	31.44	389.05	424.05
DP 6	31.76	420.81	455.81
DP 7	31.57	452.38	487.38
DP 8	31.48	483.86	518.86
DP 9	30.70	514.56	549.56
DP 10	31.25	545.81	580.81
DP 11	31.72	577.53	612.53
DP 12	31.35	608.88	643.88
DP 13	30.93	639.81	674.81
DP 14	31.60	670.41	705.41
DP 15	31.35	701.76	736.76 = TD

Table 3.10

Production Casing Tally 17.4-Inch PVC

Sequence No.	Length (ft)	Total Depth (feet)	Spline In Place	Time Submerged	Centralizers Depth
*Tailpiece 1	9.83		7:58	8:00	725
2	20.01	29.84	8:17	8:19	
3	19.97	49.81	8:25	8:28	
4	19.94	69.75	8:50	8:58	
5	19.97	89.72	9:07	9:18	
6	19.98	109.7	9:24	9:29	638
7	19.96	129.66	9:37	9:40	
8	19.98	149.64	9:51	9:53	
9	19.98	169.62	9:59	10:00	
10	19.98	189.6	10:07	10:09	
11	19.95	209.55	10:20	10:23	
12	19.96	229.51	10:25	10:28	
13	19.96	249.47	10:35	10:47	478
14	19.98	269.45	10:53	10:55	
15	19.98	289.43	11:03	11:07	
16	19.97	309.4	11:14	11:15	
17	19.98	329.38	11:23	12:24	
18	19.95	349.33	11:28	11:34	
19	19.97	369.3	11:39	11:41	
20	19.97	389.27	11:45	11:57	338
21	19.97	409.24	12:01	12:04	
22	19.99	429.23	12:09	12:14	
23	19.98	449.21	12:24	12:28	
24	19.98	469.19	12:35	12:39	
25	19.98	489.17	12:46	13:14	238
26	19.94	509.11	13:16	13:25	
27	19.97	529.08	13:28	13:30	
28	19.98	549.06	13:35	13:40	
29	19.98	569.04	13:47	13:50	
30	19.98	589.02	13:53	14:00	
31	19.98	609	14:04	14:08	
32	19.97	628.97	14:13	14:15	
33	19.97	648.94	14:22	14:23	
34	19.96	668.9	14:28	14:30	
35	19.97	688.87	14:32	14:37	
36	19.96	708.83	14:46	14:49	
37	19.97	728.8			

Table 3-11
Production Casing Cementing Log

Stage	Date	Time	Weight (ppg)	Volume Pumped (sks)	Comments
1	2/24/05	19:49			2" Tremie at 672 feet bpl
1	2/24/05	20:53			Circulate water to establish circulation
1	2/24/05	20:56			Stop pumping preflush
1	2/24/05	20:59			Begin pumping cement
1	2/24/05	21:03	13.8		
1	2/24/05	21:05	15.0		
1	2/24/05	21:07	15.4		Sample for 72-Hour Compressive Strength
1	2/24/05	21:10	14.6		Begin pumping cement
1	2/24/05	21:16	15.1		Finish pumping cement
1	2/24/05	21:17		235	Stop pumping cement, begin freshwater chase
1	2/24/05	21:26			Finish pumping chase, 12.3 bbls.
2	2/25/05	12:00			Tag cement at 530 ft. bpl using 1.25-Inch Tremie
2	2/25/05	12:30			Trip tremie up to 520 ft. bpl
2	2/25/05	14:32			Begin freshwater flush
2	2/25/05	14:38			Start pumping cement
2	2/25/05	14:39	14.7		
2	2/25/05	14:40	15.1		
2	2/25/05	14:42	15.2		Sample for 72-Hour Compressive Strength
2	2/25/05	14:44	15.4		Stop pumping cement, break loose header
2	2/25/05	14:45			Pull 42 feet of tremie, base at 478 feet bpl.
2	2/25/05	14:51			Reconnect tremie, header, and hose
2	2/25/05	14:54			Begin pumping cement
2	2/25/05	14:56	14.1		
2	2/25/05	14:57	14.4		
2	2/25/05	14:59	15.0		
2	2/25/05	15:00	15.0		
2	2/25/05	15:02	13.8		
2	2/25/05	15:04			Stop pumping cement
2	2/25/05	15:08			Pull 42 feet of tremie, base at 436 feet bpl.
2	2/25/05	15:12			Start pumping cement
2	2/25/05	15:14	15.2		
2	2/25/05	15:17	14.8	235	Stop pumping cement, flush out pump
2	2/25/05	15:30			Pull 84 feet of tremie, base at 352 feet bpl.
2	2/25/05	15:31			Begin pumping displacement chase
2	2/25/05	15:35			Finish pumping displacement chase
3	2/26/05	3:00			Tag cement at 250 feet bpl, pull tremie up to 247 feet bpl.
3	2/26/05	4:20			Begin pumping pre-flush
3	2/26/05	4:22			End Pre-flush.
3	2/26/05	4:25			Begin pumping cement
3	2/26/05	4:26	15.6		
3	2/26/05	4:28	15.8		
3	2/26/05	4:30	15.7		
3	2/26/05	4:32	15.5		Sample for 72 hour compressive strength
3	2/26/05	4:33	15.5		
3	2/26/05	4:37	15.0		
3	2/26/05	4:41	15.2		Stop to fix discarge
3	2/26/05	4:44			Start pumping again
3	2/26/05	4:46	15.2		
3	2/26/05	4:48		235	Stop pumping cement. Pump chase.
3	2/26/05	4:54			Begin to trip of 1.25-Inch Tubing
3	2/26/05	5:07			Finish tripping all tremie from well

Table 3-12
Production Casing Cement Stage and Volume Summary

Stage	Date	Cement additives	Yield (cf/sk)	Theoretical Fill			Actual Fill			Tag Depth (ft bpl)	Percent Filled (I/Fx100)	Cum. Total (cu ft)	Observer Init.
				Interval	Footage	Volume (cf)	Interval	Footage	Volume (cf)				
1	2/24/05	Neat	1.28	738-570	168	300.8	738-530	208	371	530	124%	371	AWM
2	2/25/05	Neat	1.28	530-352	178	300.8	530-250	278	544	250	156%	915	AWM
3	2/26/05	Neat	1.28	250-114	136	300.8	250-37	213	443	37	157%	1358	AWM

Table 3-13

Drill String Tally for 15-Inch Open Hole Drilling

Description	Unit Length (feet)	Total String Length (feet)	TD (ft) w/Kelly Down 35' BPL
12.25-Inch Button Bit	1.20	1.20	36.2
15-Inch Hole Opener	4.65	5.85	40.85
Sub	2.0	7.85	42.85
8-Inch Collar 1	29.00	36.85	71.85
Collar 2	29.22	66.07	101.07
Collar 3	30.73	96.80	131.8
Collar 4	30.30	127.10	162.1
Heavyweight 1	29.92	157.02	192.02
HW 2	30.95	187.97	222.97
HW 3	29.30	217.27	252.27
Drill Pipe 1	30.60	247.87	282.87
DP 2	31.31	279.18	314.18
DP 3	31.35	310.53	345.53
DP 4	31.02	341.55	376.55
DP 5	30.61	372.16	407.16
DP 6	31.55	403.71	438.71
DP 7	31.78	435.49	470.49
DP 8	30.65	466.14	501.14
DP 9	31.30	497.44	532.44
DP 10	31.60	529.04	564.04
DP 11	31.36	560.40	595.4
DP 12	31.34	591.74	626.74
DP 13	31.69	623.43	658.43
DP 14	31.05	653.48	688.48
DP 15	31.48	685.96	720.96
DP 16	31.20	717.16	752.16
DP 17	31.33	748.49	Total Depth = 773'

Table 4-1

Specific Capacity Data Table for ASR-8

Time	Time since start of Pumping	Drawdown in ASR-8 (ft.)	Totalizer in Gallons	Average flow rate per Step (gpm)	Specific Capacity in gpm/ft. of drawdown	Notes
13:18	0	0.00	69993200	0	NA	Initial Meter No Flow
14:18	60	5.72	70005470	205	35.8	Artesian flow only
15:18	120	14.23	70032770	455	32.0	Pump started
16:18	180	28.51	70080000	787	27.6	Pump running
17:18	240	42.86	70145900	1098	25.6	"