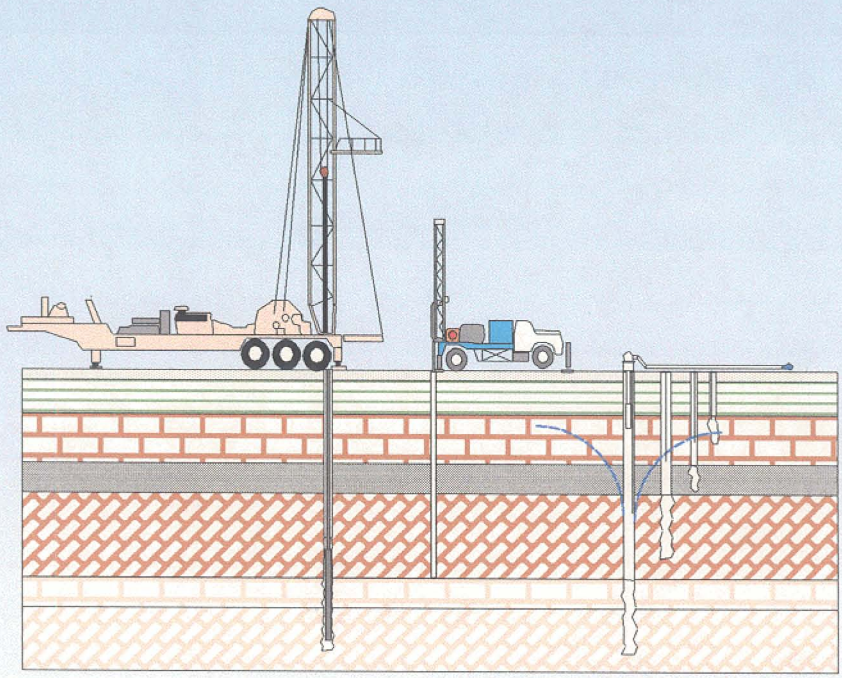
ROMP 9.5 IAS
MONITOR WELL SITE
DESOTO COUNTY, FLORIDA

PHASE TWO

MONITOR WELL CONSTRUCTION AND AQUIFER PERFORMANCE TESTING



Geohydrologic Data Section
Resource Data Department
Southwest Florida Water Management District

June 2000

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The geological evaluations and interpretations contained in the *ROMP 9.5 Monitor Well Construction and Aquifer Performance Testing Report* have been prepared by or approved by a licensed Professional Geologist in the State of Florida, in accordance with Chapter 492, Florida Statutes.

MICHAEL T. GATES LICENSE No. 0001799 STATE OF FLORIDA PROFESSIONAL GEOLOGIST

M. T. Gates

Michael T. Gates
Professional Geologist
License No. PG 1799

Date: 6-19-2000

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By M. T. Gates

Southwest Florida Water Management District

Resource Data Department
Timothy De Foe, Director

Geohydrologic Data Section
S. Greg McQuown, Manager

Southwest Florida Water Management District
2379 Broad Street
Brooksville, Florida 34609-6899

June 2000

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1.0 INTRODUCTION

The Intermediate Aquifer System (IAS) is present in the southern half of the Southwest Florida Water Management District (SWFWMD) and covers approximately 5,000 square miles. Within the SWFWMD, the IAS is present in DeSoto, Hardee, Manatee, Sarasota, Charlotte, and parts of Highlands, Hillsborough, and Polk Counties (Figure 1). The ROMP (Regional Observation and Monitor-well Program) 9.5 IAS well site is the pilot site for a joint project between the SWFWMD and the United States Geological Survey (USGS). The goal of the project is to determine the regional hydrogeologic framework of the IAS in West Central Florida.

Drilling, testing, and monitor well construction was planned in two phases at ROMP 9.5. The first phase involved core drilling from land surface to 543 feet below land surface (bls) to define the stratigraphy and hydrology of the site. The data collected during the first phase (November 1996 - March 1997) is presented in: *ROMP 9.5 - Phase One - Core Drilling and Testing* (Gates, 1998). This report, *ROMP 9.5 - Phase Two - Monitor Well Construction and Aquifer Performance Testing*, presents the monitor well construction information and the hydraulic data collected during the aquifer performance tests (APT's) in the intermediate and Upper Floridan aquifers (UFA).

Note: in this report two permeable zones are identified within the IAS. The uppermost zone is identified as the upper permeable zone (UPZ). The deeper zone is referred to as the lower permeable zone (LPZ). The upper zone may be equivalent to "permeable zone 2" defined in a report by Barr (1996). The lower zone may be equivalent to "permeable zone 3" identified in the same report.

Additional information on the ROMP 9.5 well site is presented in the USGS Water-Resources Investigations Report FL-609: *Hydrogeology and Geochemistry of the Intermediate Aquifer System in Southwest Florida with emphasis in Charlotte, DeSoto and Sarasota Counties*.

The author would like to thank the following individuals for their assistance and dedication during the extensive well construction and testing phase of the project: Pat Meadors, former Well Driller (CME coring rig), SWFWMD, Lloyd Johnson, Senior Well Driller (Drilling Contractor

Supervisor), SWFWMD, Lynn Barr, Hydrologist, USGS. In addition, Stephanie Baldini, SWFWMD assisted with the APT data analyses, and created the spreadsheets used in the data analyses.

2.0 SITE LOCATION

The ROMP 9.5 well site is located in DeSoto County, northeast of the city of Northport on the R.V. Griffin Reserve (Figure 2). The well site is located in Section 31, Township 38 South, Range 23 East at latitude: 27° 07' 37" longitude: 82°02' 51" at a surface elevation of 38 feet above the National Geodetic Vertical Datum of 1929 (NGVD) (Figure 3). The ROMP 9.5 monitor well site diagram is presented in Figure 4.

3.0 MONITOR WELL CONSTRUCTION

A total of eighteen monitor wells were constructed at the ROMP 9.5 well site to monitor the surficial, intermediate, and Upper Floridan aquifers. Monitor wells were installed into the permeable zones and confining units of the IAS to monitor water level changes during the APT's. Three monitor wells (MW-3, 4, and 18) were previously constructed during the coring phase by the District-owned CME 75 drilling rig. Drilling and construction of the other 15 monitor wells began in May 1997 and was completed in November 1997. The 15 monitor wells were drilled by a contracted private drilling firm, Diversified Drilling, Inc., using a Speedstar 25 drilling rig. Mud- rotary and reverse-air methods of drilling were utilized to construct the monitor wells.

Two monitor wells were constructed to accommodate pumps for the APT's: a 12-inch diameter Suwannee Limestone UFA monitor well (MW-1), and an 8-inch diameter intermediate aquifer system LPZ monitor well (MW-2). Thirteen, 2-inch observations wells (MW-5,6,7,8,9,10,11,12,13,14, 15,16, and 17) were constructed in the IAS permeable and confining zones. Well construction details for the monitor wells are presented in Table 1. Figures 5 through 22 present the well construction diagrams. Figure 23 presents a diagram of the hydrogeology of the ROMP 9.5 well site.

3.1 PUMPED WELLS

The UFA pumped well (MW-1) was constructed by drilling a 24-inch diameter borehole from land surface to 60 feet bls using the mud-rotary drilling method. Sixty feet of 18-inch welded steel casing was installed to the bottom of the borehole. The casing was then pressure grouted in place using the casing method of grouting. A 17.5-inch borehole was then drilled from 60 ft bls to 505 ft bls. Twelve-inch welded steel casing was then installed from land surface to 505 ft bls. The 12-inch casing was pressure grouted in place. A 10.5-inch borehole was drilled from 505 ft bls to 801 ft bls using the reverse-air method of drilling. The well was developed by allowing the well to free flow at the surface until the water appeared clear. The well was capped with a 12-inch x 4-inch bushing and 4-inch ball valve. A locking steel cover was installed over the well. Figure 5 presents the as-built diagram for MW-1.

The IAS LPZ pumped well (MW-2) was constructed by drilling a 19-inch diameter borehole from land surface to 60 feet bls using the mud-rotary drilling method. Sixty-feet of 12-inch welded steel casing was installed in the borehole and pressure grouted in place. An 11.5-inch borehole was then drilled from 60 ft bls to 205 ft bls. Two hundred six feet of 8-inch diameter PVC casing was installed to the bottom of the borehole and pressure grouted in place. A 7.5-inch borehole was drilled from 205 ft bls to 331 ft bls using the reverse-air method of drilling. The well was allowed to flow at the surface until the water appeared clear. The well was capped with an 8-inch x 4-inch bushing and 4-inch ball valve. A locking steel cover was installed over the well. Figure 6 presents the as-built diagram of MW-2.

3.2 PERMEABLE ZONE OBSERVATION WELLS

Five IAS LPZ observation (OB) wells and 1 UFA OB well were installed to monitor the water level changes during the aquifer performance tests. The 5 IAS wells (MW-8, 11, 13, 14, 16) were installed at distances of 100, 200, 400, and 800 feet from the IAS pumped well (MW-2). These wells were installed to determine changes in the hydraulic properties of the IAS with respect to distance. The MW-16 IAS well was installed 100 feet from, and at a right angle (south) to the IAS pumped well. This well was installed to detect any differences in the hydraulic properties due to anisotrophy. The UFA OB well (MW-5) was installed 100 feet from the UFA pumped well (MW-1).

The 5 IAS LPZ OB wells were constructed by drilling a 13-inch borehole from land surface to 60 feet bls. Sixty feet of PVC casing was then installed to the bottom of the borehole and pressure grouted in place. A 5.625-inch borehole was then drilled from 60 feet bls to 330 feet bls. Two-hundred six feet of 2-inch PVC casing was then installed into the borehole. Two, 2-inch x 6-inch formation packers were fitted to the bottom of the casing between 204 and 205 feet bls. Approximately 10 feet of bentonite pellets were installed above the formation packers from 204 feet bls to 194 feet bls. The bentonite pellets were allowed to hydrate, then approximately 2 feet of 6-20 silica sand was installed above the bentonite seal from 194 feet bls to 192 feet bls. The 2-inch PVC casing was then tremie grouted from 192 feet bls to land surface. All wells were fitted with 2-inch PVC caps and surrounded with locking steel protective covers.

The UFA OB well (MW-5) was constructed by drilling a 17.5-inch borehole from land surface to 65 feet bls. Sixty-six feet of 12-inch welded steel casing was installed to the bottom of the borehole and pressure grouted in place. A 7.625-inch borehole was then drilled from 65 feet bls to 800 feet bls. Five hundred and three feet of 2-inch PVC casing was installed into the borehole. Two, 2-inch x 6-inch formation packers were fitted to the bottom of the PVC casing between 500 and 501 feet bls. Approximately 7 feet of bentonite pellets were installed above the formation packers from 500 feet bls to 493 feet bls. The bentonite pellets were allowed to hydrate, then 3 feet of 6-20 silica sand was installed above the bentonite seal from 493 feet bls to 490 feet bls. The 2-inch PVC casing was then tremie grouted from 490 feet bls to land surface. The well was fitted with a 2-inch PVC cap and surrounded with a locking steel protective cover.

3.3 SEMI-CONFINING UNIT OBSERVATION WELLS

Six observation wells (MW-7, 9, 10, 12, 15, 17) were constructed to monitor the water levels within the confining units (B and C) directly above and below the IAS LPZ layer. These wells were located at 100 and 200 feet distances from the IAS pumped well (MW-2). One OB well

(MW-6) was installed in the lower confining unit C, directly above the Suwannee permeable zone of the UFA at a distance of 100 feet from the UFA pumped well (MW-1).

Three wells (MW-9, 12, 17) were constructed to monitor the confining unit *above* the IAS LPZ layer (**confining unit B**). Construction of these 3 wells began by drilling a 17.5-inch borehole from land surface to 60 feet bls using the mud-rotary method of drilling. Sixty one feet of 12-inch diameter welded steel casing was then installed to the bottom of the borehole and pressure grouted in place. An 11.875-inch borehole was then drilled from 60 feet bls to 180 feet bls. One hundred eighty one feet of 6-inch PVC casing was installed into the borehole and pressure grouted in place. A 5.625-inch borehole was then reverse-air drilled from 180 feet bls to 190 feet bls. Approximately 10 feet of 2-inch PVC .010 slot screen was installed from 190 feet bls to 180 feet bls and 2-inch PVC casing was installed from 180 feet bls to land surface. Six-twenty grain sand was installed around the PVC screen from 180 feet bls to 175 feet bls. Bentonite pellets were installed from 175 feet bls to 155 feet bls. The bentonite was allowed to hydrate, then the 2-inch PVC was tremie grouted from 155 feet bls to land surface. All wells were fitted with caps and surrounded with a locking steel protective cover.

The MW-7, MW-10, MW-15 wells were installed into the confining unit directly *below* the IAS LPZ layer (**confining unit C**). Construction began by drilling a 17.5-inch borehole from land surface to 60 feet bls using the mud-rotary method. Sixty feet of 12-inch welded steel casing was installed to the bottom of the borehole and pressure grouted in place. An 11.5-inch borehole was then drilled from 60 feet bls to 340 feet bls. Three hundred feet of 6-inch PVC casing was installed to the bottom of the borehole and pressure grouted in place. A 5.625-inch borehole was then reverse-air drilled from 340 feet bls to 350 feet bls. Ten feet of 2-inch PVC .010 slot screen was installed from 350 feet bls to 340 feet bls and 2-inch PVC casing was installed from 340 feet bls to land surface. Six-twenty grain sand was installed around the screen from 350 feet bls to 335 feet bls. Bentonite pellets were installed from 335 feet bls to approximately 315 feet bls and allowed to hydrate. The 2-inch casing was then tremie grouted from 315 feet bls to land surface. A locking steel protective cover was installed around the well.

The MW-6 well was installed into the lower portion of **confining unit C**, just above the UFA Suwannee Limestone permeable zone. The well was constructed by drilling a 17.5-inch borehole from land surface to 62 feet bls. Sixty-two feet of 12-inch welded steel casing was installed to the bottom of the borehole and pressure grouted in place. An 11.5-inch borehole was then drilled from 62 feet bls to 470 feet bls. Six inch PVC casing was installed to the bottom of the borehole and pressure grouted in place. A 5.625-inch borehole was then drilled from 470 feet bls to 480 feet bls. Upon drilling to 480 feet bls the well flowed at the surface. It appeared the confining unit had been penetrated and the borehole was intercepting the permeable zone. The borehole was back-plugged with bentonite pellets from 480 feet bls to 475 feet bls until the water flow significantly decreased. Five feet of 2-inch PVC .010 slot screen was installed from 475 feet bls to 470 feet bls and 2-inch PVC casing was installed from 470 feet bls to land surface. Six-twenty grain sand was installed around the screen from 475 feet bls to 462 feet bls. Bentonite pellets were installed from 462 feet bls to 446 feet bls. The 2-inch casing was then tremie grouted from 446 feet bls to land surface. A locking steel protective cover surrounds the well.

4.0 AQUIFER PERFORMANCE TESTING

Aquifer performance tests (APT's) were conducted on the lower permeable zone of the intermediate aquifer system and the Suwannee Limestone permeable zone of the Upper Floridan aquifer during January and February of 1998. The APT's were conducted to determine the horizontal and vertical hydraulic conductivity, transmissivity, storativity, and leakance of the water bearing and confining units at ROMP 9.5. Tables 2 - 6 present the hydraulic values from each test.

An In-Situ® data logger and pressure transducers were used to measure and record the water level changes in the wells during the aquifer tests. AquiferTest® for Windows, by Waterloo Hydrogeologic, Inc., was used to for the data analysis of the IAS and UFA aquifer tests. Additionally, a spreadsheet program was created to analyze the data using the Neuman and Witherspoon ratio method. The analytical methods used are based on equations developed by: Hantush (1955), Neuman and Witherspoon (1972), and Theis (1935) and Cooper and Jacob (1946). A description of each method is presented in Appendices A, B, and C.

4.1 INTERMEDIATE AQUIFER SYSTEM APT

The IAS background water levels were collected from December 16, 1997 to January 12, 1998. The IAS lpz pumping phase was conducted from January 12, 1998 to January 15, 1998. The recovery phase was recorded from January 15, 1998 to January 21, 1998.

4.1.1 Methods

The 8-inch diameter IAS LPZ monitor well (MW-2) was pumped with a diesel powered 4-inch centrifugal pump at 425 gallons per minute (gpm) for 66.5 hours. The discharge water was pumped through a 4-inch flexible hose 150 feet to a creek adjacent to the site. The discharge rate was measured with an in-line flow-meter and an orifice plate and manometer tube. During the drawdown and recovery phase of the APT, water levels changes were measured in the 8-inch PZ2 pumped well (MW-2), the 5 IAS lower permeable zone OB wells (MW-8, 11, 13, 14, 16), the 3 *confining unit B* wells (MW-9, 12, 17), the 3 *confining unit C* wells (MW-7, 10, 15), the 3 UFA wells (MW-1, 5, 6), and the 2 surficial aquifer wells (MW-3, 4) see figures 4 and 23.

4.1.2 Results

Prior to the IAS pumping phase, background water levels were recorded in all the surficial, IAS, and UFA permeable zones (Figure 24). During the period from 12-16-1997 to 1-6-1998, two episodes of drawdown occurred in the IAS *upper* permeable zone (MW-18). This drawdown is apparently the result of offsite pumping from a well installed into the same zone. This thin permeable zone appears to be of very low transmissivity. A previous specific capacity test of this zone produced only .07 gpm/feet.

During the pumping phase of the test, maximum drawdown in the pumped well (MW-2) was 20.6 feet. The greatest amount of drawdown in the observation wells, 5.3 feet, occurred in MW-16 located 100 feet **south** of the pumped well. Maximum drawdown in MW-8, 100 feet west of the pumped well was 4.7 feet. As expected, drawdown in the observation wells diminished with increasing distance from the pumped well. Approximately 2.5 feet of drawdown was recorded in MW-14 located 800 feet west of the pumped well. Figure 25 presents the drawdown curves of all the LPZ observation wells.

Drawdown in the monitor wells installed into *semi-confining unit B*, occurred approximately 100 minutes after the start of the test. The delayed drawdown in these wells is indicative of leakance through the confining layer. This data was used in the Neuman-Witherspoon analyses to determine values for leakance in semi-confining unit B. Drawdown occurred almost immediately in the wells installed into *semi-confining unit C*. This indicates the wells were in hydraulic connection with the overlying IAS lower permeable zone. The maximum drawdown recorded in the semi-confining unit C wells, was 5.5 feet in MW-15, located 100 feet south of the pumped well. Figure 26 presents the IAS drawdown curves for the confining unit wells.

Virtually no drawdown occurred in the wells monitoring the surficial aquifer or the UFA during the IAS drawdown phase. This was an indication of good hydraulic separation between the surficial aquifer and the IAS lower permeable zone and the UFA. Figure 27 presents curves of the surficial aquifer and UFA during the IAS drawdown phase.

The recovery phase of the test was recorded for 1000 minutes after the pump was turned off. Water levels in all IAS permeable zone wells began to recover within one to three minutes. Water levels in semi-confining unit C began recovering within one minute of pump shutoff, while water levels in semi-confining unit B wells did not begin recovering for 100 minutes. Figures 28 to 30 present the recovery curves of all wells monitored.

The drawdown data from the five 2-inch LPZ OB wells was analyzed using the ***Hantush Method (leaky, no aquitard storage)***. The Hantush results are summarized in Table 2. The average transmissivity (T) was 1.44×10^4 ft^2/day. The average horizontal hydraulic conductivity (K_h) was 1.11×10^2 ft/day. The average storativity (S) was 2.18×10^{-4}. Table 3 summarizes the hydraulic values for Confining Unit B (between UPZ and LPZ). The average hydraulic resistance ($\frac{b'}{K'}$) was 2.69×10^6 days. The average vertical hydraulic conductivity (K') was 4.54×10^{-3} feet/day. The average leakance ($\frac{K'}{b'}$) was 3.69×10^{-5} (feet/day)/foot.

Drawdown data from MW-8 and MW-9 was analyzed using the ***Neuman Witherspoon ratio method (1972)***. The Neuman Witherspoon results are summarized in Table 3. The hydraulic diffusivity ($\frac{K'}{S'_s}$) was 123 ft^2/day. The calculated vertical hydraulic conductivity (K_v) was 1.23 x 10^{-3} feet/day. The leakance was 1.00 x 10^{-5} (feet/day)/foot.

The recovery data from the five LPZ OB wells was analyzed using the ***Theis & Jacob Recovery Method (confined)***. The Theis and Jacob results are summarized in Table 4. The average transmissivity (T) was 1.60 x 10^4 ft^2/day. The average horizontal hydraulic conductivity (K_h) was 1.23 x 10^2 ft/day.

Appendix D presents the IAS curve match analyses for the Hantush and Theis & Jacob methods, and the spreadsheet data for the Neuman and Witherspoon ratio method.

4.2 UPPER FLORIDAN APT

The UFA background water levels were recorded from January 28, 1998 to February 2, 1998. The pumping phase was conducted from February 2, 1998 to February 3, 1998. The recovery phase was recorded from February 3, 1998 to February 19, 1998.

4.2.1 Methods

The 12-inch diameter Suwannee Limestone UFA monitor well (MW-1) was pumped with a 30 horse-power (HP) diesel powered line-shaft turbine pump at 800 gpm for 24 hours. The discharge water was pumped through a 6-inch flexible hose 150 feet to a creek adjacent to the site. The discharge rate was measured with an in-line flow-meter and an orifice plate and manometer tube. During the drawdown and recovery phases of the test water level changes were measured in the 12-inch pumped well (MW-1), the UFA permeable zone observation well (MW-5), the lower part of semi-confining unit C (MW-6), the upper part of semi-confining unit C (MW-7, MW-15), the IAS lower permeable zone (MW-2), the semi-confining unit B (MW-17), and the IAS upper permeable zone (MW-18).

4.2.2 Results

Prior to the UFA pumping phase, the background water levels were recorded in the UFA and IAS permeable zones (Figure 31). The water level recovery of the UFA wells at the beginning of the background data results from a short test of the pump earlier in the day. During the background period, three episodes drawdown occurred in MW-18. The drawdown episodes are thought to be due to offsite pumping of this zone previously described in Section 4.1.2.

During the pumping phase maximum drawdown in the pumped well was 65 feet bls. Maximum drawdown in the UFA observation well (MW-5) was 16 feet. Maximum drawdown in the lower semi-confining unit C well (MW-6) was 10 feet bls. This well may be in hydraulic connection with the underlying UFA permeable zone. Figure 32 presents the drawdown curves of the UFA wells. Drawdown in the IAS permeable zone well (MW-2) and semi-confining unit B wells (MW-15 & MW-17) occurred after 970 minutes of pumping (Figure 33). The water levels in the IAS upper permeable zone well (MW-18) and semi-confining unit B well (MW-17) rose approximately 0.5 feet during the drawdown phase (Figure 33).

The recovery phase of the test was recorded for approximately 16 days (22,915 minutes) after the pump was turned off. The water levels in the UFA wells began to recover within the first minute (Figure 34). The water level in the IAS permeable zone well (MW-2) drew down further, before starting to recover after 20,000 minutes. The water levels in semi-confining units B and C also drew down further before starting recovery at 20,000 minutes. During this time drawdown due to offsite pumping was again noted in MW-18 (Figure 35). Offsite pumping in the IAS appears to have effected the recovery of water levels in the IAS permeable zones and confining units.

The drawdown and recovery data from the Suwannee Limestone OB well (MW-5) was analyzed using the Hantush Method and Theis and Jacob Methods, respectively. The drawdown data collected from MW-5 and MW-7 was analyzed using the Neuman and Witherspoon ratio method (1972). The hydraulic values for the Suwannee Limestone permeable zone are summarized in Table 5. Table 6 summarizes the hydraulic values for Confining Unit C (between LPZ and the UFA).

The ***Hantush Method*** values for the Suwannee Limestone permeable zone are as follows: transmissivity (T) = 4.87×10^3 ft^2/day, horizontal hydraulic conductivity (K_h) = 1.62×10^1 feet/day, storativity (S) = 3.00×10^{-4}. Values for confining unit C are as follows: hydraulic resistance ($\frac{b'}{K'}$) = 8.19×10^2 days, vertical hydraulic conductivity (K_v) = 2.08×10^{-1} feet/day, leakance ($\frac{K'}{b'}$) = 1.22×10^{-3} (feet/day)/foot.

The ***Theis and Jacob Method*** values for the Suwannee Limestone permeable zone are as follows: transmissivity (T) = 6.09×10^3 ft^2/day, horizontal hydraulic conductivity (K_h) = 2.03×10^1 feet/day.

The ***Neuman and Witherspoon Method*** values for the confining unit C are as follows: hydraulic diffusivity ($\frac{K'}{S's}$) = 2.92×10^3 ft^2/day, calculated vertical hydraulic (K_v) = 2.92×10^{-2} feet/day. Leakance ($\frac{K'}{b'}$) = 1.72×10^{-4} (feet/day)/foot.

Appendix E presents the UFA curve match analyses for the Hantush and Theis & Jacob methods, and the spreadsheet data for the Neuman and Witherspoon ratio method.

5.0 SUMMARY

A hydrogeologic investigation was completed in two phases at the ROMP 9.5 site in DeSoto County. During phase one, lithologic coring and testing of the site was performed to define the stratigraphy and hydrology of the site. Phase one was conducted from November 1996 to May 1997. Based on the results of phase one, monitor wells were designed and aquifer performance tests were planned for the intermediate aquifer and Suwannee Limestone permeable section of Upper Floridan aquifer.

Phase two of the project involved constructing the monitor wells and conducting the aquifer performance tests. Eighteen monitor wells were installed into the permeable and confining units of the surficial, intermediate, and Upper Floridan aquifers. Aquifer performance tests were conducted on the lower permeable zone of the IAS and the Suwannee Limestone permeable zone of the UFA. The APT's were conducted to determine the hydraulic properties of the aquifers and confining units.

The data collected from the ROMP 9.5 well site will be used by the SWFWMD and the USGS to develop maps, cross-sections, and regional models for the intermediate aquifer system in southwest Florida.

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TABLES

Table 1. Well Construction Details

Well Number	Well Cluster	Formation Monitored	Layer Monitored	Casing Interval (ft from surface)	Monitored Interval (ft bls)	Well Elevation (ft NGVD)
MW-1	Pumped	Suwannee Lm	UFA	12" steel (+3 - 505)	OH (505 - 801)	40.66
MW-2	Pumped	Arcadia Fm	IAS lower permeable zone	8" pvc (+3 - 205)	OH (205 -331)	41.21
MW-3	Pumped	Undiff Sands	surficial aquifer	4" pvc (+3 - 12)	SCR (12 - 37)	39.97
MW-4	Pumped	Undiff Sands	surficial aquifer	4" pvc (+3 - 2)	SCR (2 - 8)	40.39
MW-5	100'	Suwannee Lm	UFA	2" pvc (+3 - 502)	OH (502 - 800)	40.83
MW-6	100'	Suwannee Lm	semi-confining unit C-lower	2" pvc (+3 - 470)	SCR (470 - 475)	41.05
MW-7	100'	Arcadia Fm	semi-confining unit C-upper	2" pvc (+3 - 340)	SCR (340 - 350)	41.14
MW-8	100'	Arcadia Fm	IAS lower permeable zone	2" pvc (+3 - 205)	OH (205 -330)	41.17
MW-9	100'	Arcadia Fm	semi-confining unit B	2" pvc (+3 - 180)	SCR (180 -190)	41.06
MW-10	200'	Arcadia Fm	semi-confining unit C-upper	2" pvc (+3 - 340)	SCR (340 - 350)	40.64
MW-11	200'	Arcadia Fm	IAS lower permeable zone	2" pvc (+3 - 205)	OH (205 - 330)	40.73
MW-12	200'	Arcadia Fm	semi-confining unit B	2" pvc (+3 - 180)	SCR (180 -190)	40.42
MW-13	400'	Arcadia Fm	IAS lower permeable zone	2" pvc (+3 - 205)	OH (205 - 330)	40.58
MW-14	800'	Arcadia Fm	IAS lower permeable zone	2" pvc (+3 - 205)	OH (205 - 331)	38.99
MW-15	#2 100'	Arcadia Fm	semi-confining unit C-upper	2" pvc (+3 - 340)	SCR (340 - 350)	39.84
MW-16	#2 100'	Arcadia Fm	IAS lower permeable zone	2" pvc (+3 - 205)	OH (205 - 330)	39.46
MW-17	#2 100'	Arcadia Fm	semi-confining unit C-upper	2" pvc (+3 - 180)	SCR (180 -190)	39.97
MW-18	Core	Arcadia Fm	IAS upper permeable zone	4" pvc (+3 - 61)	OH (61 -77)	40.03

welltbl.wb2

Table 2. Hydraulic Values for the IAS Lower Permeable Zone Drawdown Phase

Well Analyzed	Distance and direction from from pumped well (MW-2) (feet)	Method	Transmissivity (T) ft^2/day	Horizontal Hydraulic Conductivity (K_h) ft/day	Storativity (S)
MW-8 (ob)	100 west	Hantush	1.45E+04	1.12E+02	1.61E-04
MW-11 (ob)	200 west	Hantush	1.63E+04	1.25E+02	7.30E-05
MW-13 (ob)	400 west	Hantush	1.67E+04	1.28E+02	1.70E-04
MW-14 (ob)	800 west	Hantush	1.15E+04	8.90E+01	6.32E-04
MW-16 (ob)	100 south	Hantush	1.29E+04	9.99E+01	5.19E-05
	aptbl.wb3	**Average**	**1.44E+04**	**1.11E+02**	**2.18E-04**

Table 3. Hydraulic Values for Semi-Confiing Unit B

Wells Analyzed	Method	Hydraulic Diffusivity (K'/S'_s) ft^2/day	Hydraulic Resistance (b'/K') days	Vertical Hydraulic Conductivity (K') ft/day	Leakance (K'/b') feet/day/foot
MW-9 & MW-8	Neuman & Witherspoon[1]	123	N/A	1.23E-03	1.00E-05
MW-8 (ob)	Hantush	N/A	6.86E+05	1.79E-04	1.46E-06
MW-11 (ob)	Hantush	N/A	2.44E+06	5.04E-05	4.10E-07
MW-13 (ob)	Hantush	N/A	9.57E+06	1.29E-05	1.04E-07
MW-14 (ob)	Hantush	N/A	5.52E+03	2.23E-02	1.81E-04
MW-16 (ob)	Hantush	N/A	7.69E+05	1.60E-04	1.30E-06
	Average[2]	N/A	**2.69E+06**	**4.54E-03**	**3.69E-05**

1 -Vertical Hydraulic Conductivity value is the product of the hydraulic diffusivity and specific storage.
The value for specific storage (1.0×10^{-5} ft^{-1}) was obtained from a table of average values for porous materials (Batu 1998).
2 -Average includes Hantush values only.

Table 4. Hydraulic Values for the IAS Lower Permeable Zone Recovery Phase

Well Analyzed	Distance and direction from from pumped well (MW-2) (feet)	Method	Transmissivity (T) ft²/day	Horizontal Hydraulic Conductivity (K_h) ft/day
MW-8 (ob)	100 west	Theis & Jacob	1.40E+04	1.07E+02
MW-11 (ob)	200 west	Theis & Jacob	1.63E+04	1.25E+02
MW-13 (ob)	400 west	Theis & Jacob	1.82E+04	1.40E+02
MW-14 (ob)	800 west	Theis & Jacob	1.86E+04	1.43E+02
MW-16 (ob)	100 south	Theis & Jacob	1.27E+04	9.78E+01
		Average	**1.60E+04**	**1.23E+02**

Table 5. Hydraulic Values for the UFA Suwannee Limestone Permeable Zone

Well Analyzed	Distance and direction from from pumped well (MW-1) (feet)	Test Phase	Method	Transmissivity (T) (Feet²/day)	Horizonal Hydraulic Conductivity (K_h) (Feet/day)	Storativity (S)
MW-5 (ob)	100 west	Drawdown	Hantush	4.87E+03	1.62E+01	3.00E-04
MW-5 (ob)	100 west	Recovery	Theis & Jacob	6.09E+03	2.03E+01	N/A

Table 6. Hydraulic Values for Semi-Confining Unit C.

Wells Analyzed	Method	Hydraulic Diffusivity (K'/S's) ft²/day	Hydraulic Resistance (b'/K') days	Vertical Hydraulic Conductivity (K') ft/day	Leakance (K'/b') feet/day/foot
MW-5 (ob)	Hantush	N/A	8.19E+02	2.08E-01	1.22E-03
MW-7 & MW-5	Neuman & Witherspoon[1]	2.92E+03	N/A	2.92E-02	1.72E-04

aptbl.wb3

1 -Vertical Hydraulic Conductivity value is the product of the hydraulic diffusivity and specific storage.

The value for specific storage (1.0×10^{-5} ft^{-1}) was obtained from a table of average values for porous materials (Batu 1998).

FIGURES

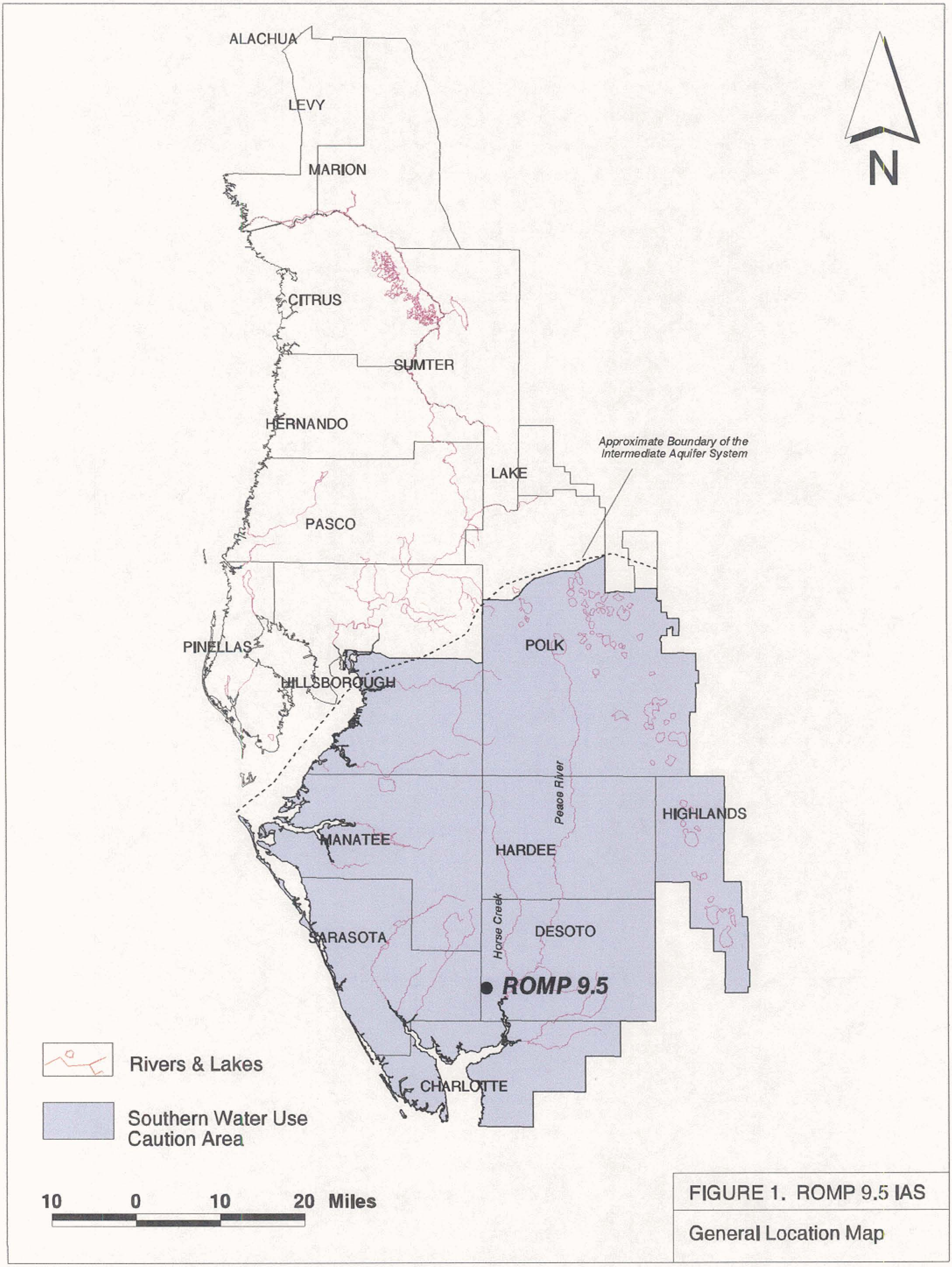


FIGURE 1. ROMP 9.5 IAS

General Location Map

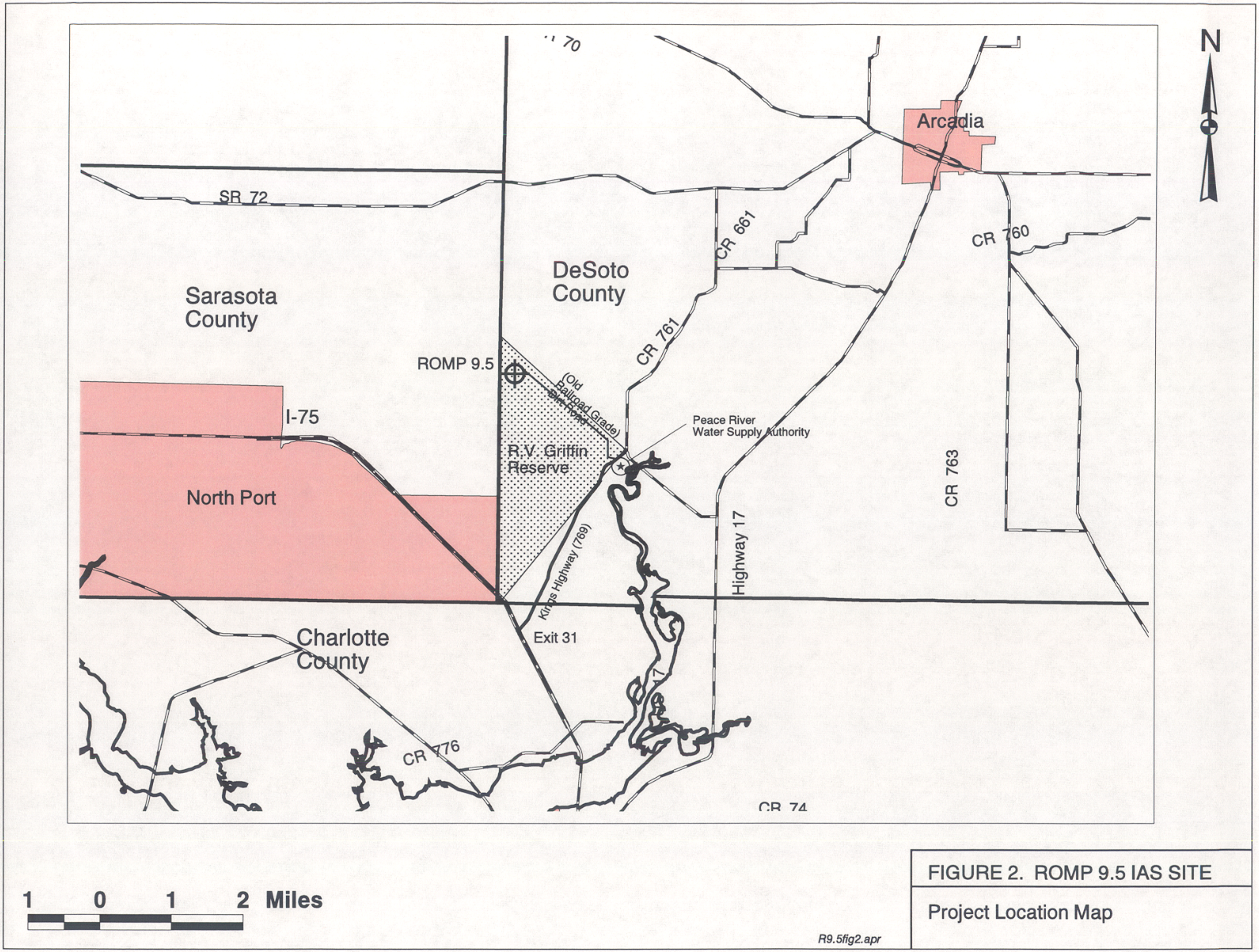
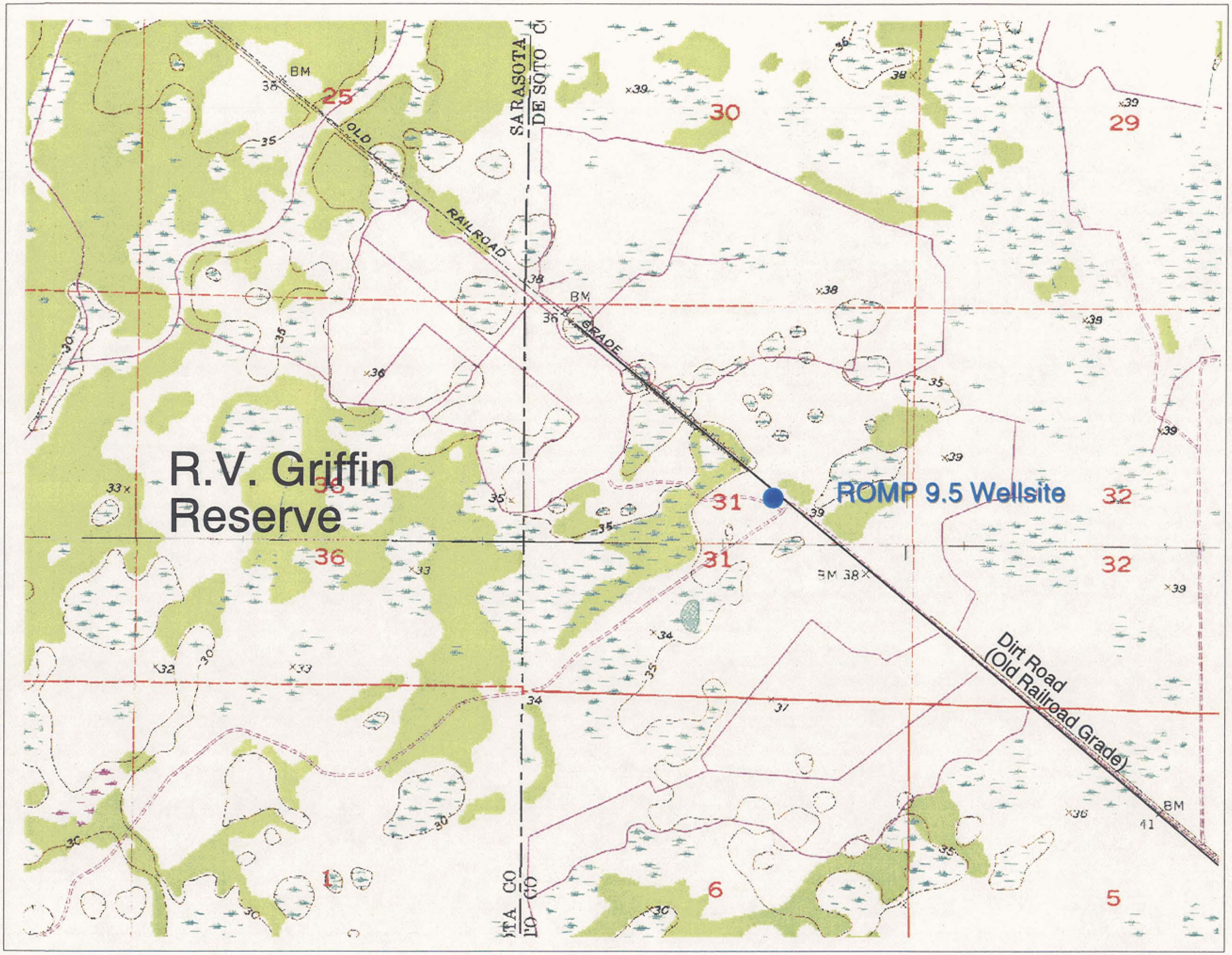


FIGURE 2. ROMP 9.5 IAS SITE

Project Location Map

R9.5fig2.apr



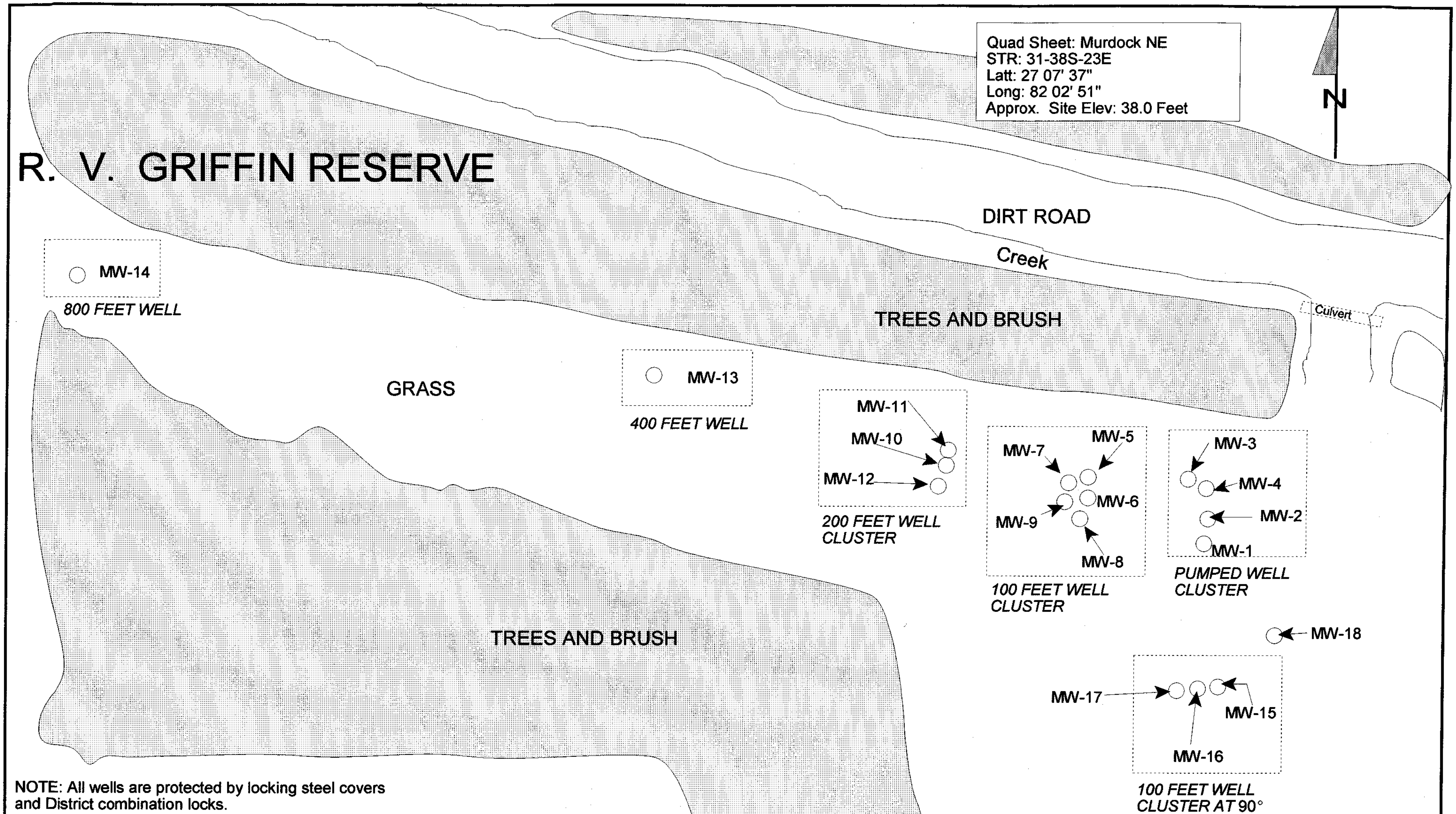
DeSoto County
Murdock NE Quad
S31-T38-R23
Latt: 27 07' 37"
Long: 82 02' 51"
Site Elev.
~38' NGVD

0.3 0 0.3 0.6 Miles

r95topo.apr

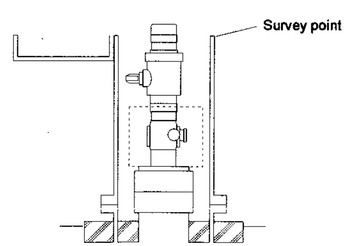
FIGURE 3. ROMP 9.5 IAS SITE

Well Site Location Map



NOTE: All wells are protected by locking steel covers and District combination locks.

Well Number	Well Cluster	Well Name	Monitored Interval ft bls)	Well Elevation (ft NGVD)
MW-1	Pumped	12" UF pumped	505 - 801	40.66
MW-2	Pumped	8" IAS pumped	205 -331	41.21
MW-3	Pumped	4" Deep Surficial	12 - 37	39.97
MW-4	Pumped	4" Shallow Surficial	2 - 8	40.39
MW-5	100'	2" UF ob	500 - 800	40.83
MW-6	100'	2" lower conf unit C	470 - 475	41.05
MW-7	100'	2" upper conf unit C	340 - 350	41.14
MW-8	100'	2" IAS ob	205 -330	41.17
MW-9	100'	2" conf unit B	180 -190	41.06
MW-10	200'	2" upper conf unit C	340 - 350	40.64
MW-11	200'	2" IAS ob	205 - 330	40.73
MW-12	200'	2" conf unit B	180 -190	40.42
MW-13	400'	2" IAS ob	205 - 330	40.58
MW-14	800'	2" IAS ob	205 - 331	38.99
MW-15	#2 100'	2" upper conf unit C	340 - 350	39.84
MW-16	#2 100'	2" IAS ob	205 - 330	39.46
MW-17	#2 100'	2" conf unit B	180 -190	39.97
MW-18	Core	4" upper IAS	61 -77	40.03



Note: MW-1 and MW-2 have flowing well head.

9.5\figures\site3.wpg 6-16-98

FIGURE 4. ROMP 9.5 IAS SITE

Monitor Well Site Diagram

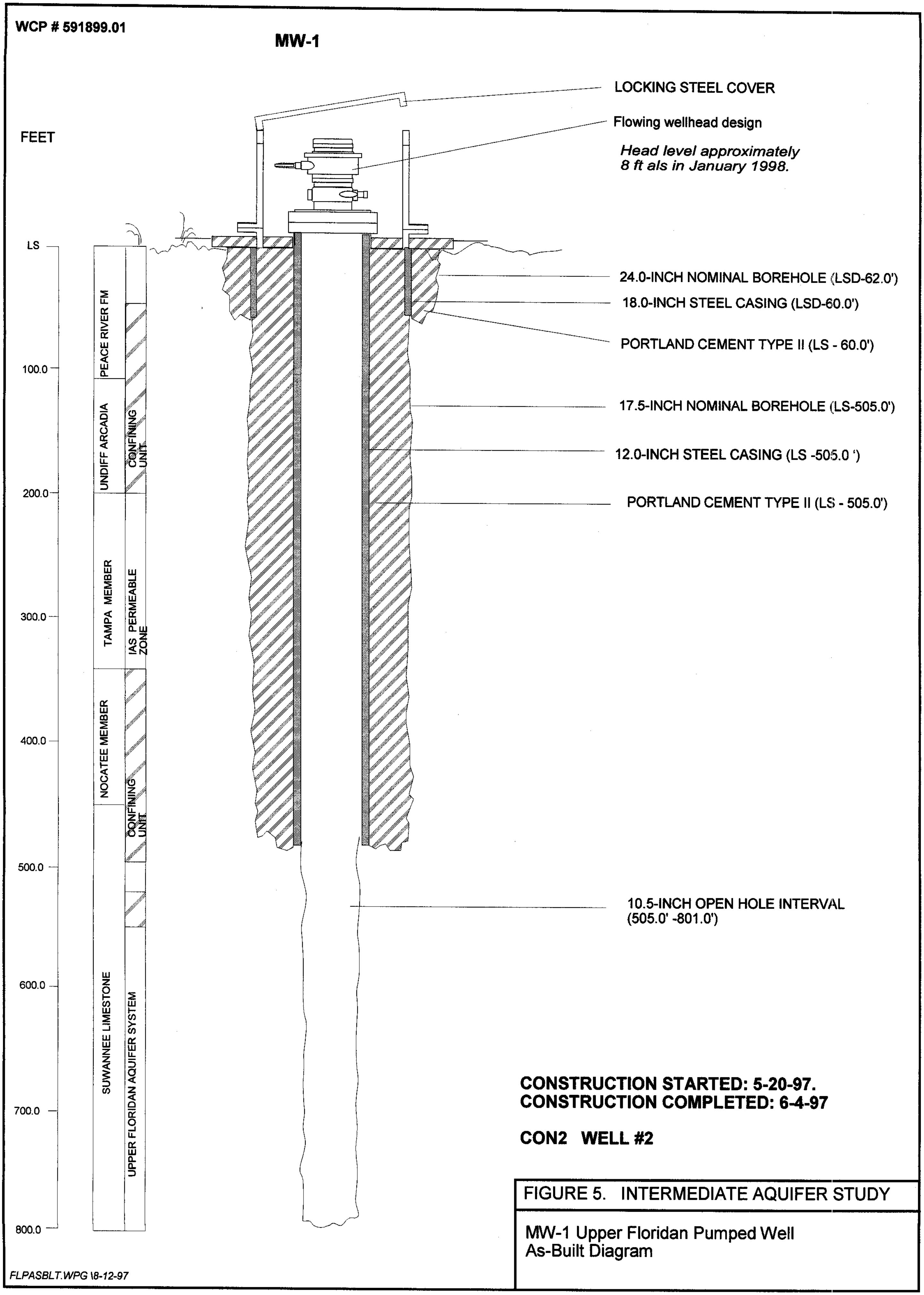
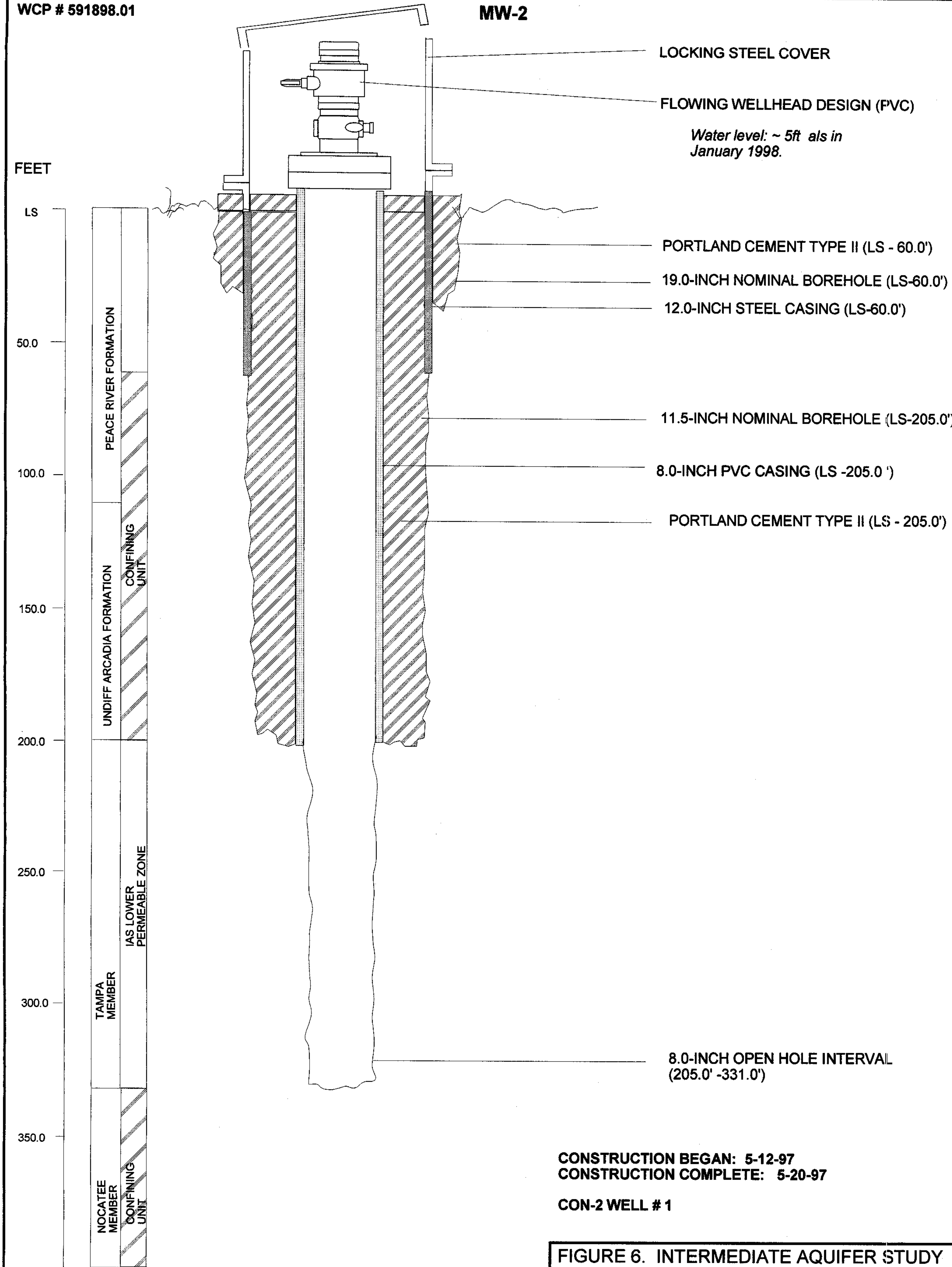


FIGURE 5. INTERMEDIATE AQUIFER STUDY

MW-1 Upper Floridan Pumped Well As-Built Diagram

WCP # 591898.01

MW-2



CONSTRUCTION BEGAN: 5-12-97
CONSTRUCTION COMPLETE: 5-20-97

CON-2 WELL # 1

FIGURE 6. INTERMEDIATE AQUIFER STUDY

MW-2 IAS Lower Permeable Zone Pumped Well As-Built Diagaram

LIPMPABT.WPG 8-14-97

WCP # 585394.01

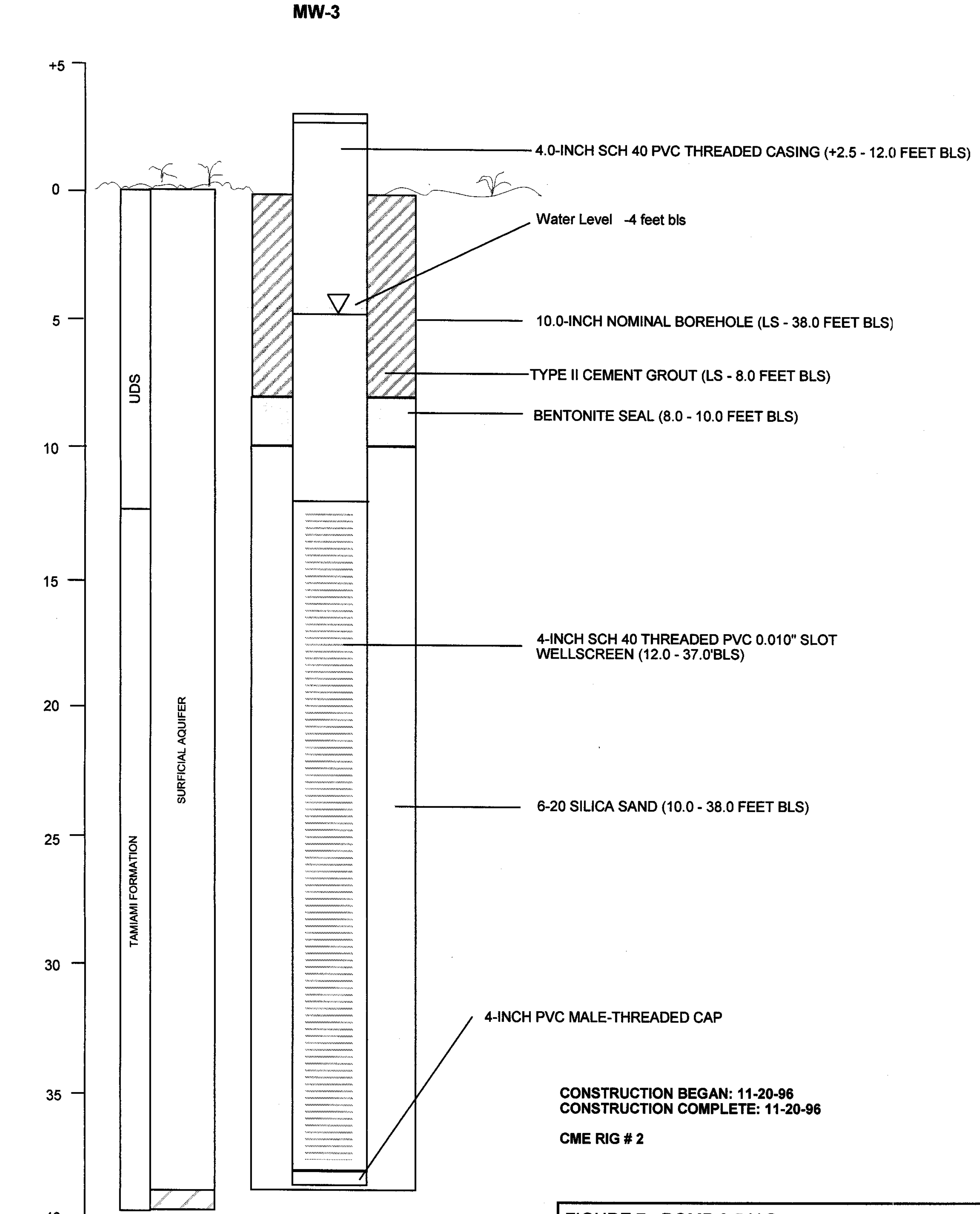


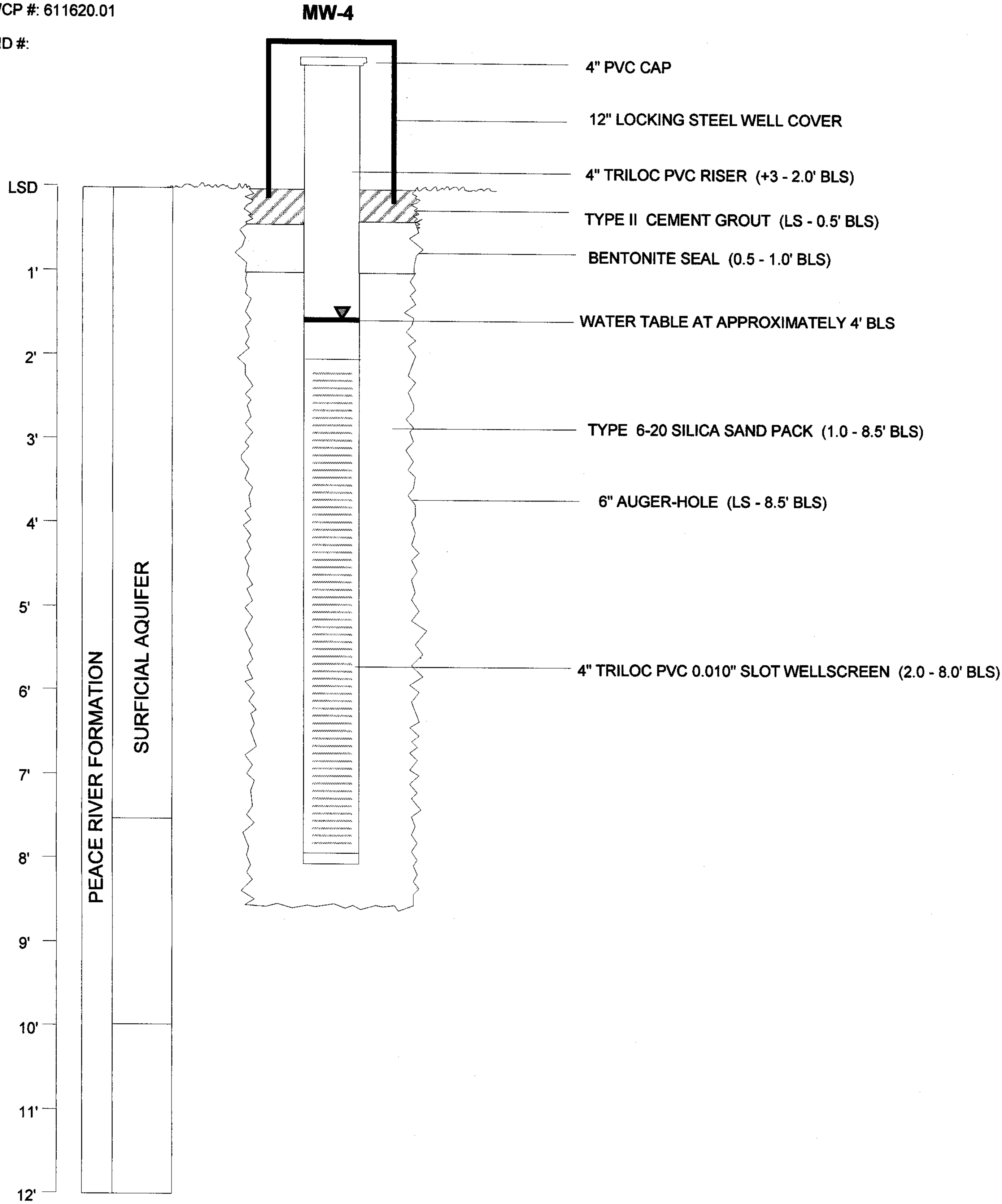
FIGURE 7. ROMP 9.5 IAS

MW-3 Lower Surficial Monitor Well
As-Built Diagram

Deepsurf.wpg/6-14-1999

WCP #: 611620.01

UID #:



CONSTRUCTION BEGAN: 10-27-1998
CONSTRUCTION COMPLETE: 10-27-98

CME WELL # 3

FIGURE 8. INTERMEDIATE AQUIFER STUDY

MW-4 Upper Surficial Monitor Well
As-Built Diagram

Uppersurf.WPG / 6-14-99

Permit # 593660.01

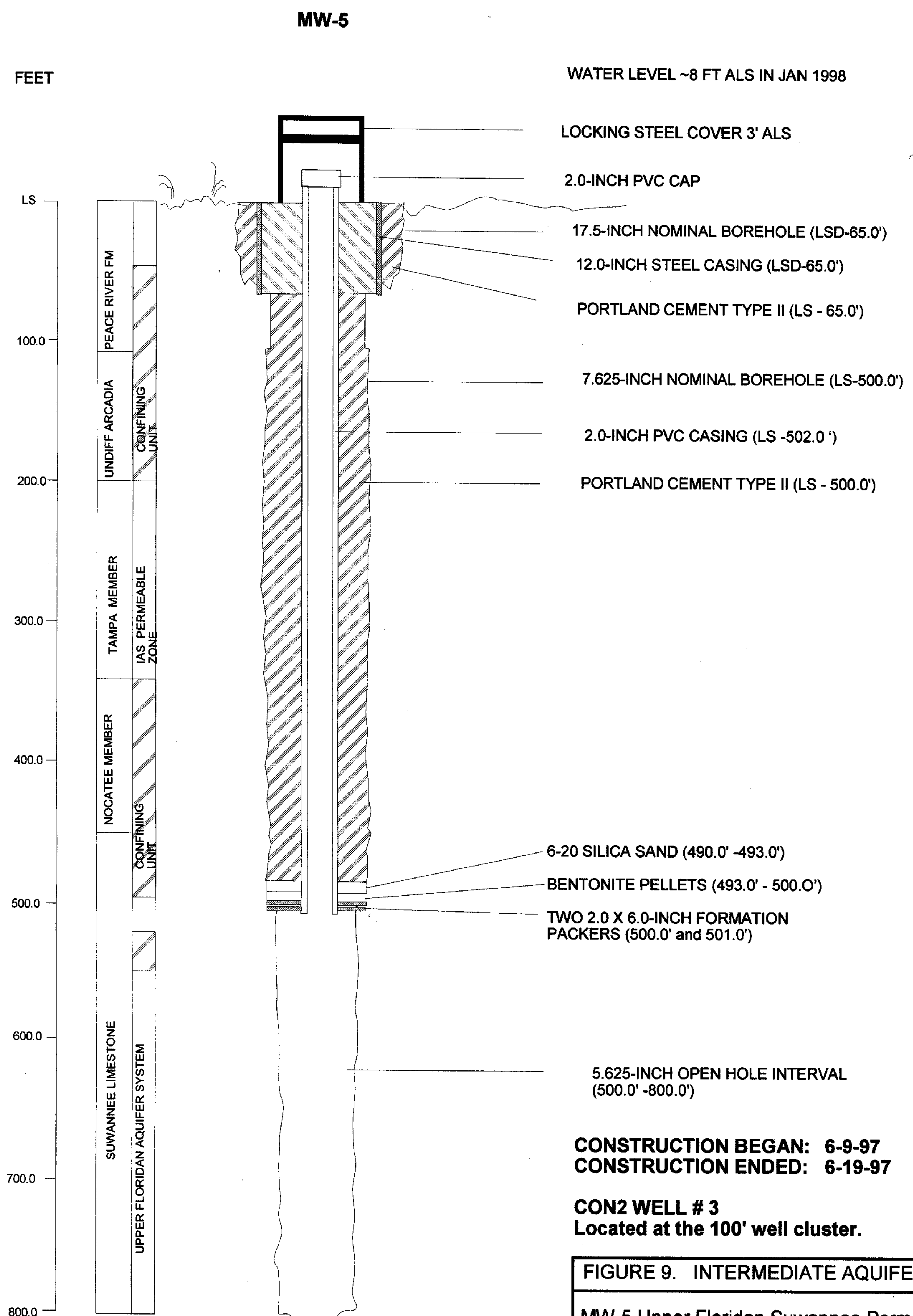
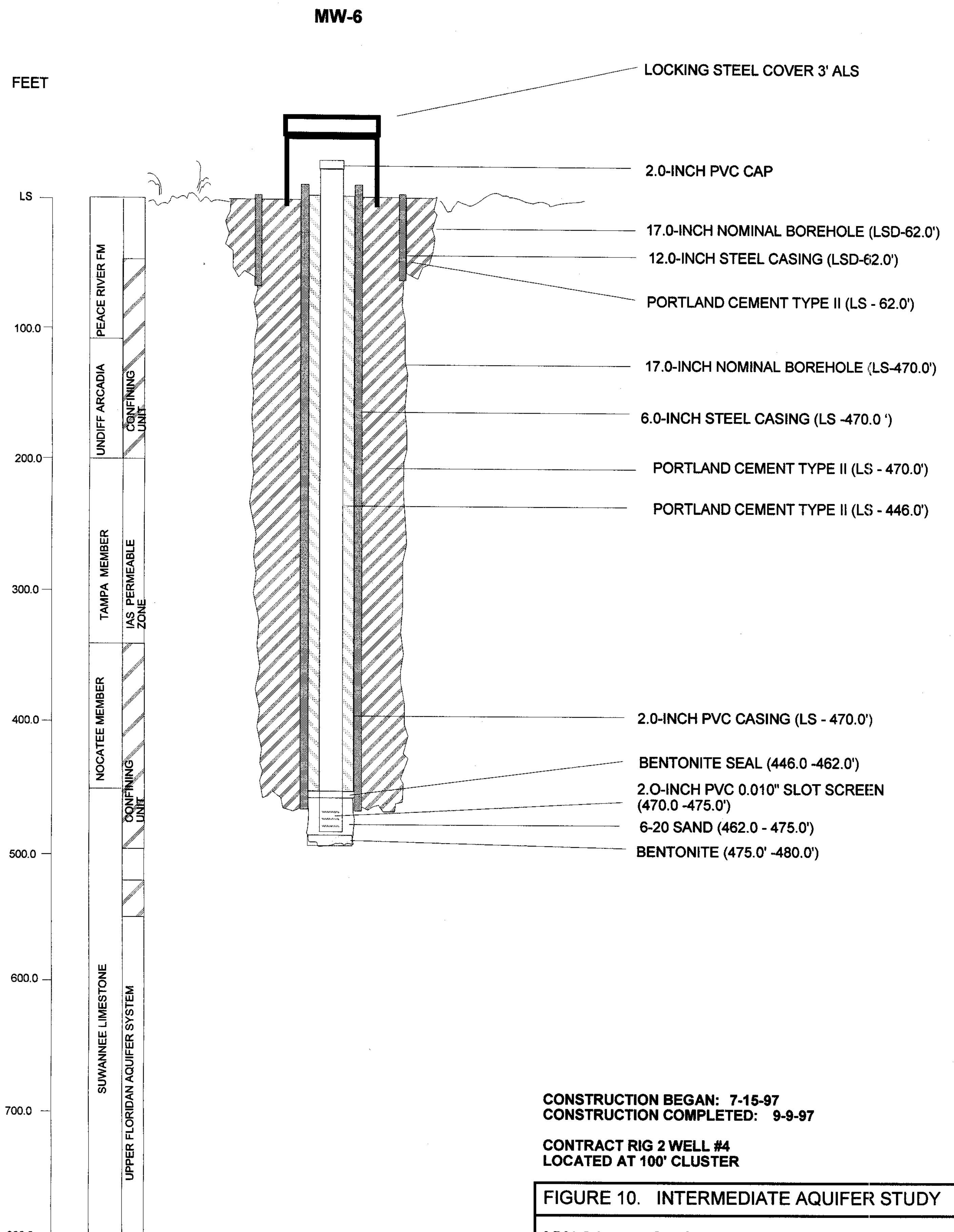


FIGURE 9. INTERMEDIATE AQUIFER STUDY

MW-5 Upper Floridan Suwannee Permeable Zone Observation Well As-Built Diagram

FLMONABT.WPG 10-30-97

WCP # 593659.01



CONSTRUCTION BEGAN: 7-15-97
CONSTRUCTION COMPLETED: 9-9-97

CONTRACT RIG 2 WELL #4
LOCATED AT 100' CLUSTER

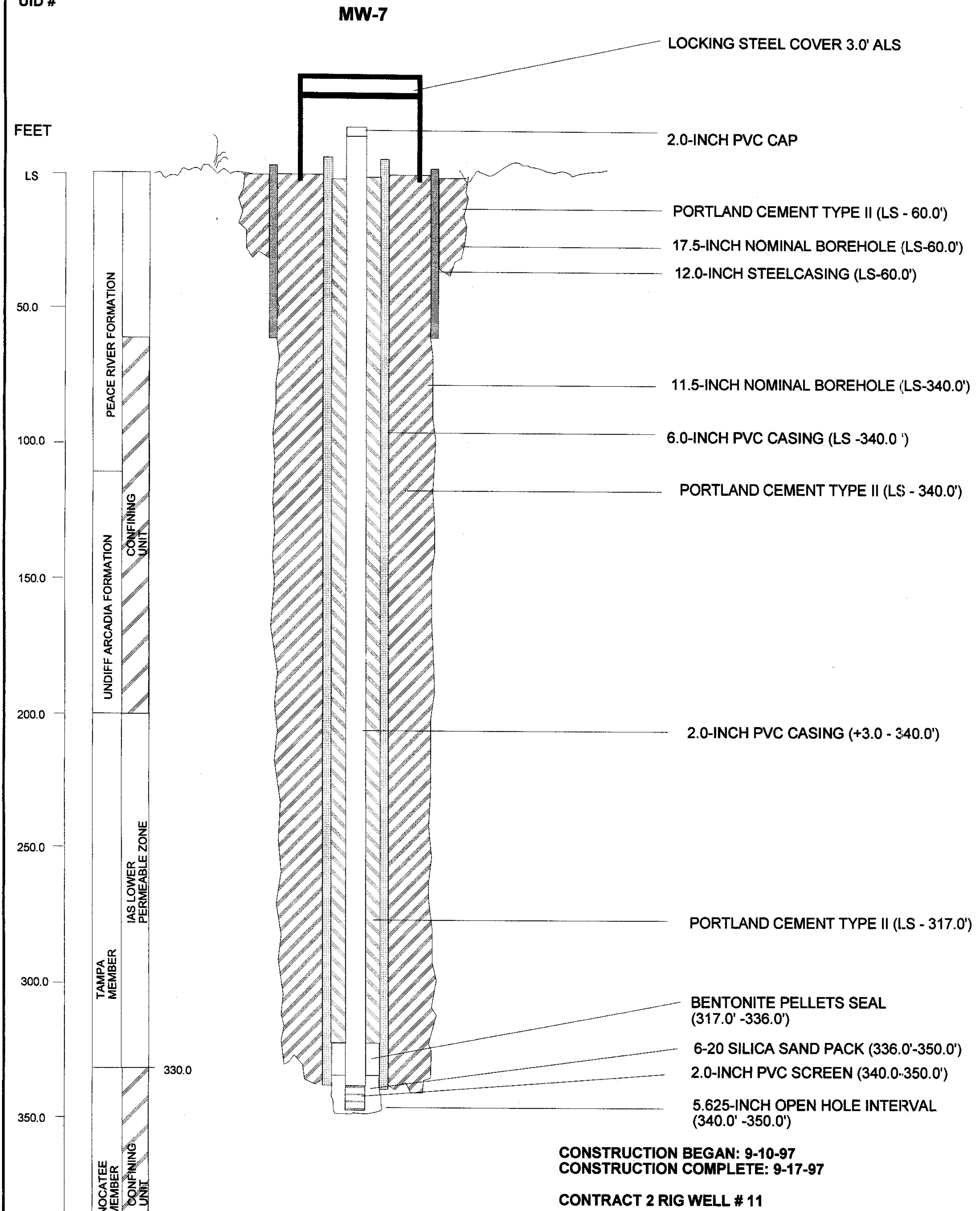
FIGURE 10. INTERMEDIATE AQUIFER STUDY

MW-6 Lower Confining Unit C
Observation Well As-Built Diagram

Mw6.WPG \6-29-99

PERMIT # 596353.01

UID #



CONSTRUCTION BEGAN: 9-10-97
CONSTRUCTION COMPLETE: 9-17-97

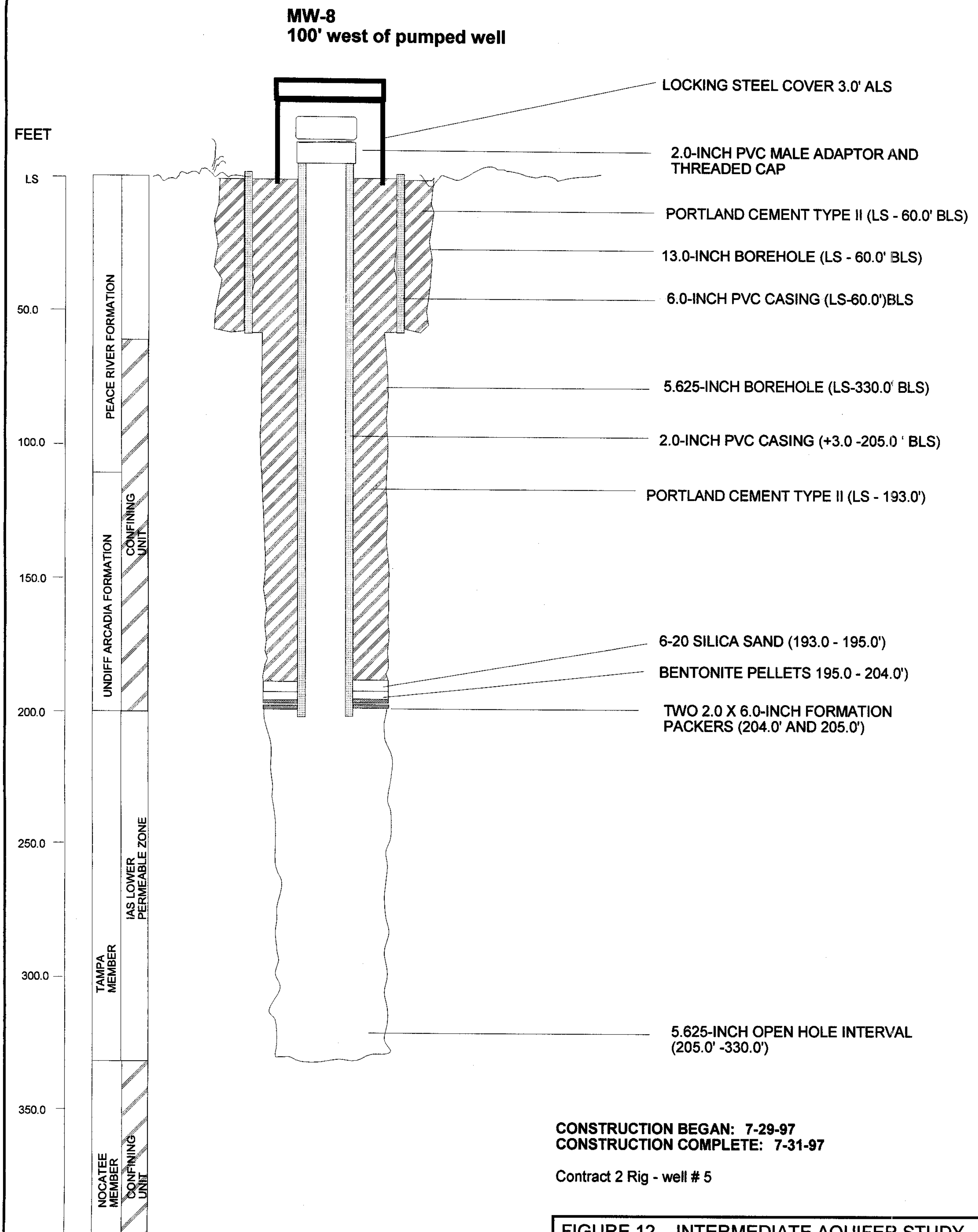
CONTRACT 2 RIG WELL # 11

FIGURE 11. INTERMEDIATE AQUIFER STUDY

MW-7 Upper Confining Unit C
Observation Well As-Built Diagram

Mw7.WPG

Permit # 593658.01



CONSTRUCTION BEGAN: 7-29-97
CONSTRUCTION COMPLETE: 7-31-97

Contract 2 Rig - well # 5

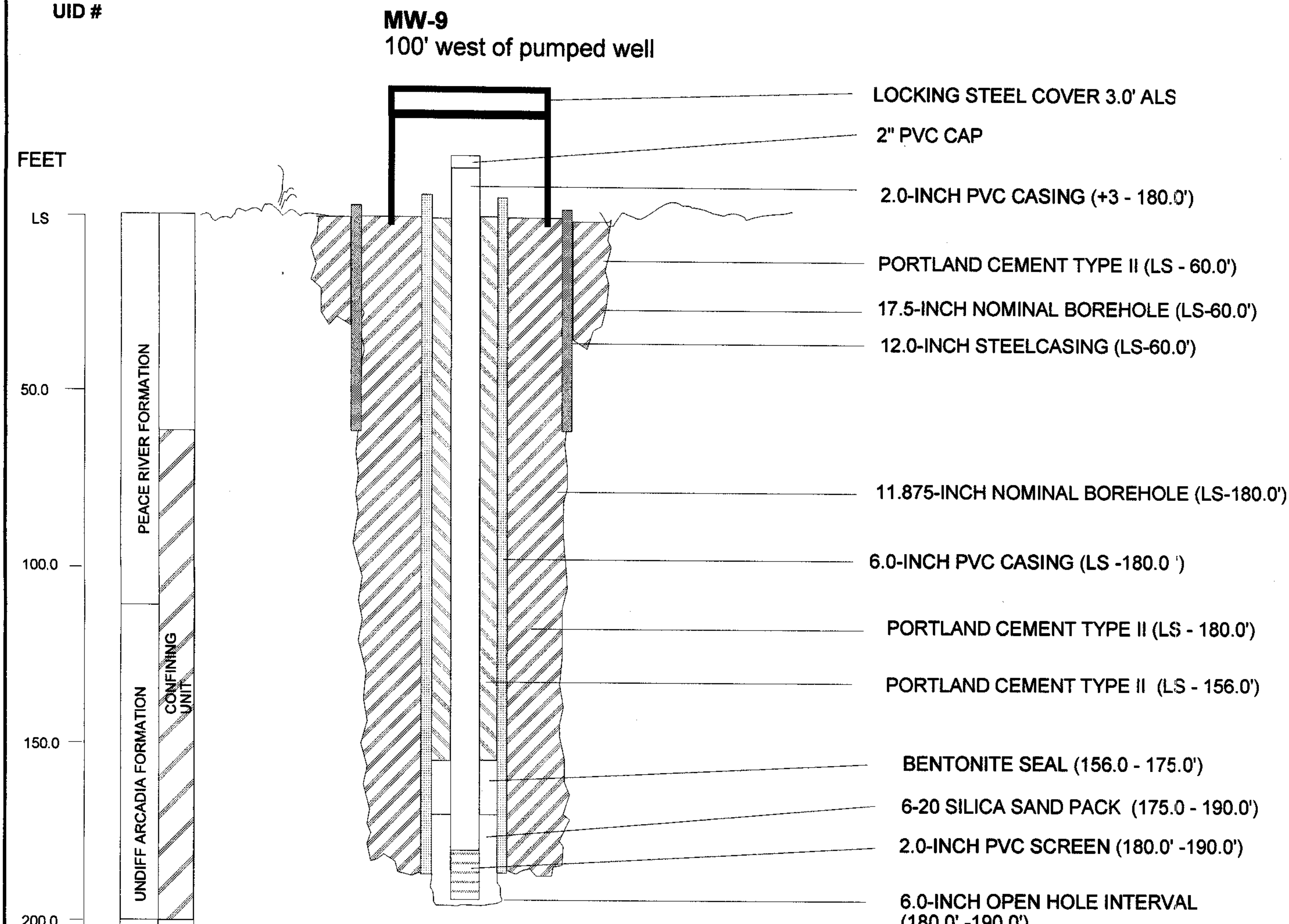
FIGURE 12 . INTERMEDIATE AQUIFER STUDY

MW-8 IAS Lower Permeable Zone Observation Well As-Built Diagram

Mw8.wpg

WCP # 597816.02

UID #



CONSTRUCTION BEGAN: 9-18-97
CONSTRUCTION COMPLETE: 9-25-97

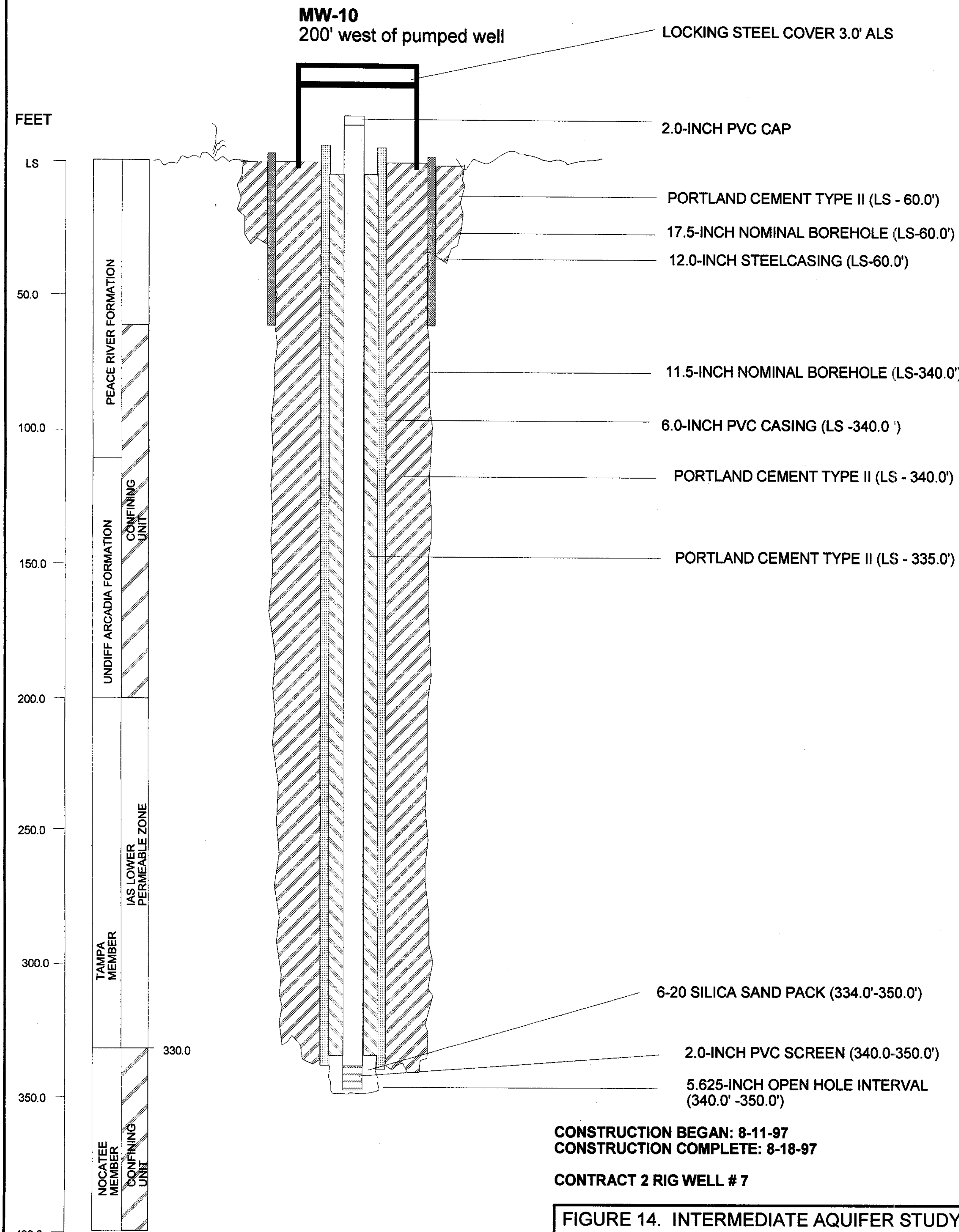
CONTRACT RIG 2 WELL # 12

FIGURE 13. INTERMEDIATE AQUIFER STUDY

MW-9 Confining Unit B
Observation Well As-Built Diagram

Mw9.wpg

PERMIT # 593656.01



CONSTRUCTION BEGAN: 8-11-97
CONSTRUCTION COMPLETE: 8-18-97

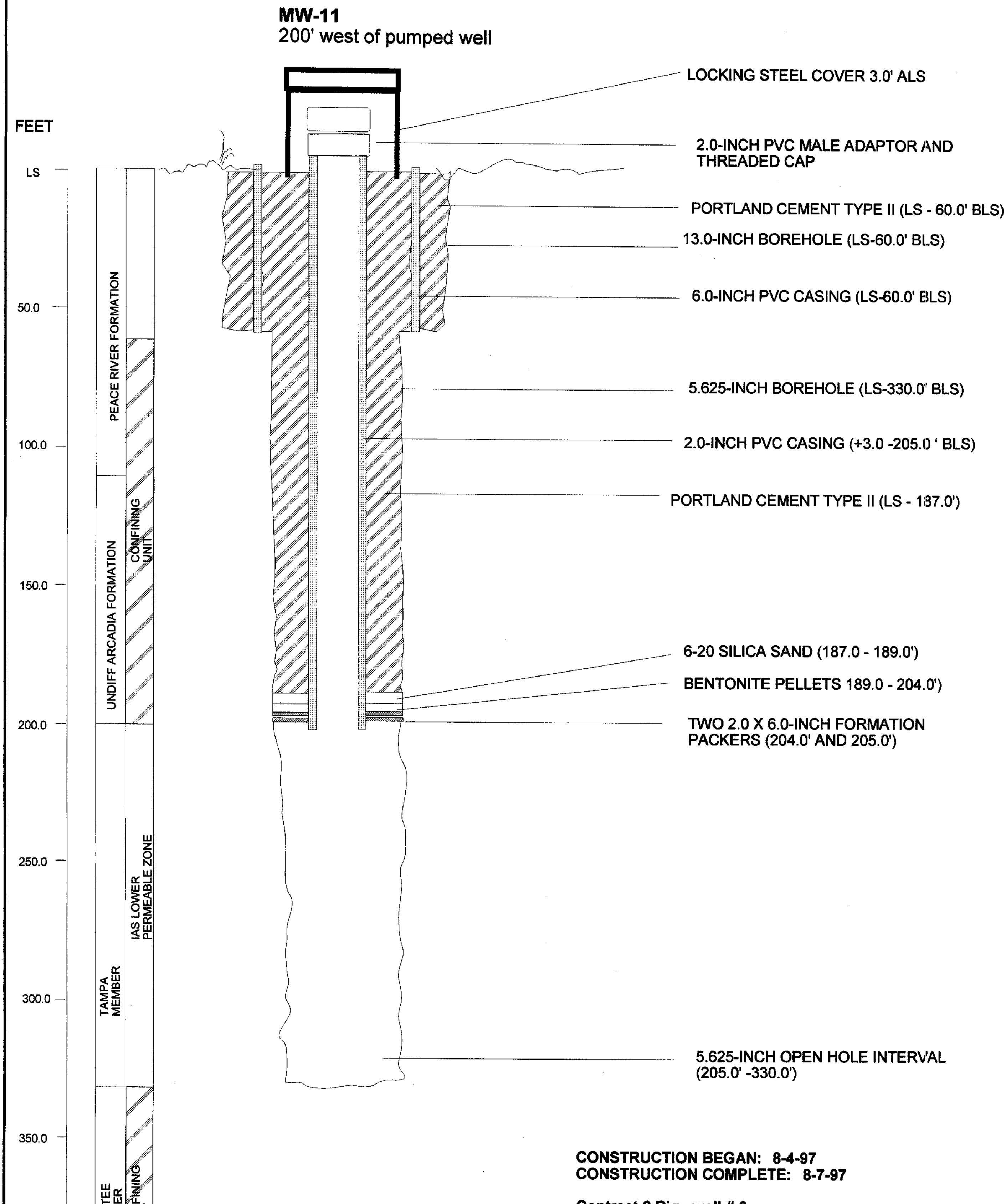
CONTRACT 2 RIG WELL # 7

FIGURE 14. INTERMEDIATE AQUIFER STUDY

MW-10 Upper Confining Unit C
Observation Well As-Built Diagram

Mw10.wpg

Permit # 596352.01



CONSTRUCTION BEGAN: 8-4-97
CONSTRUCTION COMPLETE: 8-7-97

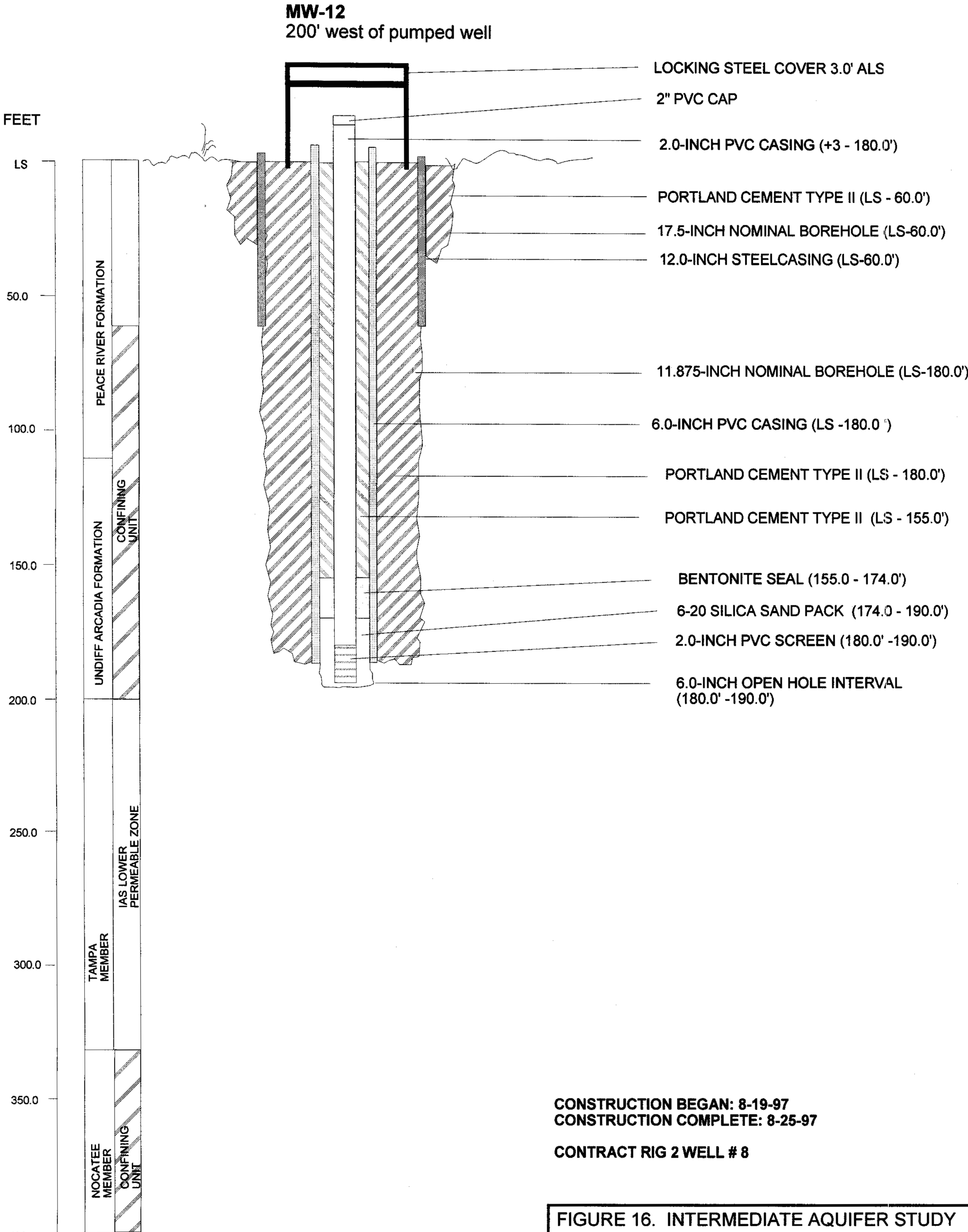
Contract 2 Rig - well # 6

FIGURE 15. INTERMEDIATE AQUIFER STUDY

MW-11 IAS Lower Permeable Zone
Observation Well As-Built

Mw11

WCP # 593654.01



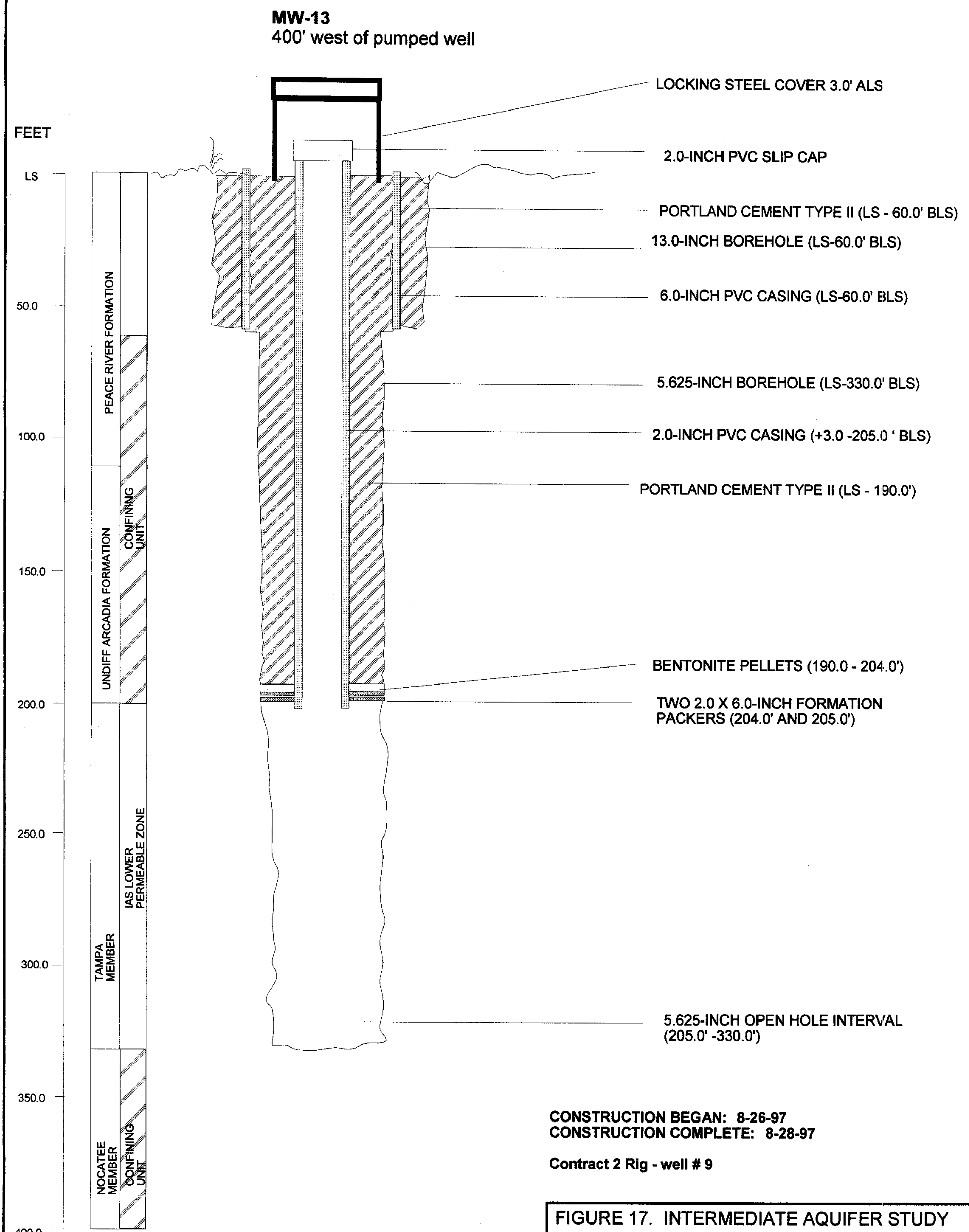
CONSTRUCTION BEGAN: 8-19-97
CONSTRUCTION COMPLETE: 8-25-97

CONTRACT RIG 2 WELL # 8

FIGURE 16. INTERMEDIATE AQUIFER STUDY
MW-12 Confining Unit B Observation Well As-Built Diagram

Mw12

Permit # 596644.01



CONSTRUCTION BEGAN: 8-26-97
CONSTRUCTION COMPLETE: 8-28-97

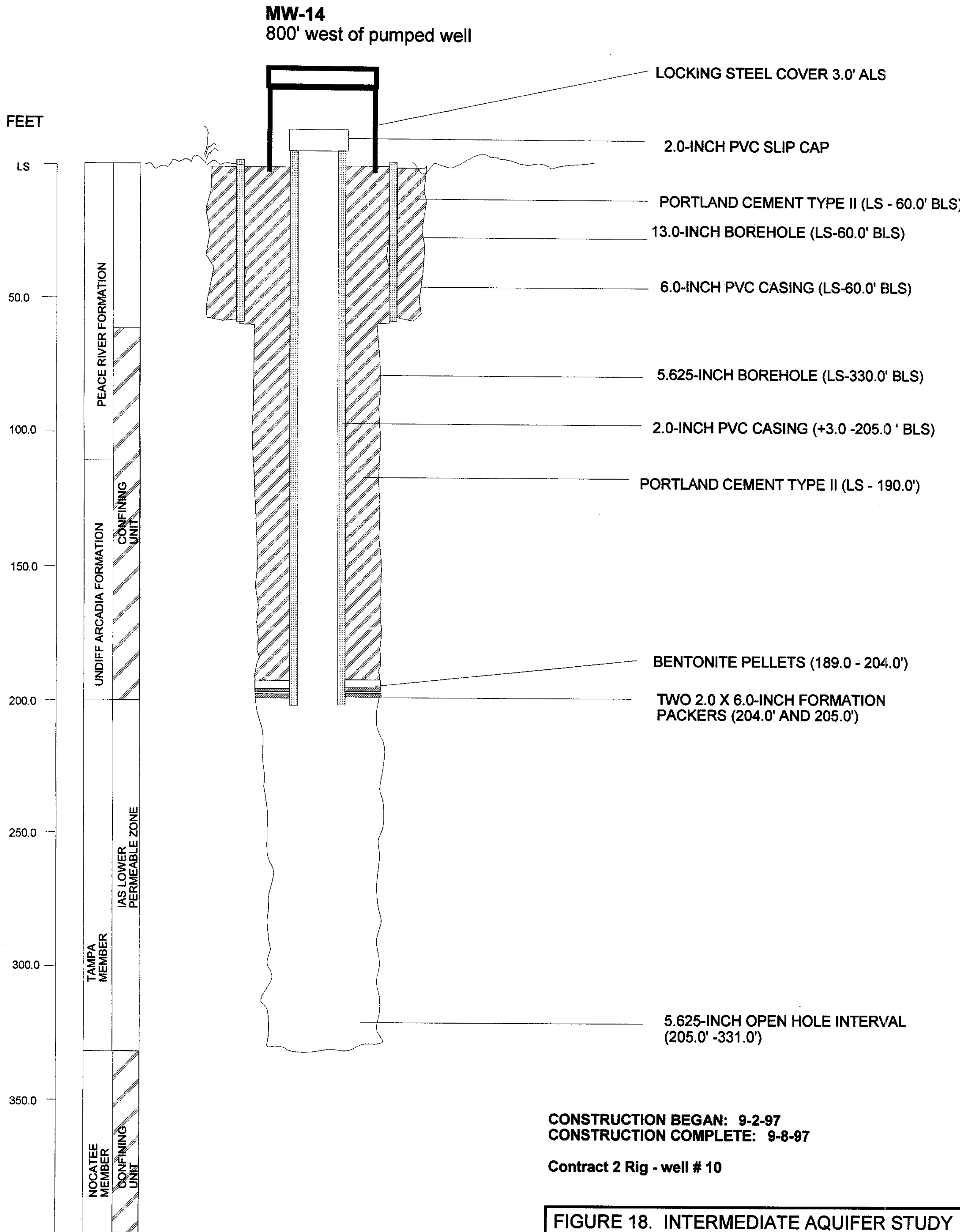
Contract 2 Rig - well # 9

FIGURE 17. INTERMEDIATE AQUIFER STUDY

MW-13 IAS Lower Permeable Zone Observation Well As-Built Diagram

Mw13.wpg

Permit # 597812.02



CONSTRUCTION BEGAN: 9-2-97
CONSTRUCTION COMPLETE: 9-8-97

Contract 2 Rig - well # 10

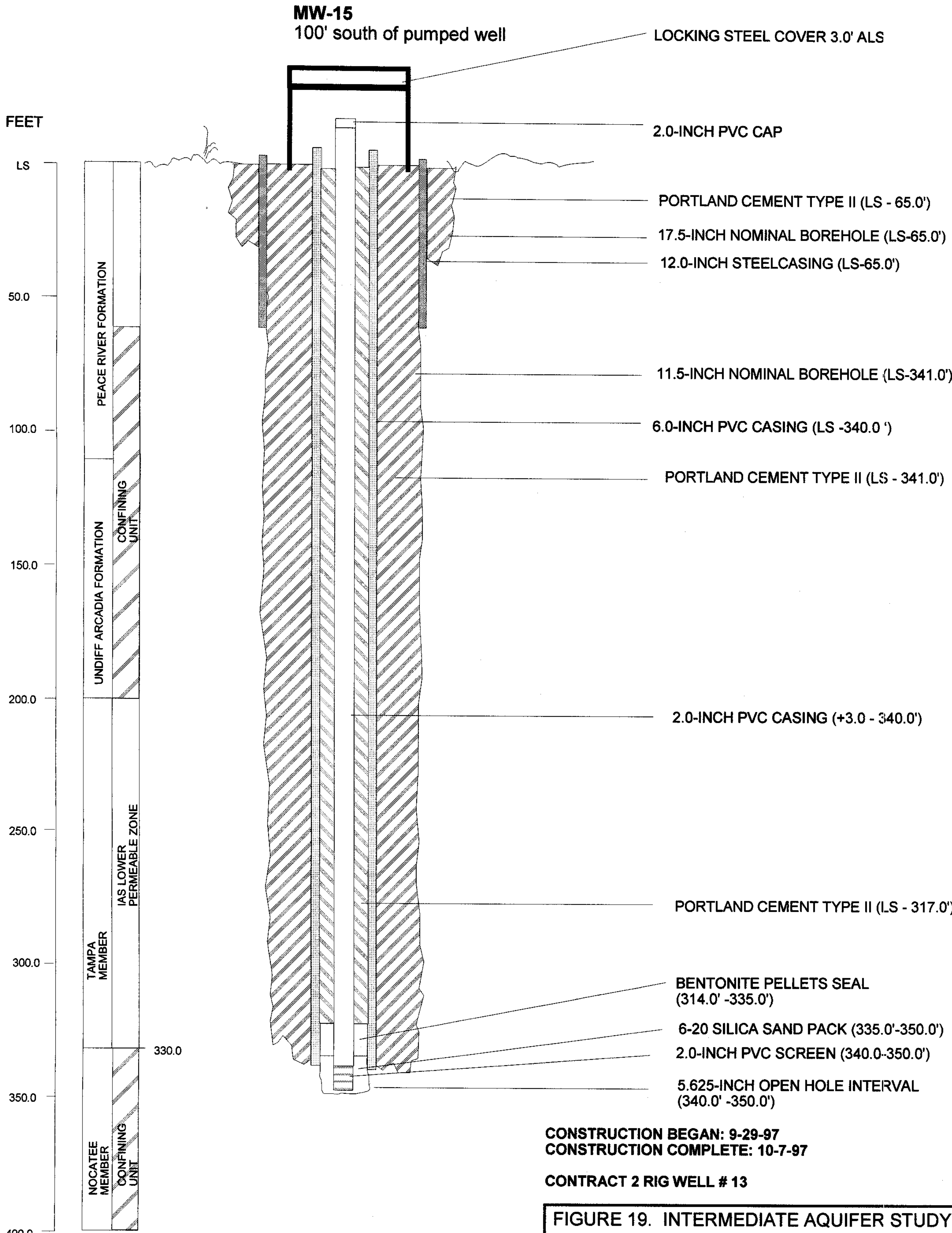
FIGURE 18. INTERMEDIATE AQUIFER STUDY

MW-14 IAS Lower Permeable Zone Observation Well As-built Diagram

MW14.WPG

PERMIT # 597811.01

UID #



CONSTRUCTION BEGAN: 9-29-97
CONSTRUCTION COMPLETE: 10-7-97

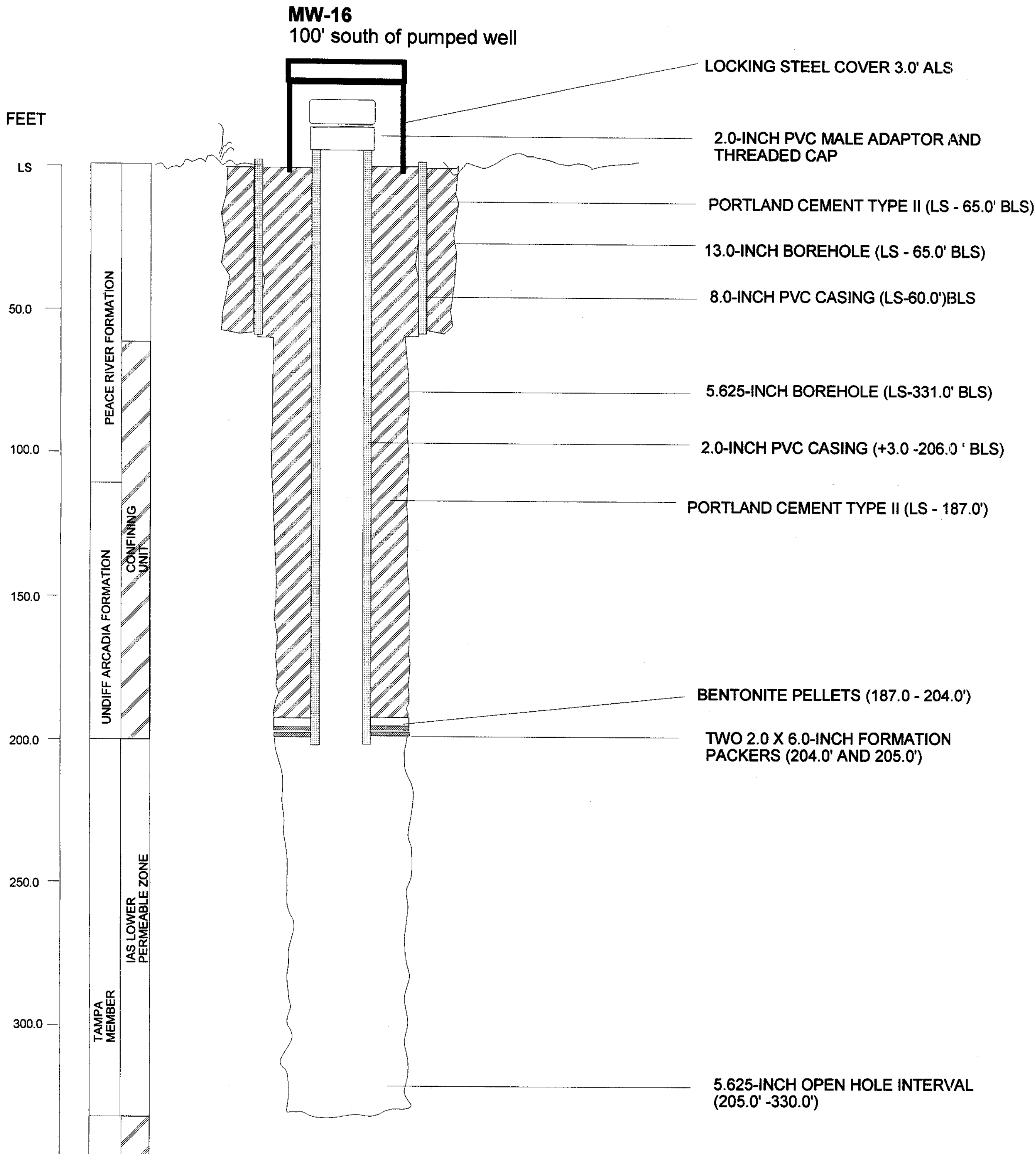
CONTRACT 2 RIG WELL # 13

FIGURE 19. INTERMEDIATE AQUIFER STUDY

MW-15 Upper Confining Unit C
Observation Well As-Built Diagram

Mw15.wpg

Permit # 597812.02



CONSTRUCTION BEGAN: 10-8-97
CONSTRUCTION COMPLETE: 10-14-97

Contract 2 Rig - well # 14

FIGURE 20. INTERMEDIATE AQUIFER STUDY

MW-16 IAS Lower Permeable Zone Observation Well As-Built Diagram

MW16.WPG

WCP # 597816.02

UID #

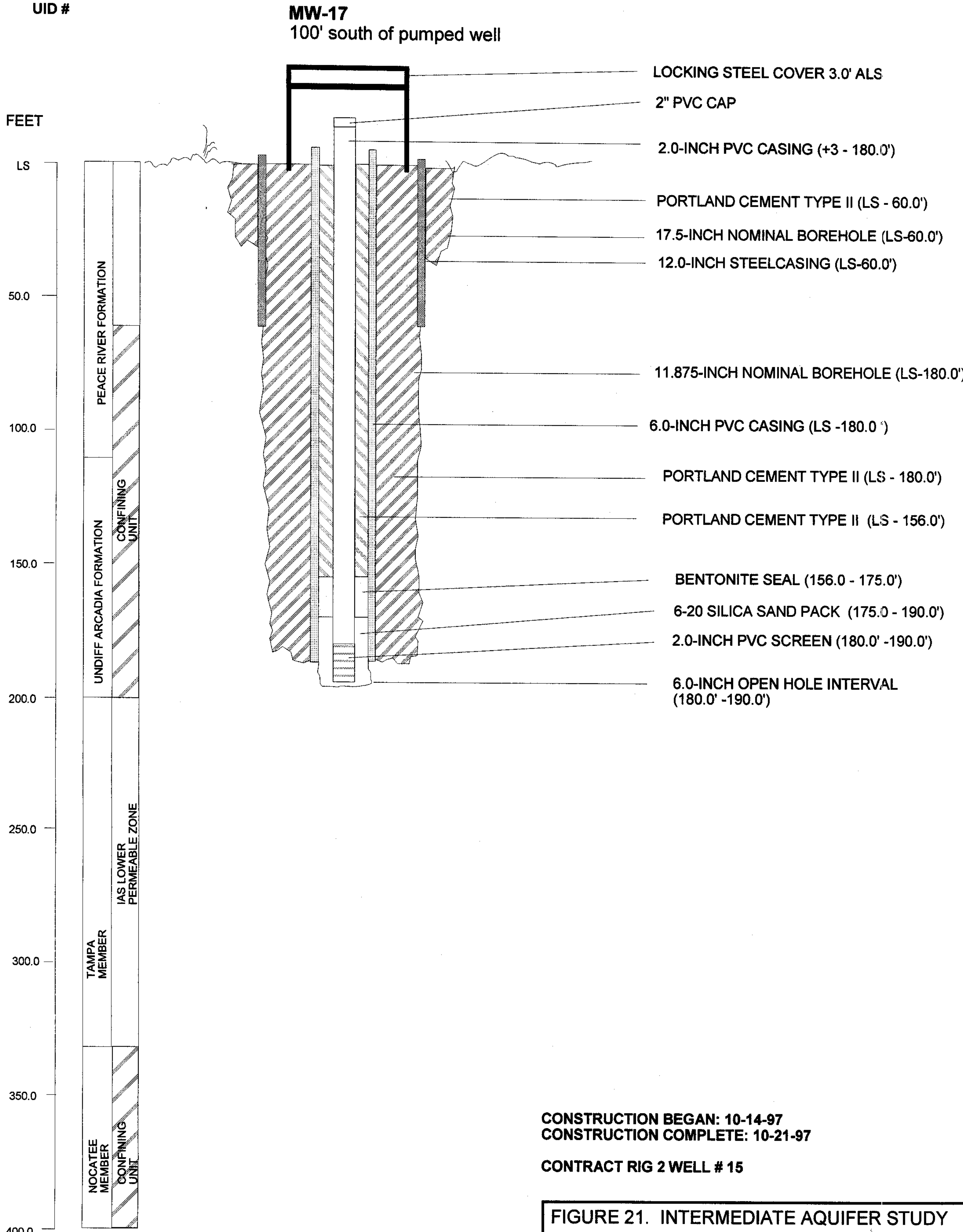


FIGURE 21. INTERMEDIATE AQUIFER STUDY

MW-17 Confining Unit B
Observation Well As-Built Diagram

MW17.WPG

WCP # 585395.01

UID #

MW-18

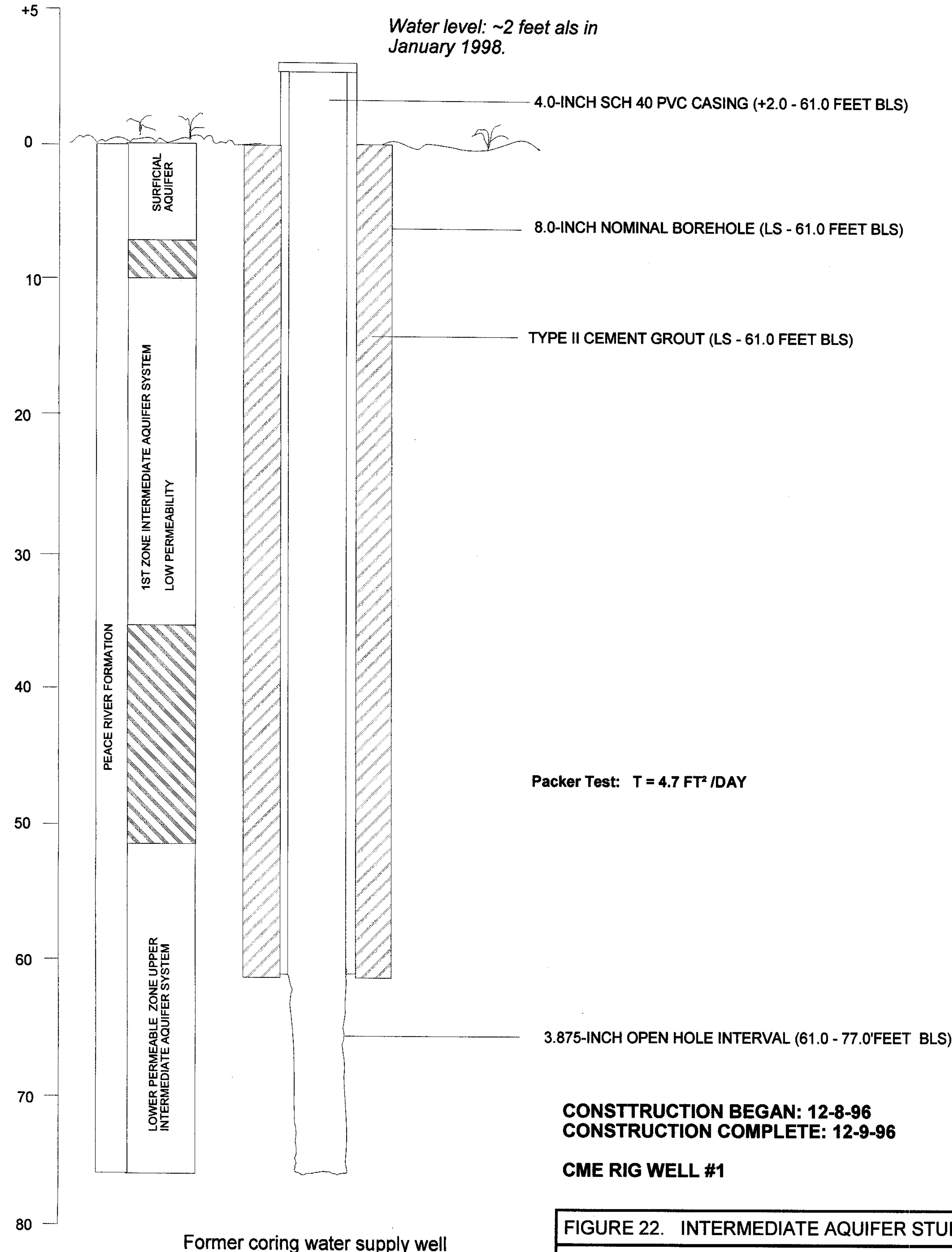


FIGURE 22. INTERMEDIATE AQUIFER STUDY

MW-18 IAS Upper Permeable Zone
As-Built Diagram

Mw18.wpg

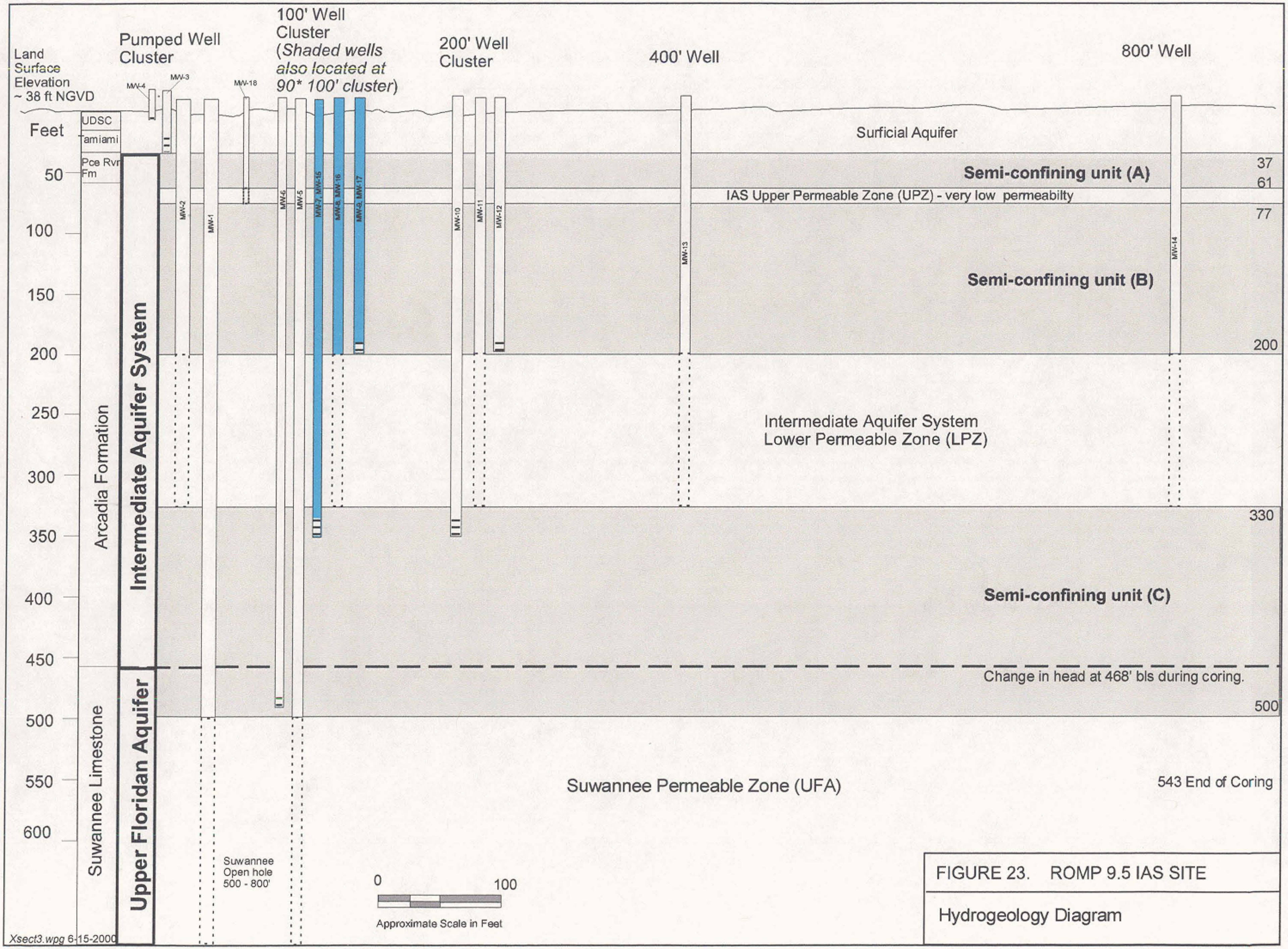
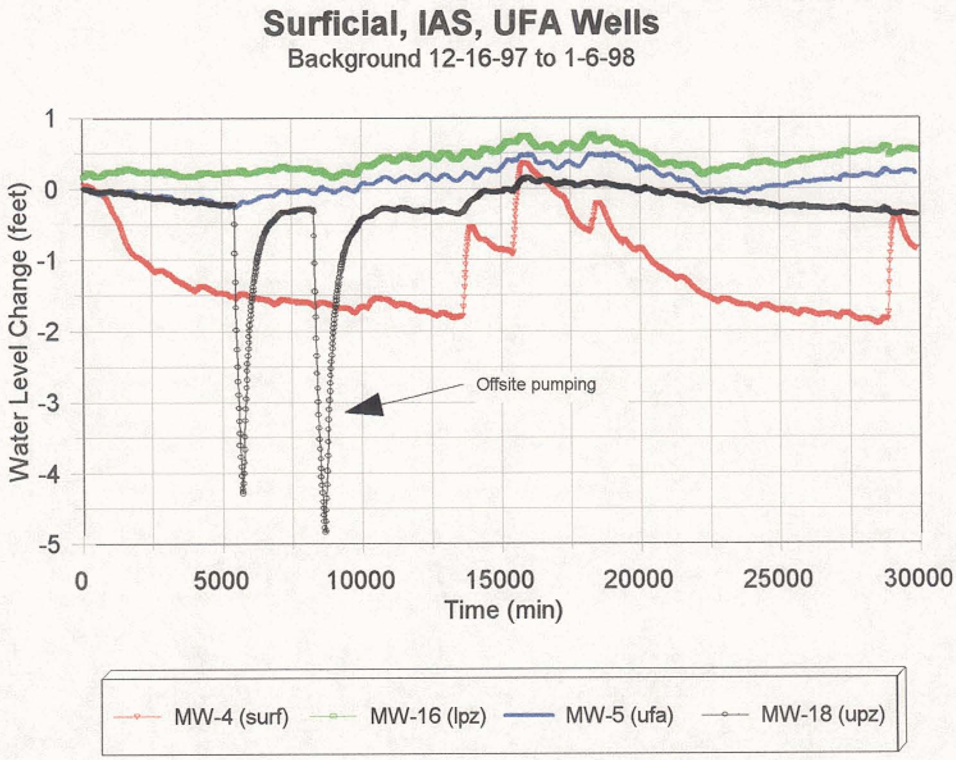


FIGURE 23. ROMP 9.5 IAS SITE

Hydrogeology Diagram



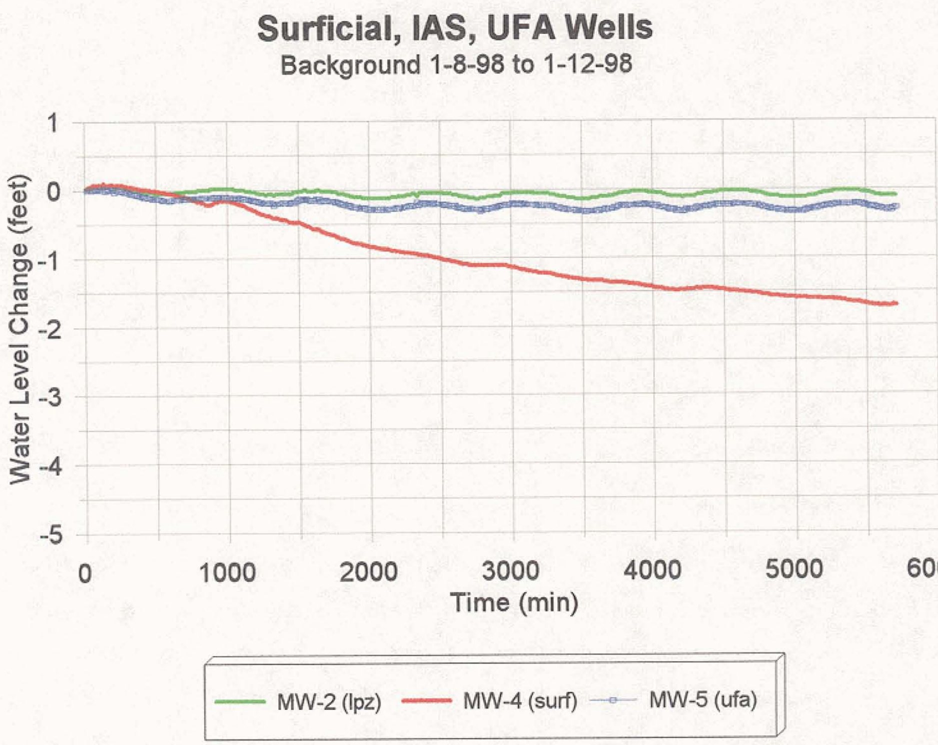
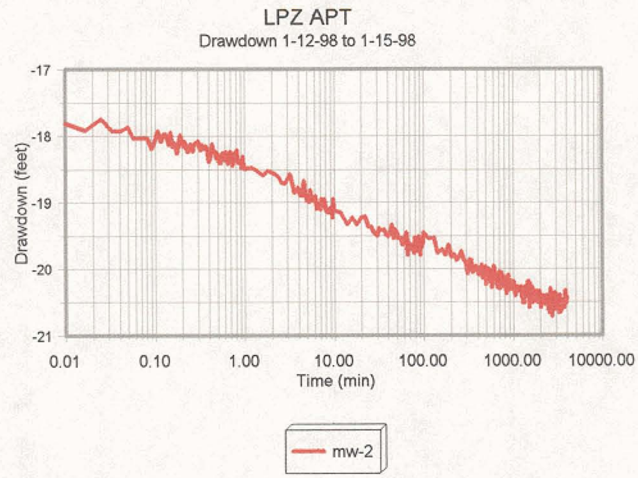
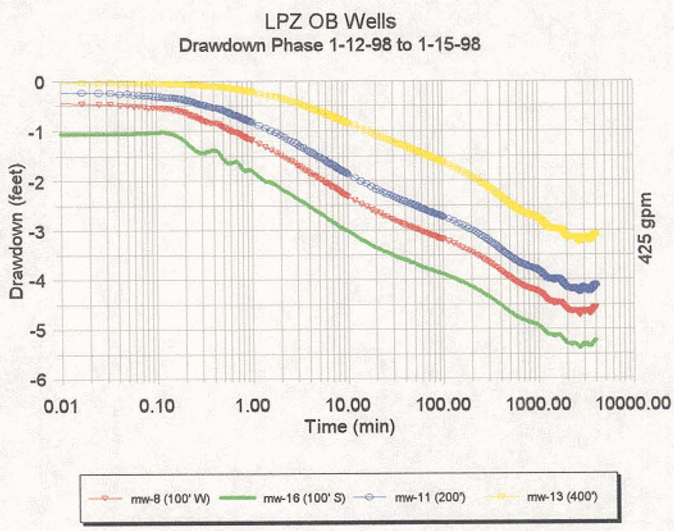


Figure 24. ROMP 9.5 IAS

Hydrographs Prior to IAS APT





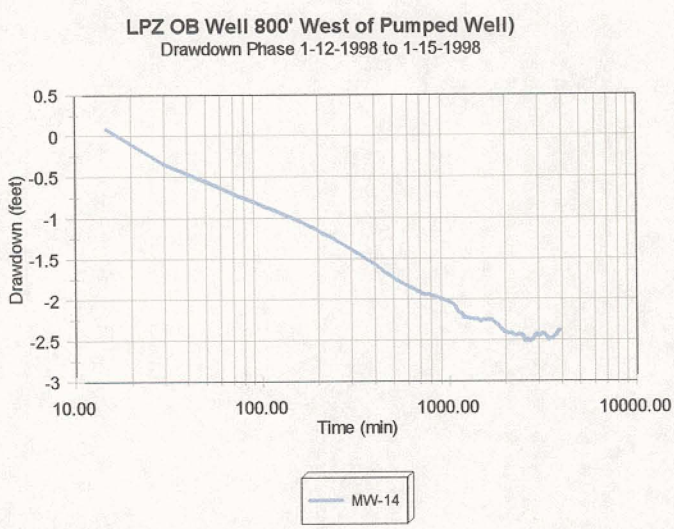
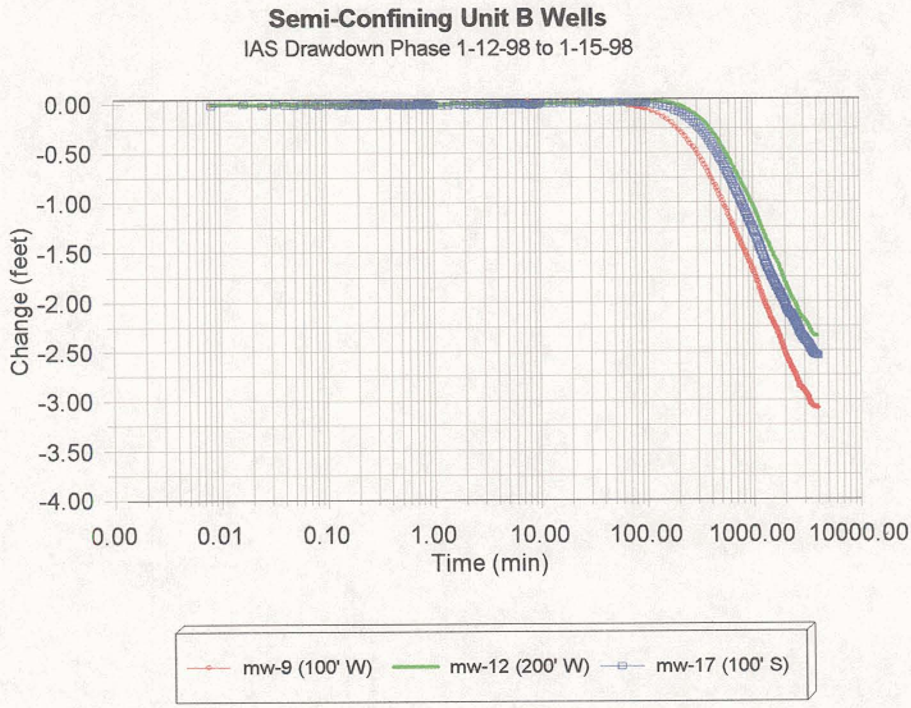


FIGURE 25. ROMP 9.5 IAS
IAS Drawdown Phase-LPZ Wells

dd.wb2-fig25



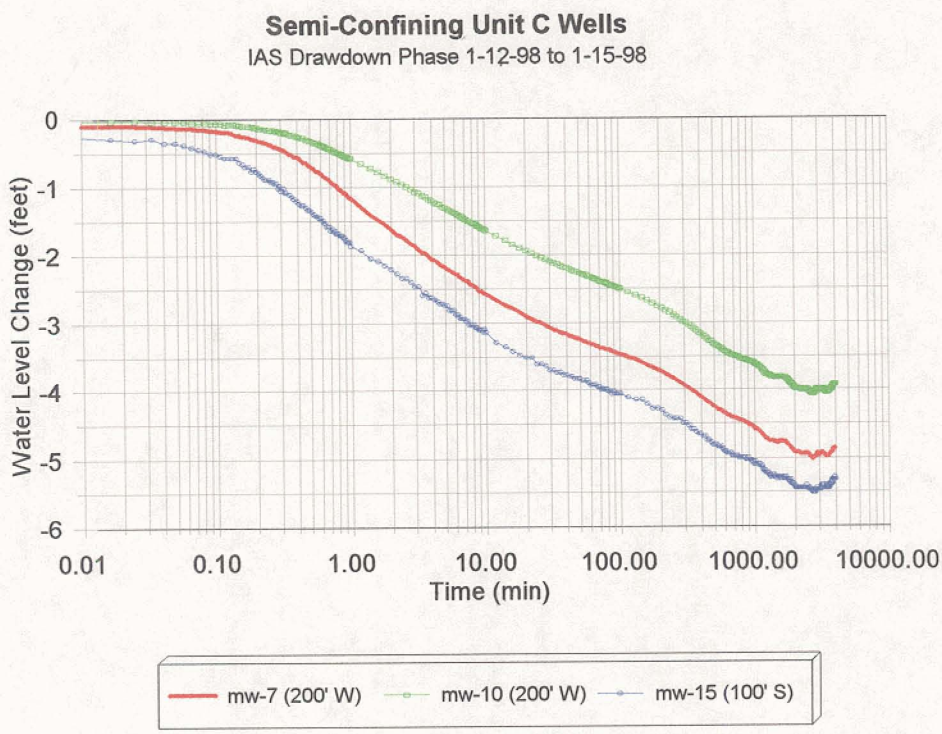
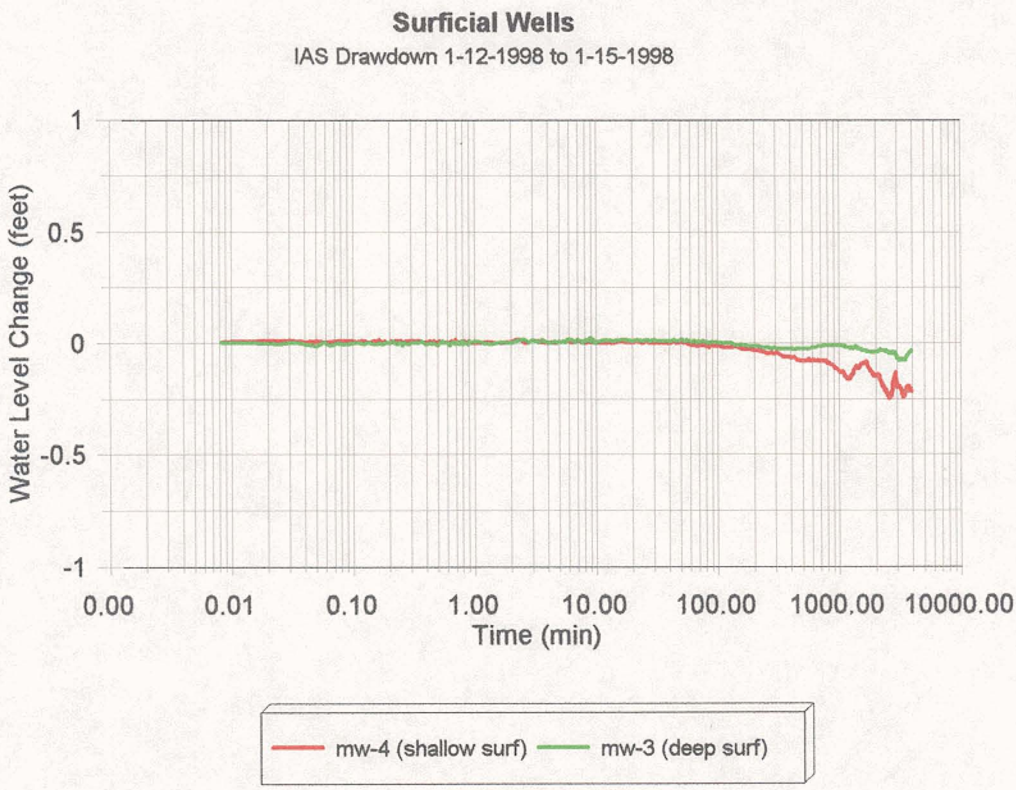


Figure 26. ROMP 9.5 IAS

IAS Drawdown Phase-Confining Unit Wells

dd.wb2-fig26



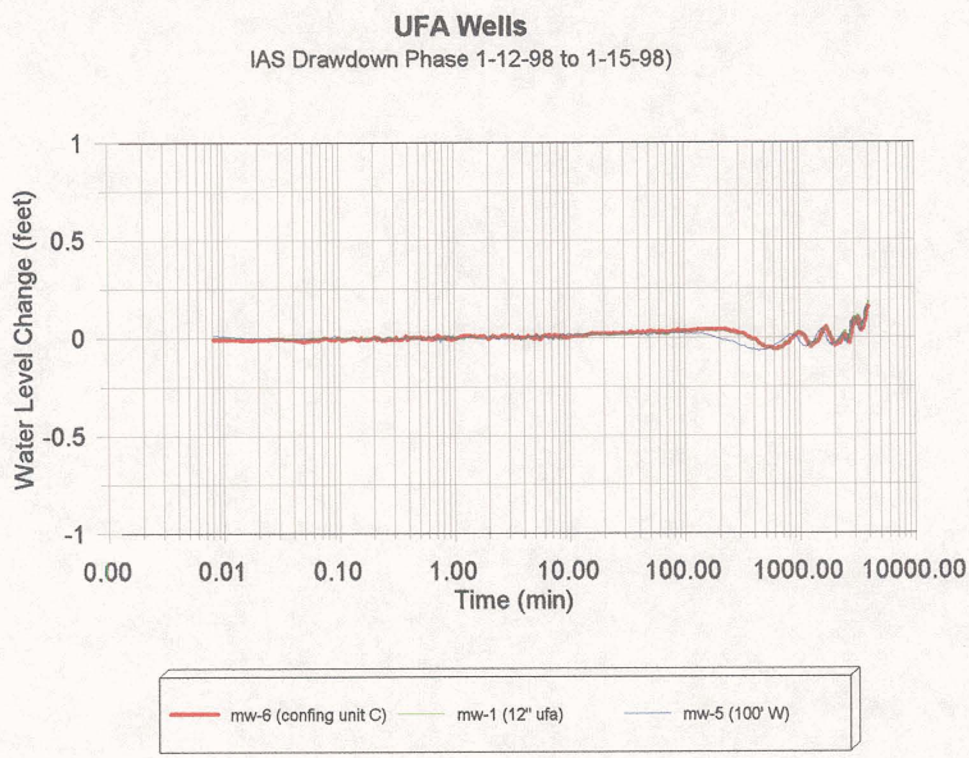
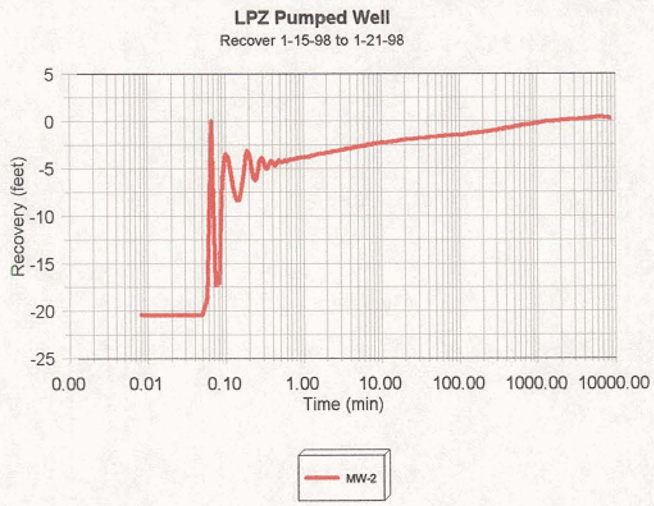
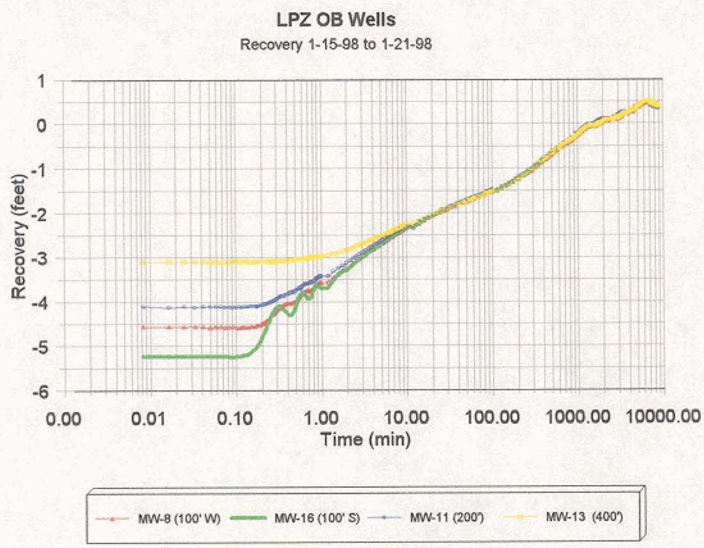


Figure 27. ROMP 9.5 IAS

IAS Drawdown Surficial & UFA Wells

dd.wb2-fig27





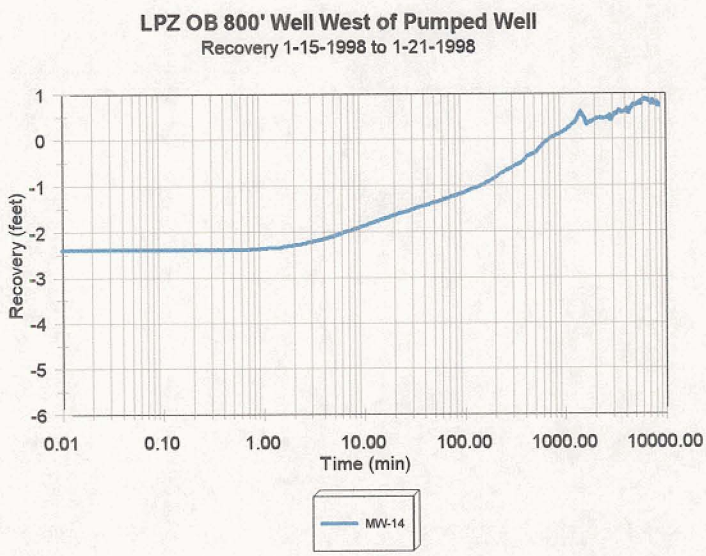
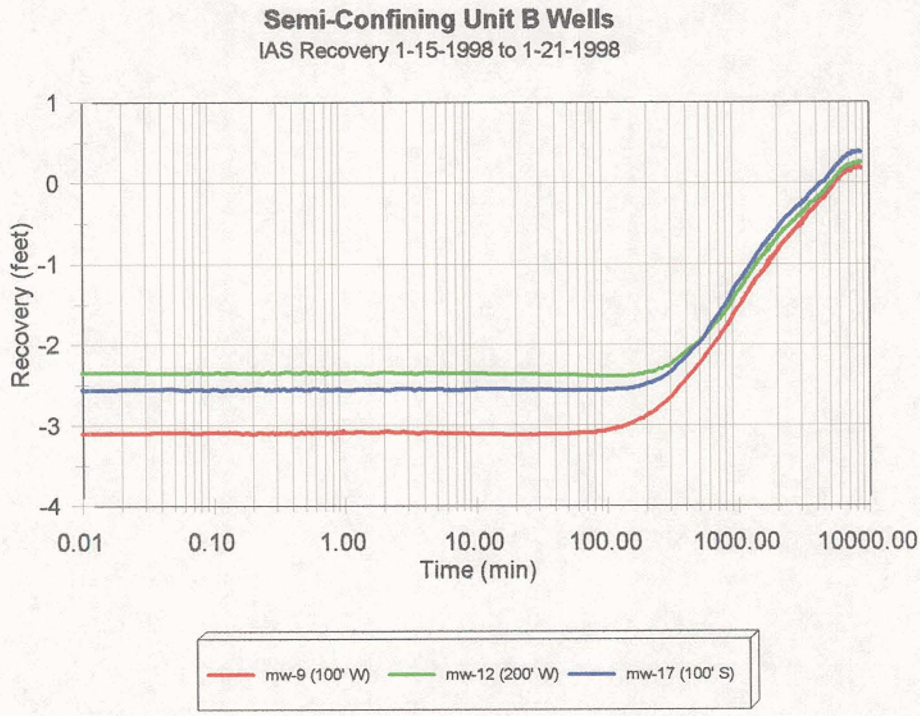


FIGURE 28. ROMP 9.5 IAS

IAS Recovery-LPZ Wells

rec.wb2-figure 28



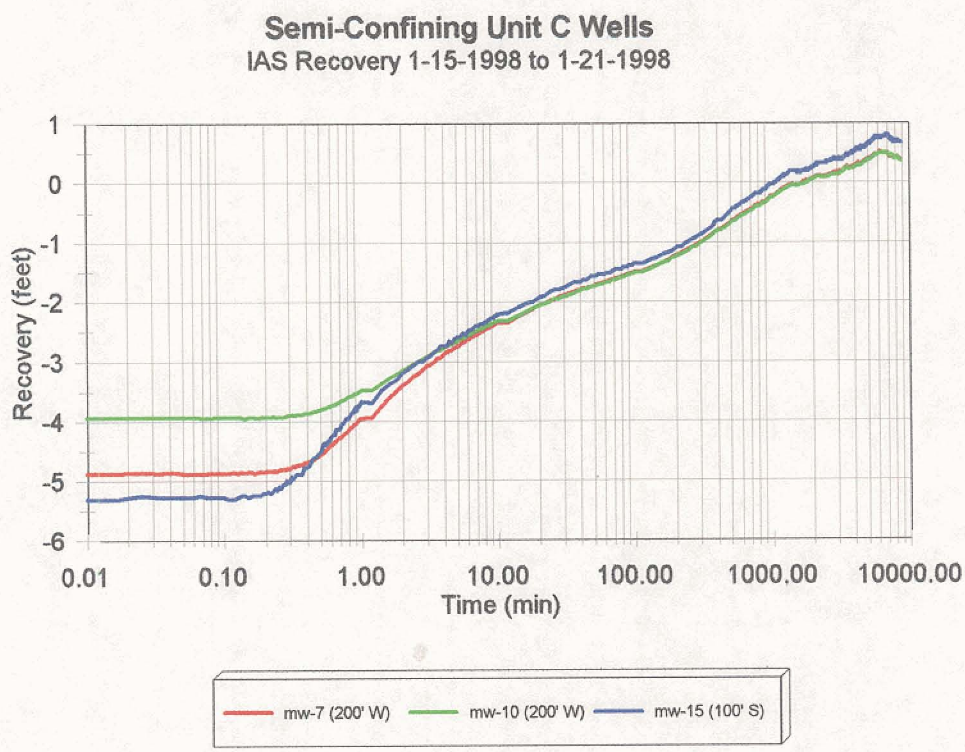
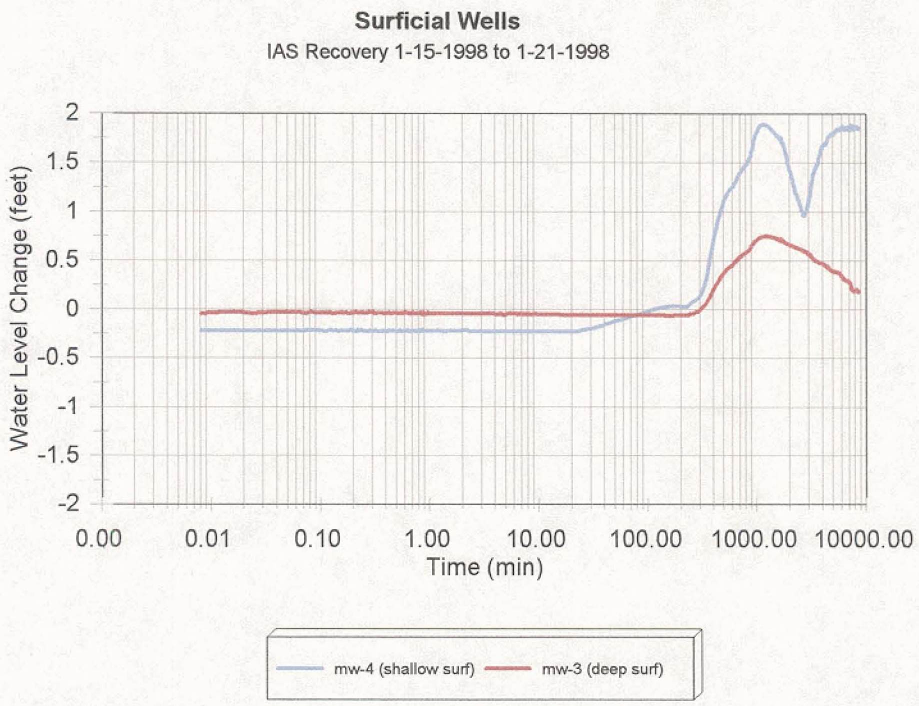
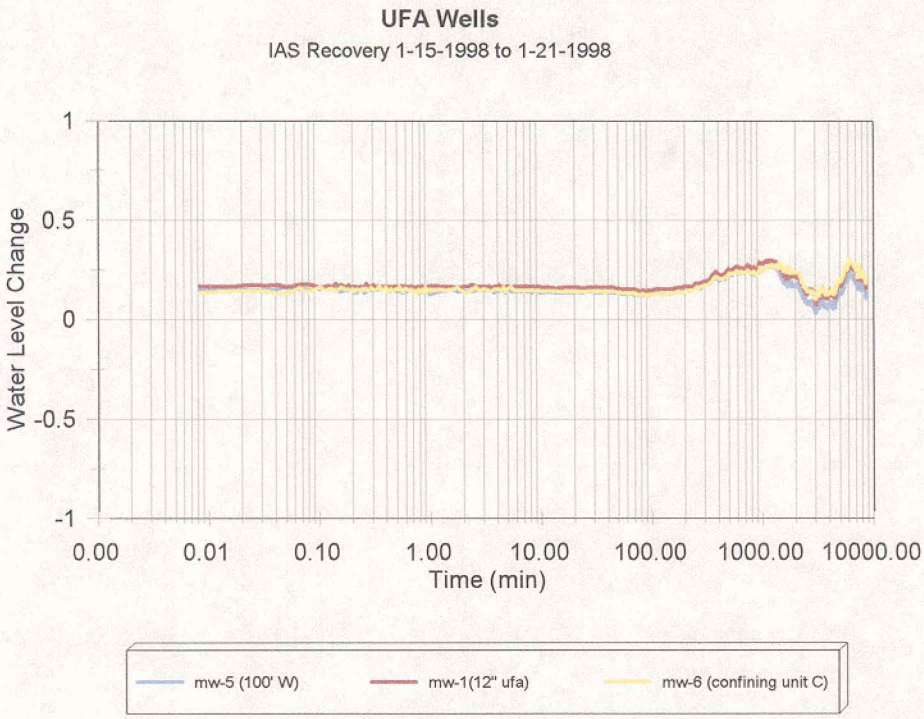


FIGURE 29. ROMP 9.5 IAS

IAS Recovery-Confining Unit Wells





rec.wb2-figure 30

Figure 30. ROMP 9.5 IAS

IAS Recovery-Surficial & UFA Wells

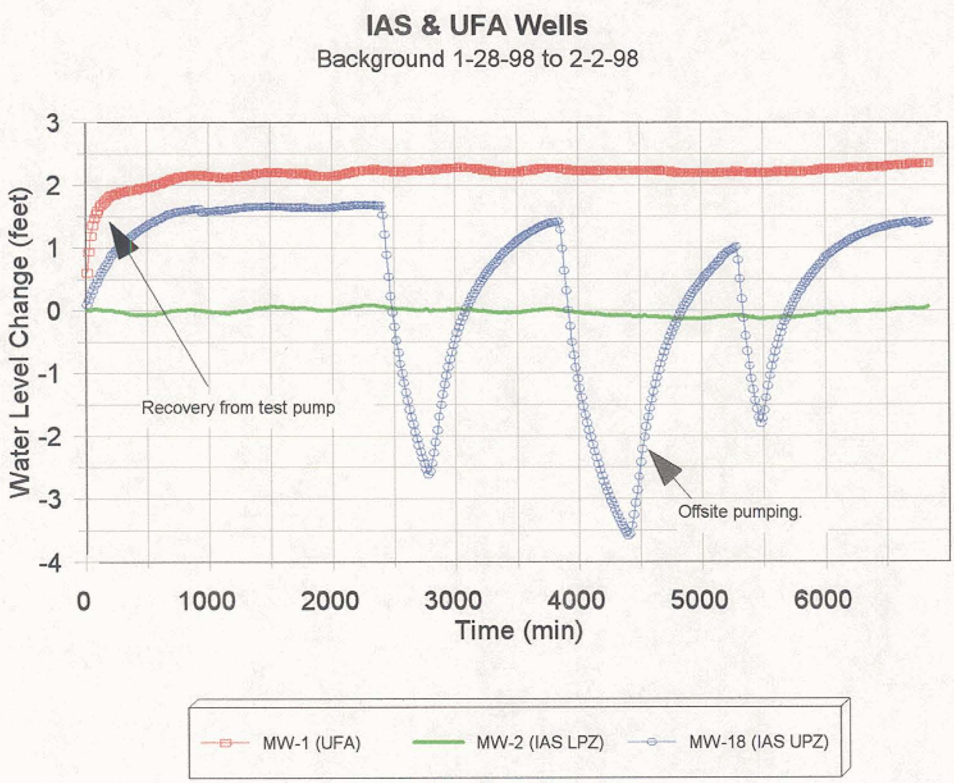
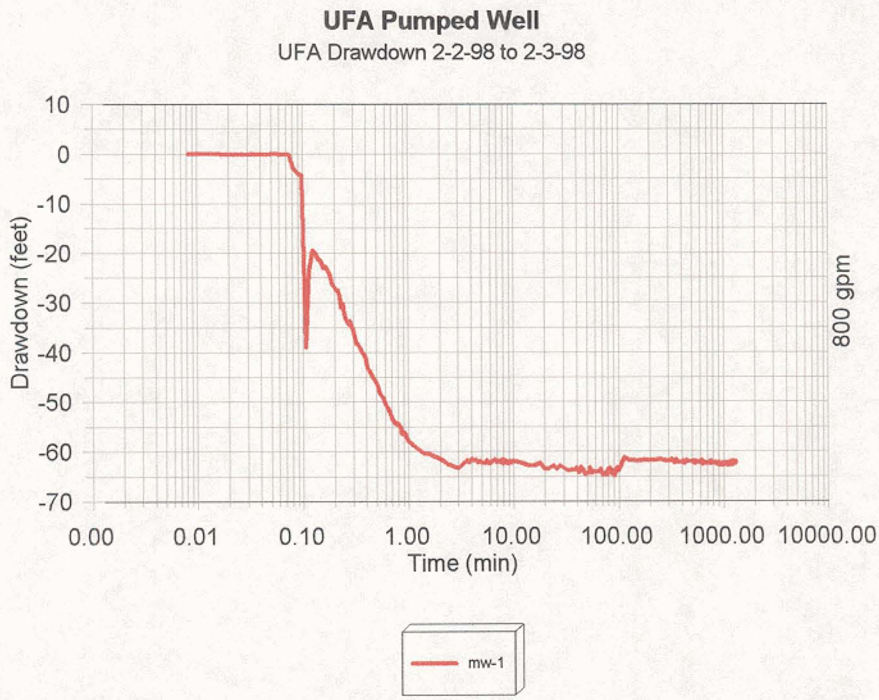


Figure 31. ROMP 9.5 IAS

Hydrograph Prior to UFA APT

suwbkg2.wb2-figure31



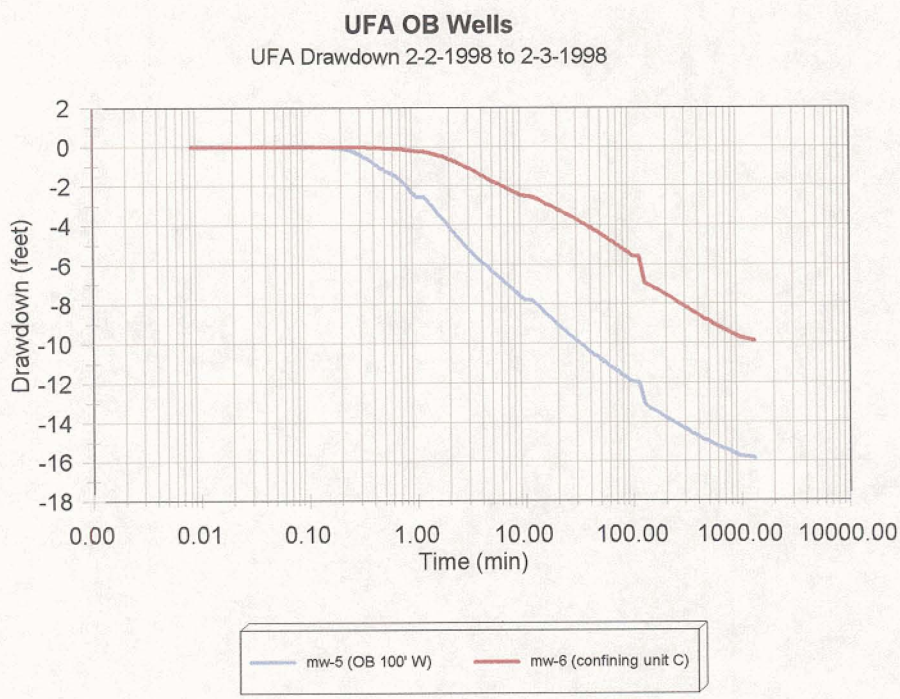
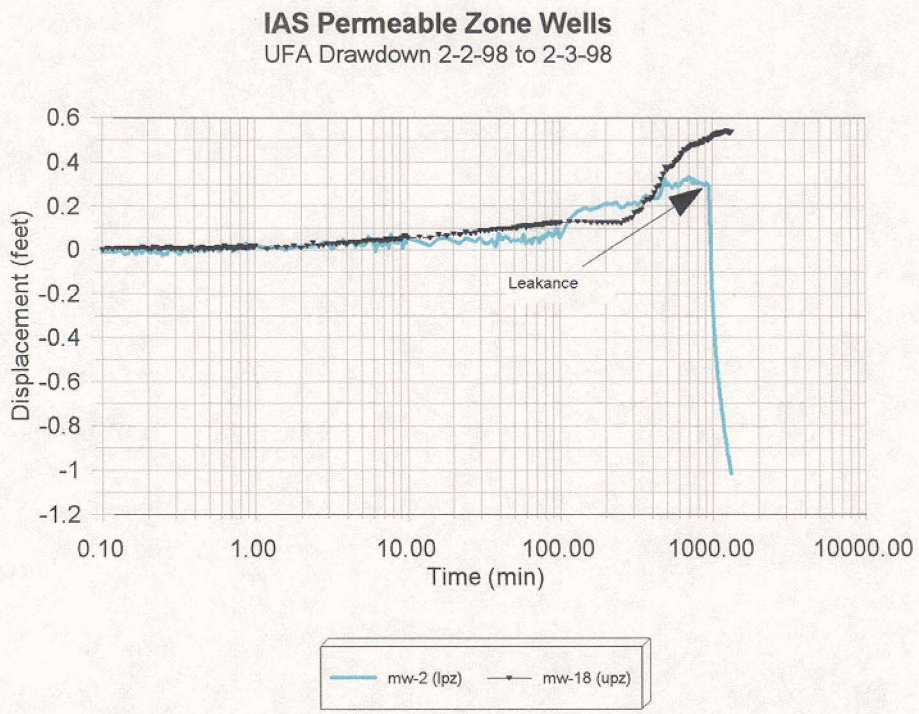


Figure 32. ROMP 9.5 IAS

UFA Drawdown-UFA Wells

suwdd.wb2figure32



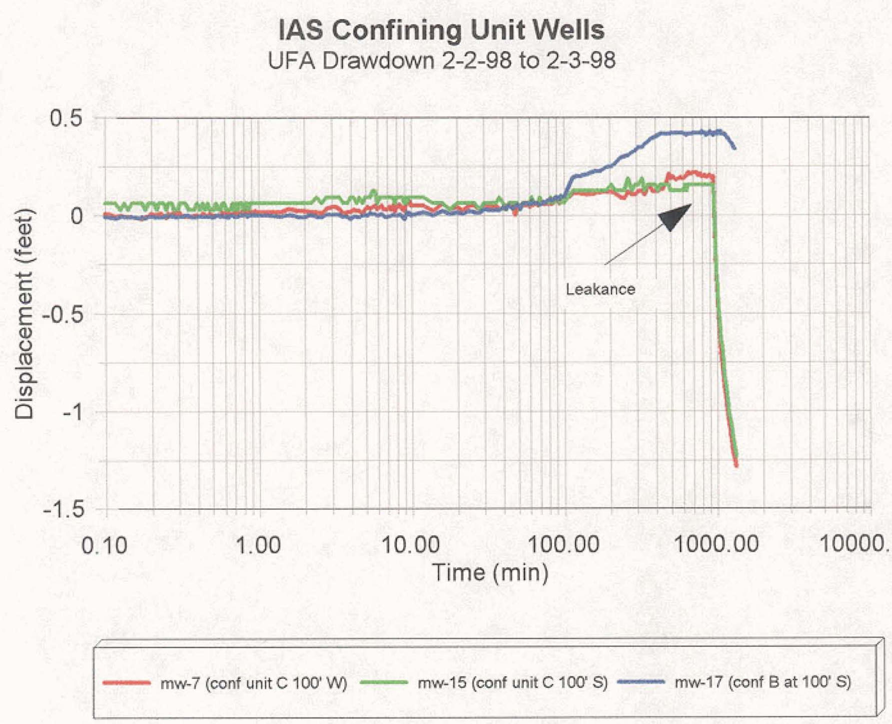
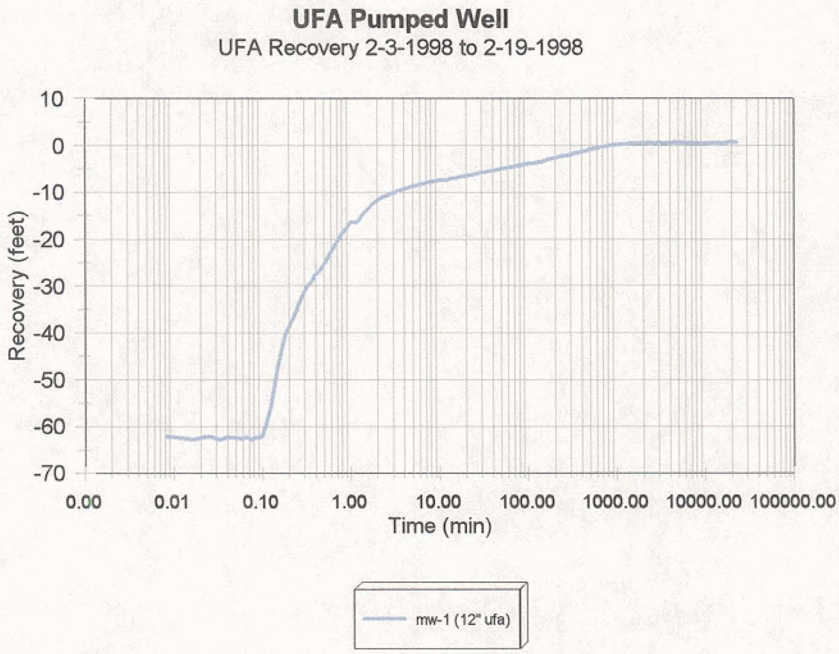


Figure 33. ROMP 9.5 IAS

UFA Drawdown-IAS Wells

sudd.wb2figure33



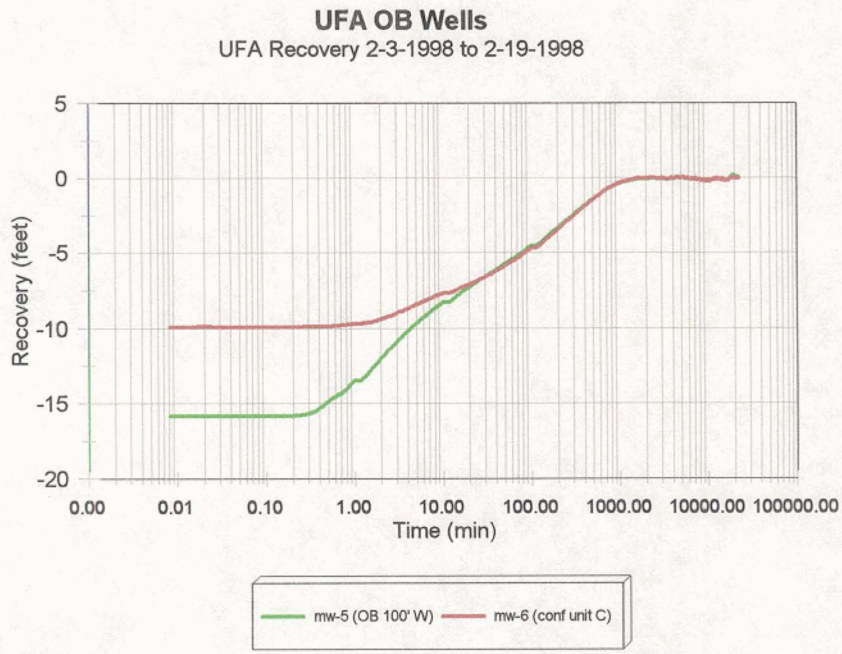
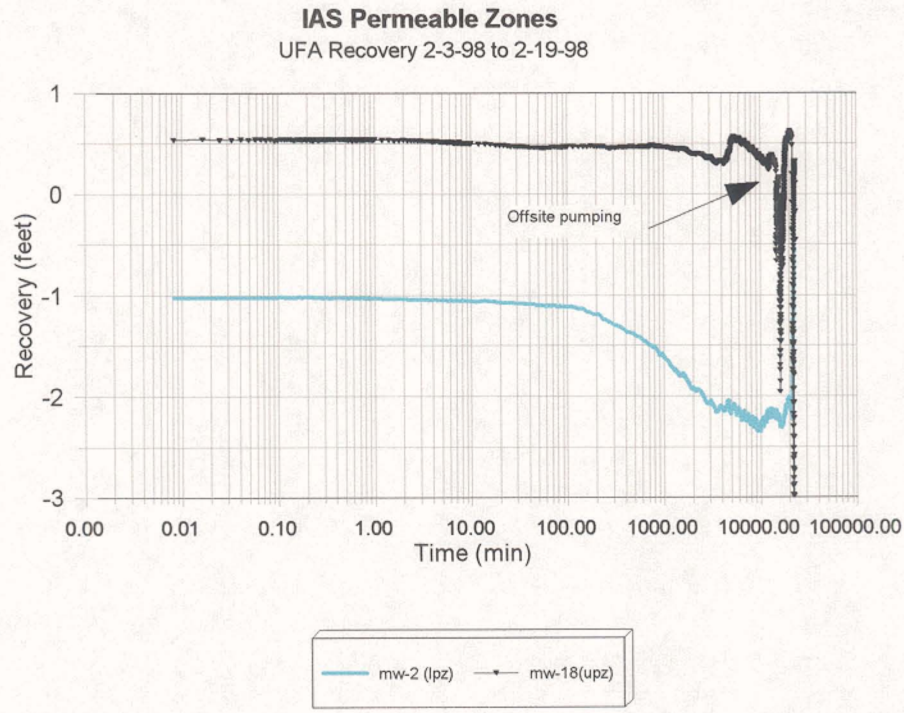


Figure 34. ROMP 9.5 IAS

suwrec.wb2figure34

UFA Recovery-UFA Wells



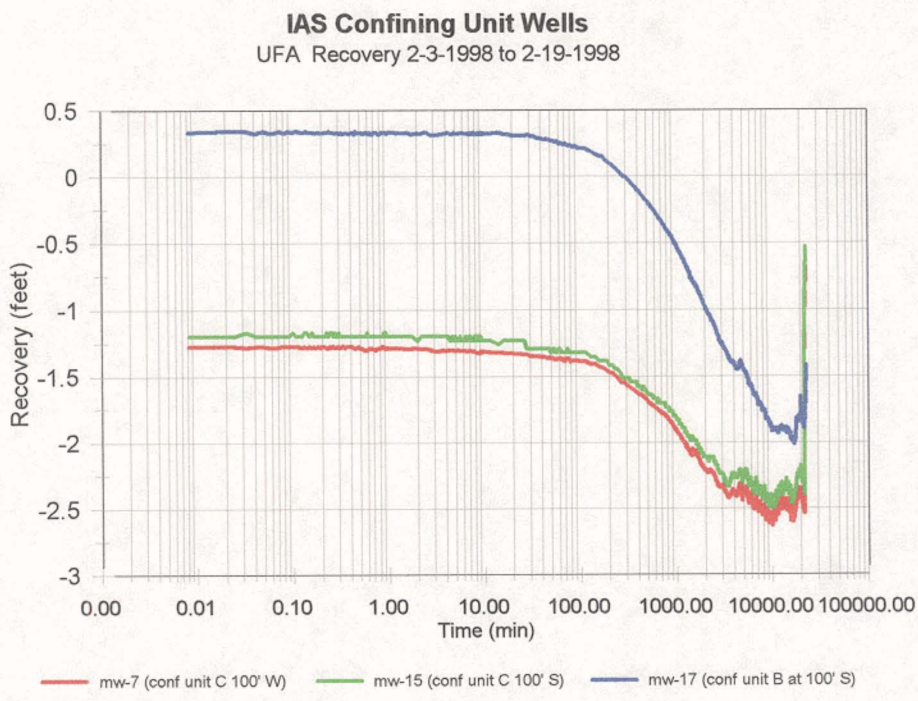


Figure 35. ROMP 9.5 IAS

UFA Recovery-IAS Wells

suwrec.wb2figure 35

APPENDIX A

Hantush Method

Hantush Method

(From: AquiferTest® User's Manual)

The Hantush Method solves the flow equation for a confined aquifer with leakage described by:

$$\frac{\partial^2 h}{\partial r^2} + \frac{1}{r}\frac{\partial h}{\partial r} - \frac{hK'}{Tb'} = \frac{S}{T}\frac{\partial h}{\partial t} \quad \text{where,}$$

K' = vertical hydraulic conductivity of the leaky layer

b' = the thickness of the leaky layer

The AquiferTest® software uses the Hantush and Jacob (1955) equation:

$$s = \frac{Q}{4\pi T} W\left(u, \frac{r}{L}\right),$$

where

$$u = \frac{r^2 S}{4\pi T}$$

where,

s = drawdown in the observation well

Q = well discharge

T = transmissivity

r = radial distance from the pumped well

L = leakage factor

S = storativity

The Hantush method assumes:

1. The aquifer is leaky and has an apparent infinite extent
2. The aquifer and the confining layer are homogeneous, isotropic, and of uniform thickness over the area influenced by pumping
3. The peizometric surface was horizontal prior to pumping
4. The well is pumped at a constant rate
5. The well is fully penetrating
6. The flow in the confining layer is vertical
7. Water removed from storage is discharged instantaneously with decline in head
8. The well diameter is small so well storage is negligible
9. Leakage through the confining layer is vertical and proportional to drawdown

10. The head in the confining layer and any un-pumped aquifers remain constant
11. Storage in the confining layer is negligible

Note: Leakance values should be used with caution. The leakance values apply only to the confining unit directly above the pumped aquifer and are for *vertical* leakance only.

The Hantush method was used to determine values for transmissivity (T), horizontal hydraulic conductivity (K_h), and storativity (S) of the aquifer, and hydraulic resistance (c) or $\left(\frac{b'}{K'}\right)$ of the leaky confining unit. The values for leakance and vertical hydraulic conductivity of the confining units were obtained from the equation $\frac{b'}{K'} = \frac{B^2}{T}$, where b' = thickness of leaky aquitard , K' = vertical hydraulic conductivity of the leaky aquitard, T= transmissivity and B = leakage factor. Matching the drawdown curve to the Hantush family of curves gives a value for $\frac{r}{B}$.

Example: if $\frac{r}{B}$ = .05 the equation becomes $\frac{b'}{K'} = \frac{\left(\frac{r}{.05}\right)^2}{T}$ where r = the distance from the observation well to the pumped well (Batu 1998).

APPENDIX B

Neuman and Witherspoon Ratio Method

Neuman and Witherspoon Ratio Method

The *Neuman and Witherspoon (1972) Ratio Method* determines the hydraulic characteristics of aquitards at small values of pumping time, when drawdown in the overlying un-pumped aquifer or aquitard is still negligible (Kruseman and de Ridder, 1994). The method uses the Theis equation to define drawdown in the pumped aquifer:

$$s = \frac{Q}{4\pi T}\int_u^\infty \frac{e^{-y}\,dy}{y} = \frac{Q}{4\pi T}W(u)$$

where

s = drawdown in the piezometer at distance r from pumped well

Q = the constant well discharge

T = transmissivity of the aquifer

u = $\frac{r^2 S}{4Tt}$ and consequently S = $\frac{4Ttu}{r^2}$

S=the storativity of the aquifer

t = the time in days since pumping started

W(u) = -0.5772 - ln u + u - $\frac{u^2}{2.2!} + \frac{u^3}{3.3!} - \frac{u^4}{4.4!} + \ldots\ldots$

Drawdown in the aquitard is described by

$$s_c = \frac{Q}{4\pi T} W(u, u_c)$$

where

$$W(u,u_c) = \frac{2}{\sqrt{\pi}} \int_{\sqrt{u_c}}^{\infty} -Ei\left(-\frac{uy^2}{y^2 - u_c}\right) e^{-y^2}\,dy$$

$$u_c = \frac{z^2 S'}{4K'b't}$$

$\frac{K'b'}{S'}$ =hydraulic diffusivity of the aquitard

z = vertical distance from aquifer-aquitard boundary to piezometer in the aquitard

At the same radial distance from the well and the same elapsed time, the ratio of the drawdown in the aquitard and the drawdown in the pumped aquifer is

$$\frac{s_c}{s} = \frac{W(u,u_c)}{W(u)}$$

The Neuman Witherspoon method assumes:

1. The aquifer is leaky
2. The aquifer and the aquitard have seemingly infinite areal extent
3. The aquifer and aquitard are homogeneous, isotropic, and of uniform thickness over the area influenced by the test
4. Prior to pumping, the piezometer surface and the water table are horizontal over the area that will be influenced by the test
5. The aquifer is pumped at a constant discharge rate
6. The well penetrates the entire thickness of the aquifer and thus receives water by horizontal flow
7. The flow in the aquitard is vertical
8. The water removed from storage in the aquifer and the water supplied by leakage from the aquitard is discharged instantaneously with decline of head
9. The diameter of the well is very small, i.e. the storage in the well can be neglected
10. The flow to the well is in an unsteady state
11. The aquitard is compressible, i.e. the changes in the aquitard storage are appreciable
12. $\beta < 1.0$, i.e. the radial distance from the well should be small ($r < 100$ m)
13. $t < \frac{S'b'}{10K'}$

The vertical hydraulic conductivity was determined from the equation $K' = \alpha S'_{s'}$, where K' = vertical hydraulic conductivity, α = hydraulic diffusivity, and $S'_{s'}$ =specific storage. The value for specific storage was obtained from a table of average values for porous materials (Batu, 1998).

Appendix C

Theis and Jacob Recovery Method

Theis and Jacob Recovery Method

(From: AquiferTest® User's Manual)

The recovery data from a well after the pump has been shut off can be used to estimate aquifer transmissivity. The AquiferTest® software uses equations developed by Theis and Cooper-Jacob to determine the aquifer parameters. The residual drawdown after pumping has ceased is described by Theis (1935) by:

$$s' = \frac{Q}{4\pi T} W(u) - W(u')$$

where

$$u = \frac{r^2 S}{4Tt}, \quad u' = \frac{r^2 S'}{4Tt}$$

where,

Q = discharge

T = transmissivity

r = distance to the observation well

s' = residual drawdown

S = storativity during pumping

S' = storativity during recovery

t = elapsed time since start of pumping

t' = elapsed time since end of pumping

The function W(u) is approximated by Cooper and Jacob(1946) by:

$$W(u) = \ln\left(\frac{4Tt}{r^2 S}\right) \text{ and } W(u') = \ln\left(\frac{4Tt'}{r^2 S'}\right)$$

The equation then becomes:

$$s' = \frac{Q}{4\pi T}\left(\ln\frac{4Tt}{r^2 S} - \ln\frac{4Tt'}{r^2 S'}\right)$$

When S and S' are constant and equal and T is constant, the equation is reduced to:

$$s' = \frac{2.3Q}{4\pi T}\log\left(\frac{t}{t'}\right)$$

The recovery data are plotted on a semi-log plot with t/t' on the logarithmic axis and s' on the arithmetic axis. A straight line is fitted to the data, with line intercepting the time axis where s' = 0 and t/t' = $(t/t')_0$. The equation then becomes:

$$0 = \frac{2.3Q}{4\pi T}\left[\log\left(\frac{t}{t'}\right)_0 - \log\left(\frac{S}{S'}\right)\right]$$

From this equation the $\left[\log\left(\frac{t}{t'}\right)_0 - \log\left(\frac{S}{S'}\right)\right] = 0$ and $(t/t')_0 = (S/S')$. The above equation then becomes

$$\Delta s' = \frac{2.3Q}{4\pi T}$$

In the above equation $\Delta s'$ is the slope of the line fit to the recovery data (Langevin, Thompson, LaRoche, Albury, Barclay, Shoemaker, Stewart, 1998).

The Theis and Jacob Recovery Method assumes:

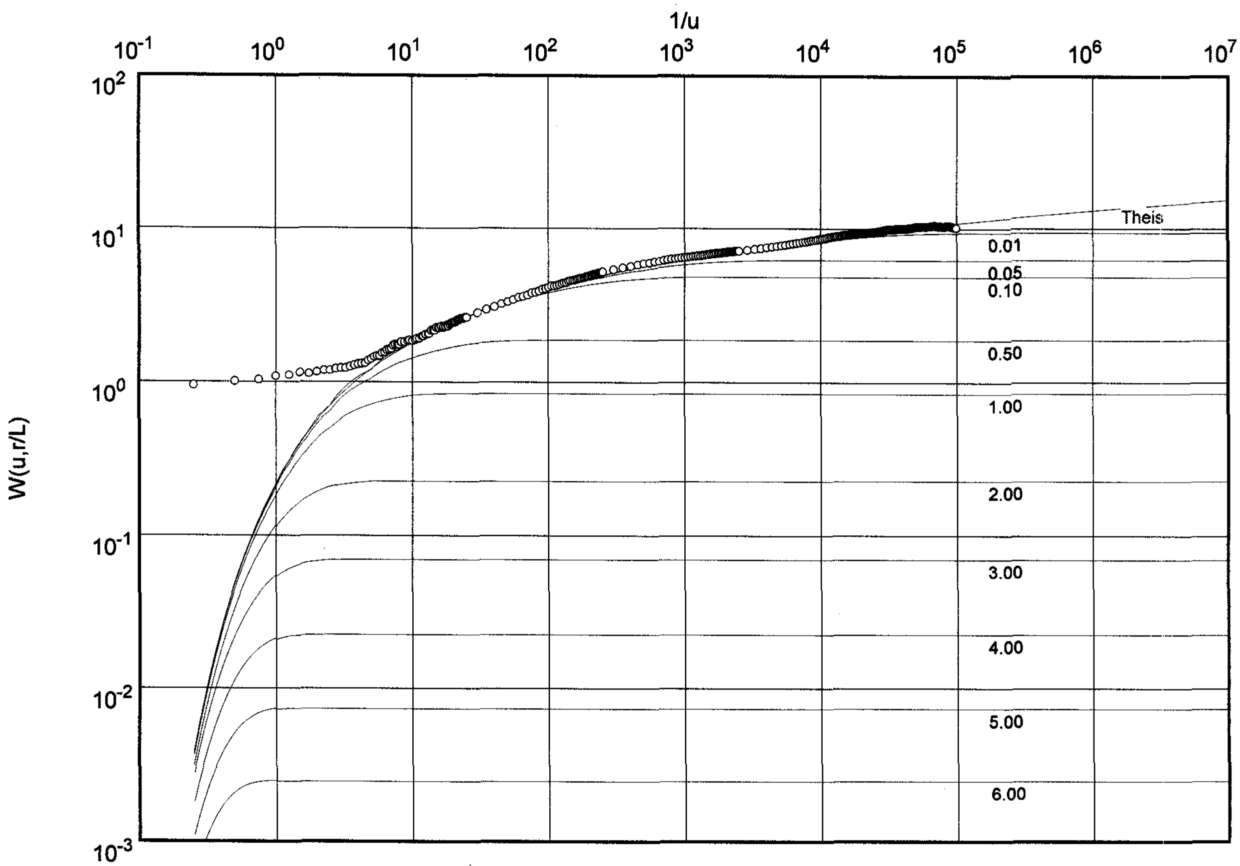
1. The aquifer is confined and has an apparent infinite extent
2. The aquifer is homogeneous, isotropic, and is of uniform thickness over the area influenced during pumping
3. The well is pumped at a constant rate
4. The well is fully penetrating
5. The water removed from storage is discharged instantaneously with decline in head
6. Well storage is negligible
7. The values of u are small ($u<0.01$)
8. The length of pumping and recovery measured is > $\frac{25r^2 2}{T}$

Appendix D

IAS Curve Matches

SWFWMD Geohydrologic Data Section Brooksville, Florida 1-800-423-1476	Pumping test analysis HANTUSH's method Leaky aquifer, no aquitard storage	Date: 2-17-99	Page 1
		Project: ROMP 9.5 Drawdown	
		Evaluated by: mtg	

Pumping Test No. #1 LPZ (Drawdown)	Test conducted on: 1-12-98
MW-8 (100' W)	
Discharge 425.00 U.S.gal/min	



○ MW-8

Transmissivity [ft²/d]: 1.45×10^4

Hydraulic conductivity [ft/d]: 1.12×10^2

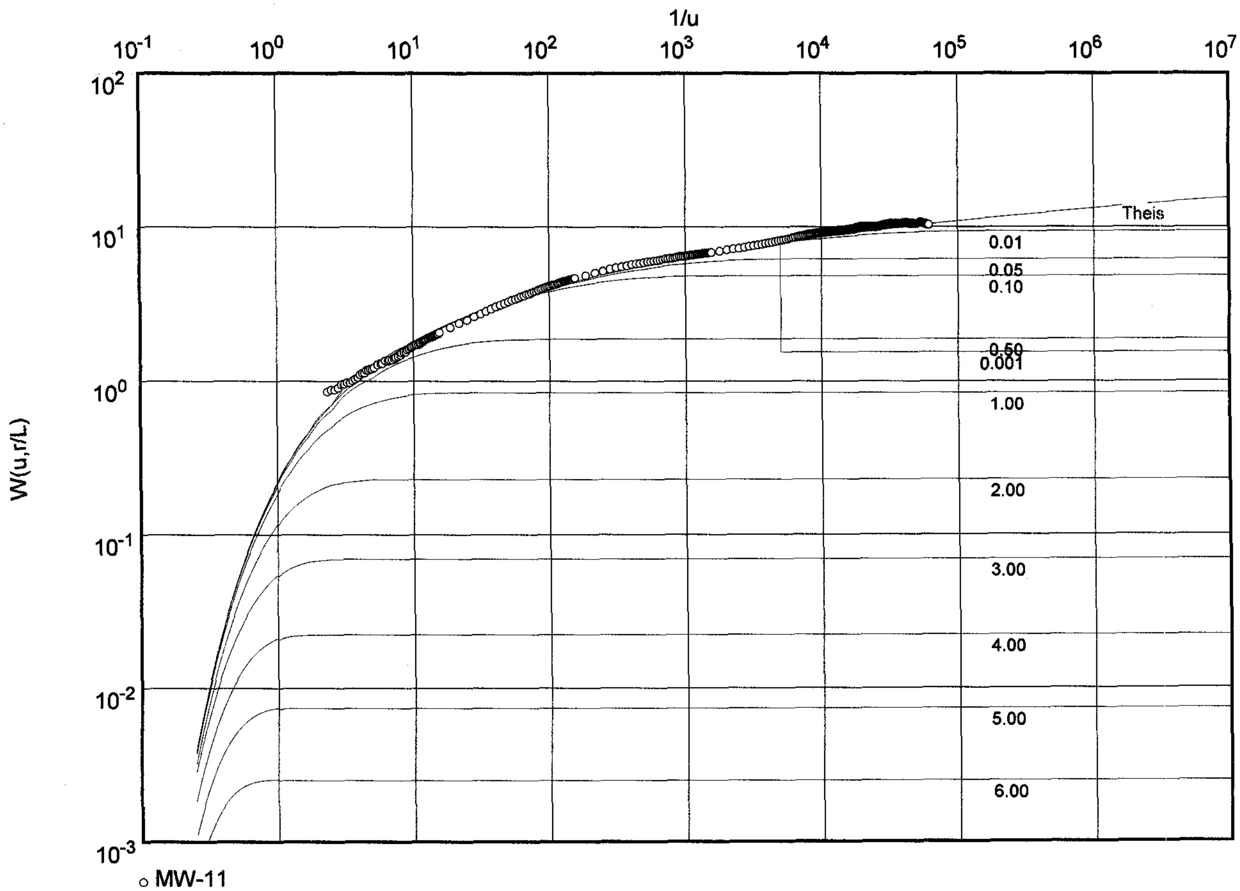
Aquifer thickness [ft]: 130.00

Storativity: 1.61×10^{-4}

Hydraulic resistance (c) [d]: 6.86×10^5

SWFWMD Geohydrologic Data Section Brooksville, Florida 1-800-423-1476	Pumping test analysis HANTUSH's method Leaky aquifer, no aquitard storage	Date: 2-17-1999	Page 1
		Project: ROMP 9.5 (IAS) DeSoto Co.	
		Evaluated by: mtg	

Pumping Test No. 1 LPZ (MW-2 Pumped)	Test conducted on: 1-12-1998
MW-11 (200' W)	
Discharge 425.00 U.S.gal/min	



Transmissivity [ft²/d]: 1.63×10^4

Hydraulic conductivity [ft/d]: 1.25×10^2

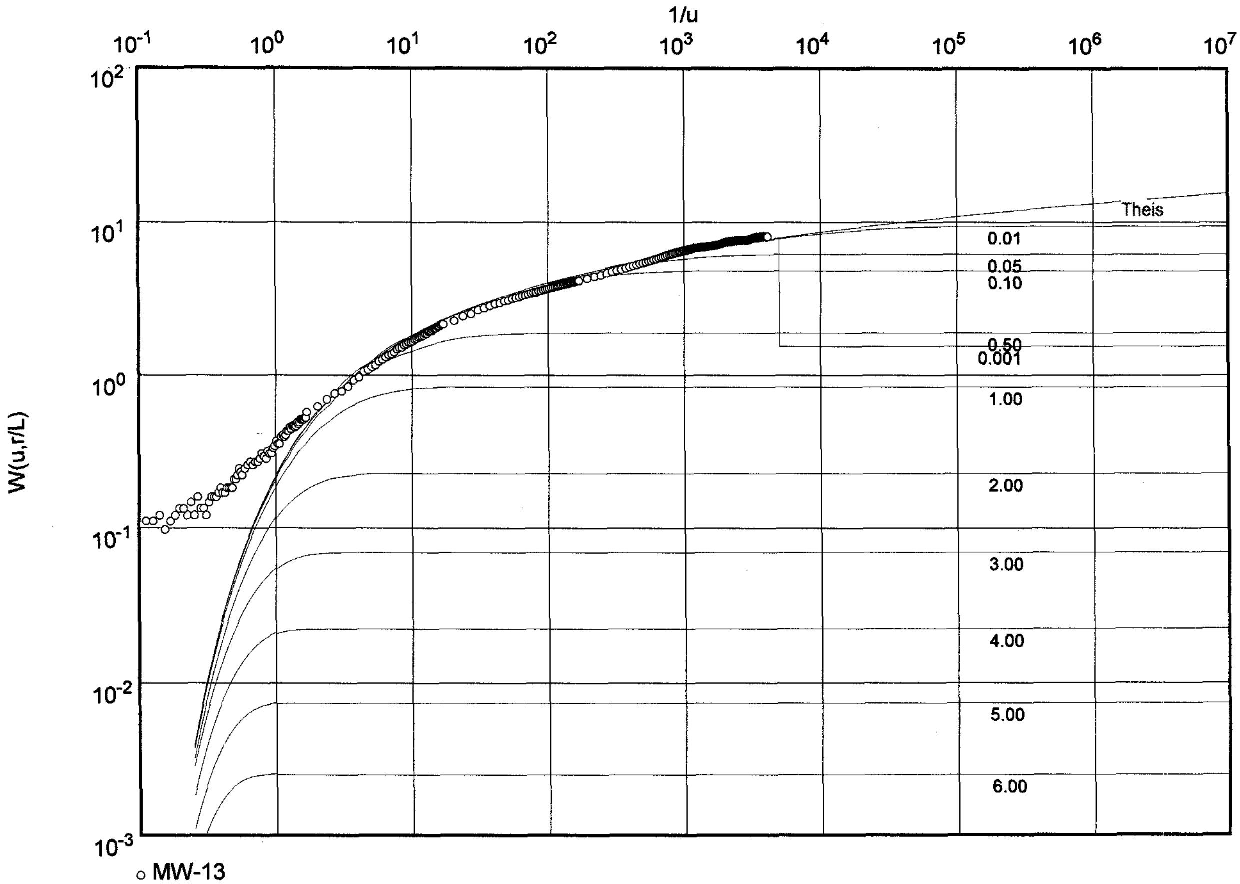
Aquifer thickness [ft]: 130.00

Storativity: 7.30×10^{-5}

Hydraulic resistance (c) [d]: 2.44×10^6

SWFWMD Geohydrologic Data Section Brooksville, Florida 1-800-423-1476	Pumping test analysis HANTUSH's method Leaky aquifer, no aquitard storage	Date: 2-17-99	Page 1
		Project: ROMP 9.5 Drawdown	
		Evaluated by: mtg	

Pumping Test No. 1 LPZ MW-2 Pumped	Test conducted on: 1-12-98
MW-13 (400' W)	
Discharge 425.00 U.S.gal/min	



Transmissivity [ft²/d]: 1.67×10^4

Hydraulic conductivity [ft/d]: 1.28×10^2

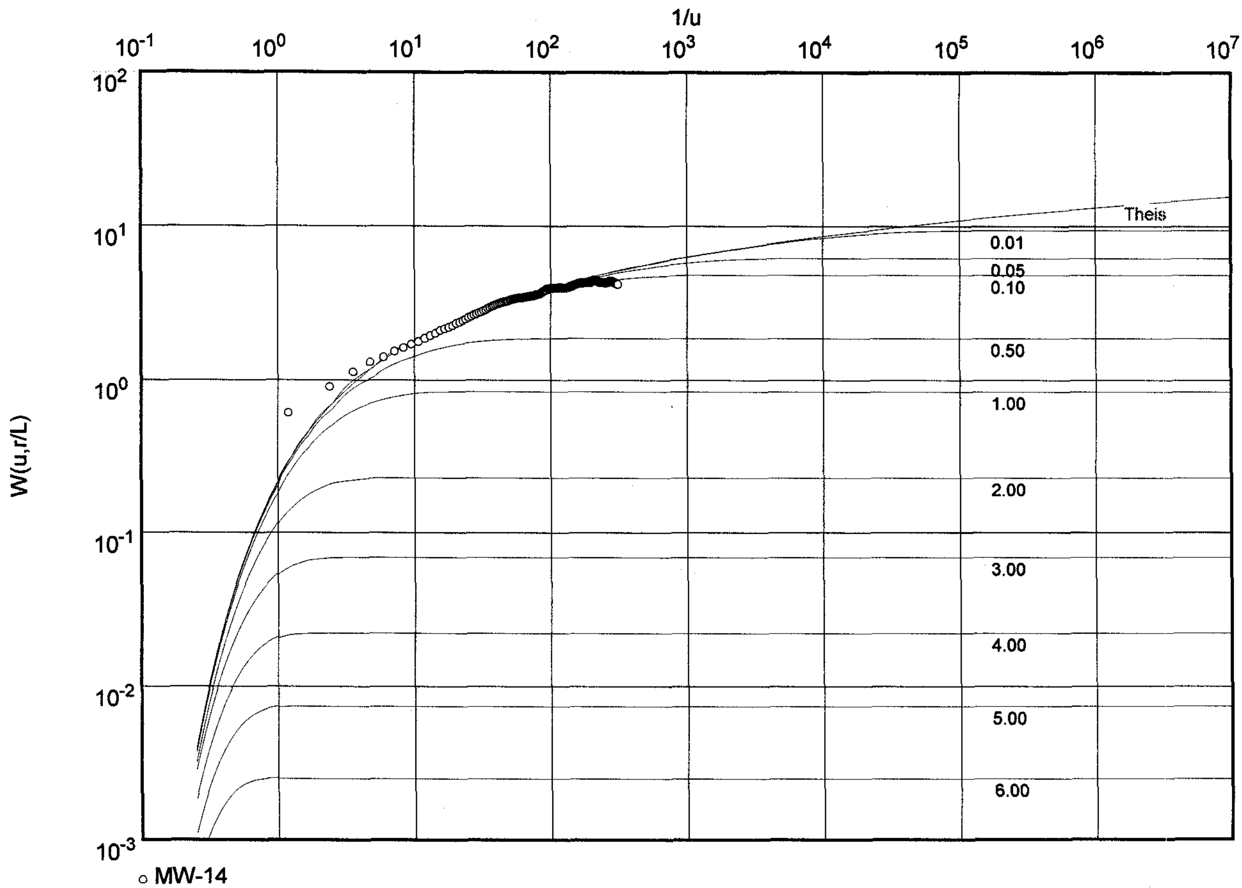
Aquifer thickness [ft]: 130.00

Storativity: 1.70×10^{-4}

Hydraulic resistance (c) [d]: 9.57×10^6

SWFWMD Geohydrologic Data Section Brooksville, Florida 1-800-423-1476	Pumping test analysis HANTUSH's method Leaky aquifer, no aquitard storage	Date: 6-2-1999	Page 1
		Project: ROMP 9.5 IAS Site	
		Evaluated by: mtg	

Pumping Test No. 1 MW-2 (pumped well)	Test conducted on: 1-12-1999
MW-14 (800' W)	
Discharge 425.00 U.S.gal/min	



Transmissivity [ft²/d]: 1.15×10^{4}

Hydraulic conductivity [ft/d]: 8.90×10^{1}

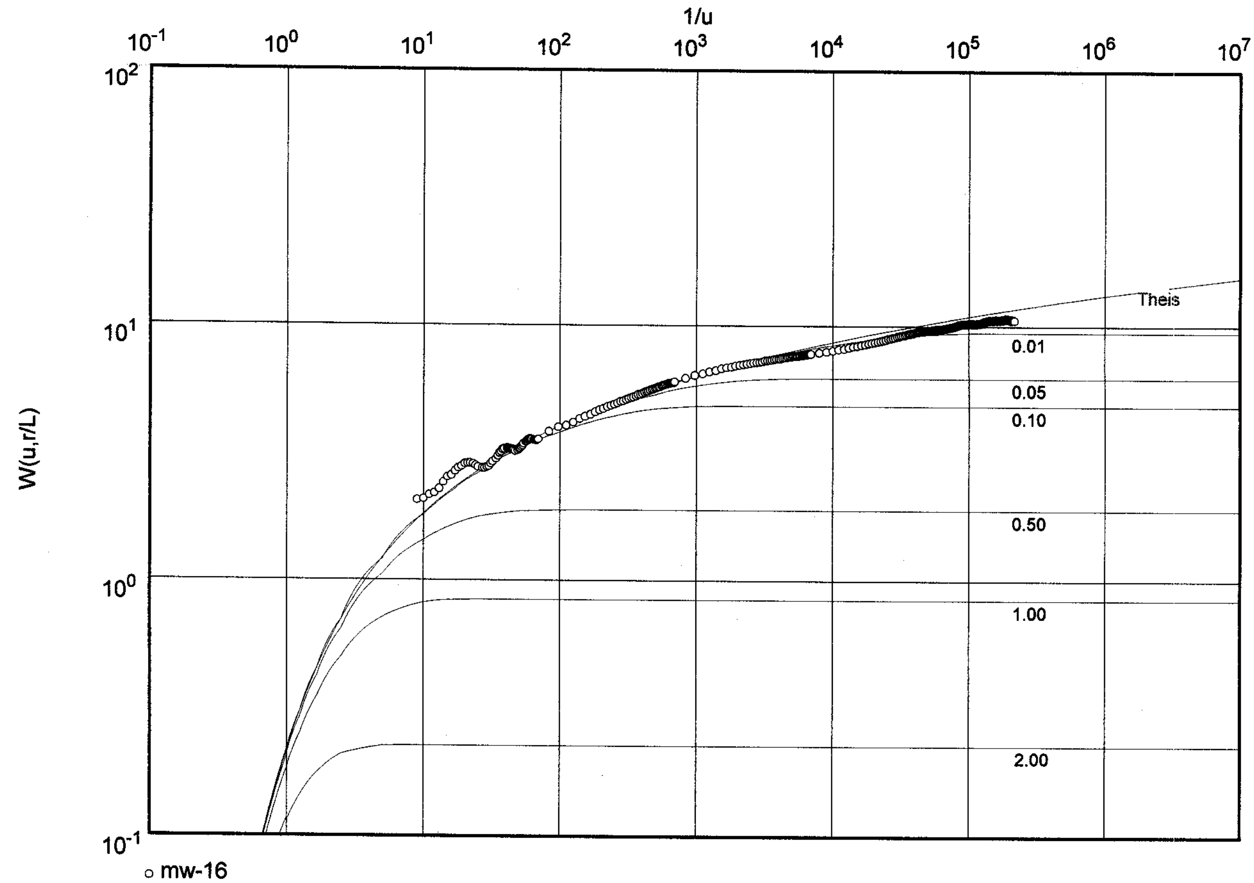
Aquifer thickness [ft]: 130.00

Storativity: 6.32×10^{-4}

Hydraulic resistance (c) [d]: 5.52×10^{3}

SWFWMD Geohydrologic Data Section Brooksville, Florida 1-800-423-1476	Pumping test analysis HANTUSH's method Leaky aquifer, no aquitard storage	Date: 2-17-1999 — Page 1 Project: ROMP 9.5 (IAS) DeSoto Co. Evaluated by: mtg

Pumping Test No. 1 LPZ MW-2 Pumped	Test conducted on: 1-12-98
MW-16 (100' S)	
Discharge 425.00 U.S.gal/min	



Transmissivity [ft²/d]: 1.29×10^4

Hydraulic conductivity [ft/d]: 9.99×10^1

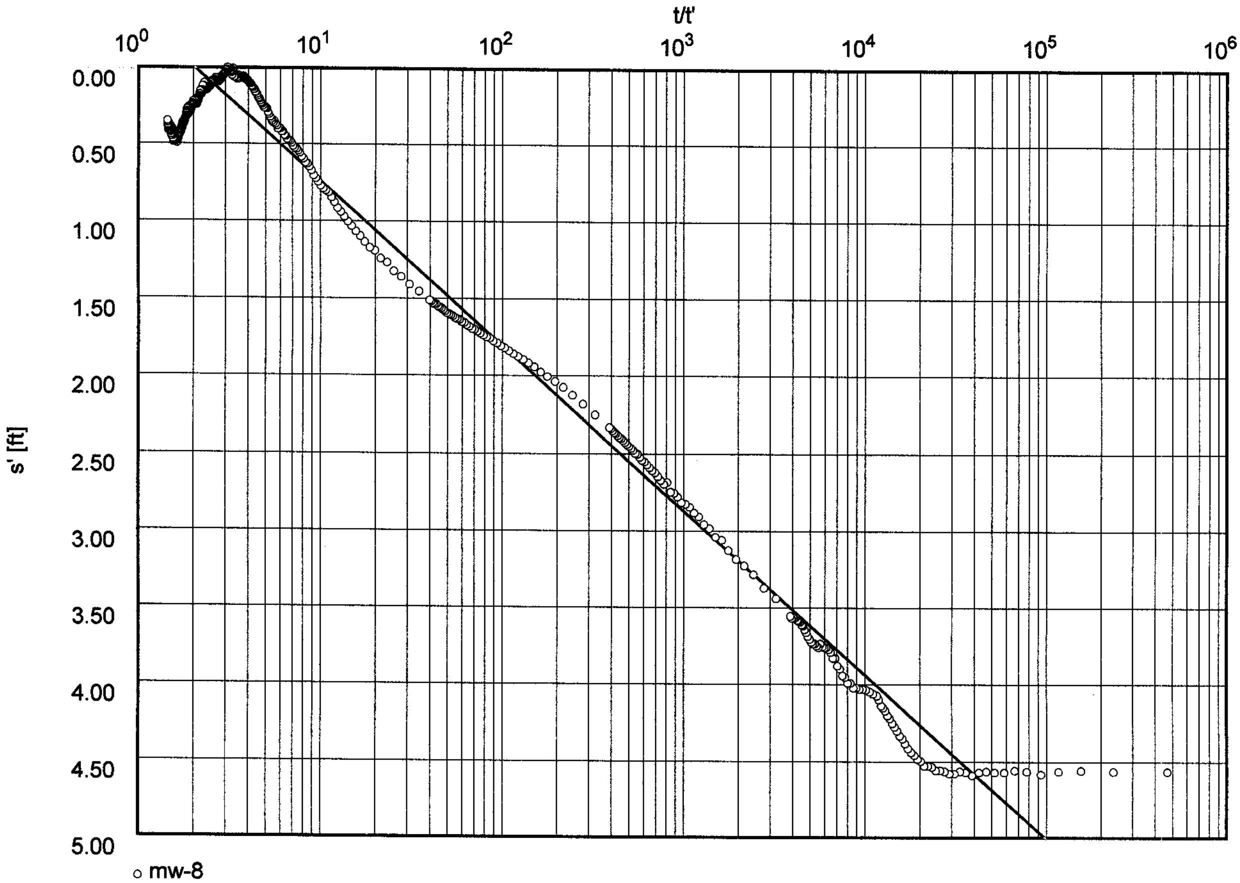
Aquifer thickness [ft]: 130.00

Storativity: 5.19×10^{-5}

Hydraulic resistance (c) [d]: 7.69×10^5

SWFWMD Geohydrologic Data Section Brooksville, Florida 1-800-423-1476	Pumping test analysis Recovery method after THEIS & JACOB Confined aquifer	Date: 2-17-1998	Page 1
		Project: ROMP 9.5 (IAS)	
		Evaluated by: mtg	

Pumping Test No. 1 LPZ MW-2 Recovery Phase	Test conducted on: 1-12-1998
MW-8 (100' W)	
Discharge 425.00 U.S.gal/min	
	Pumping test duration: 2.70000 d



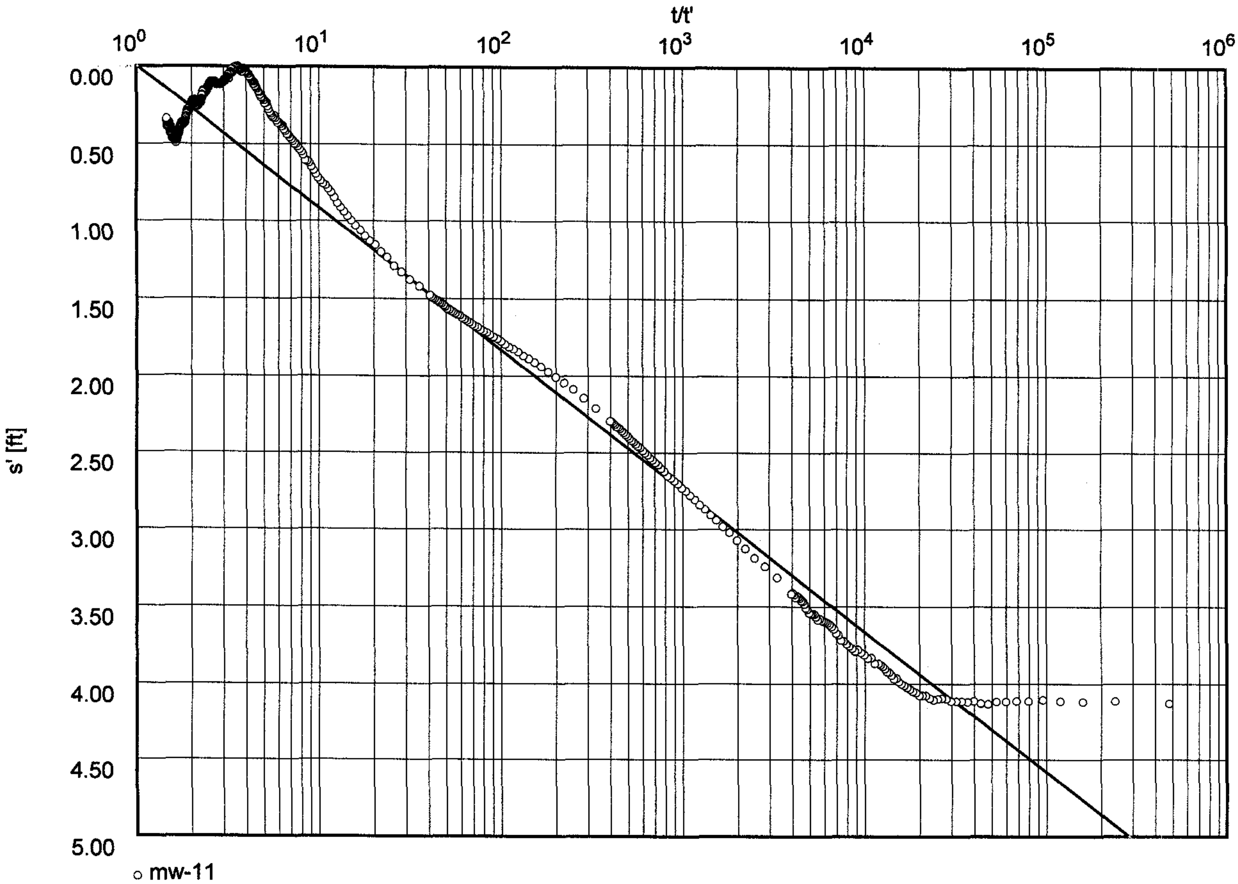
Transmissivity [ft²/d]: 1.40×10^4

Hydraulic conductivity [ft/d]: 1.07×10^2

Aquifer thickness [ft]: 130.00

SWFWMD Geohydrologic Data Section Brooksville, Florida 1-800-423-1476	Pumping test analysis Recovery method after THEIS & JACOB Confined aquifer	Date: 30.06.1999	Page 1
		Project: ROMP 9.5 IAS	
		Evaluated by: mtg	

Pumping Test No. 1 LPZ Recovery Phase	Test conducted on: 1-12-98
MW-11 (200' W)	
Discharge 425.00 U.S.gal/min	
	Pumping test duration: 2.75625 d



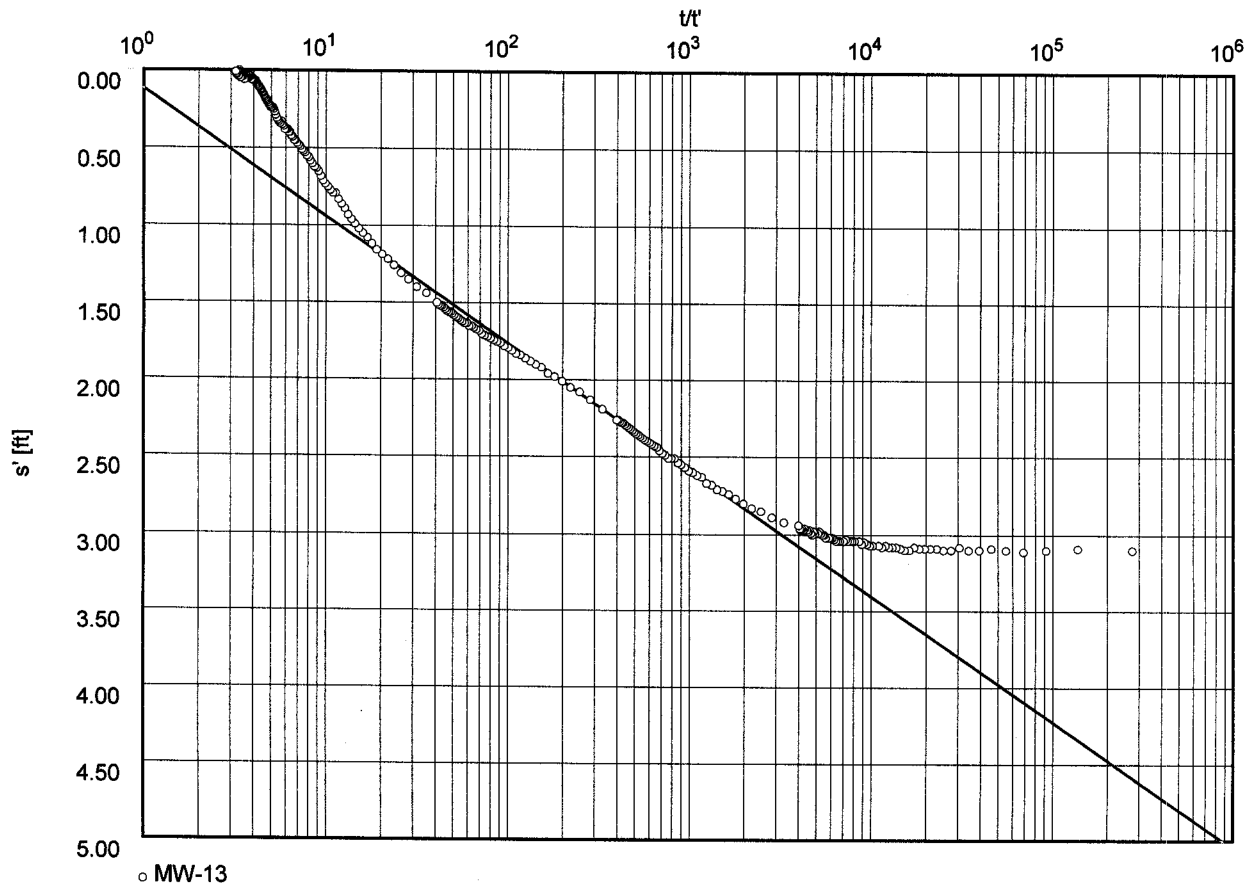
Transmissivity [ft²/d]: 1.63×10^4

Hydraulic conductivity [ft/d]: 1.25×10^2

Aquifer thickness [ft]: 130.00

SWFWMD Geohydrologic Data Section Brooksville, Florida 1-800-423-1476	Pumping test analysis Recovery method after THEIS & JACOB Confined aquifer	Date: 1-22-98	Page 1
		Project: ROMP 9.5 IAS SITE	
		Evaluated by: mtg	

Pumping Test No. 1 LPZ (Recovery)	Test conducted on: 1-12-98
MW-13 (400' W)	
Discharge 425.00 U.S.gal/min	
	Pumping test duration: 2.75625 d



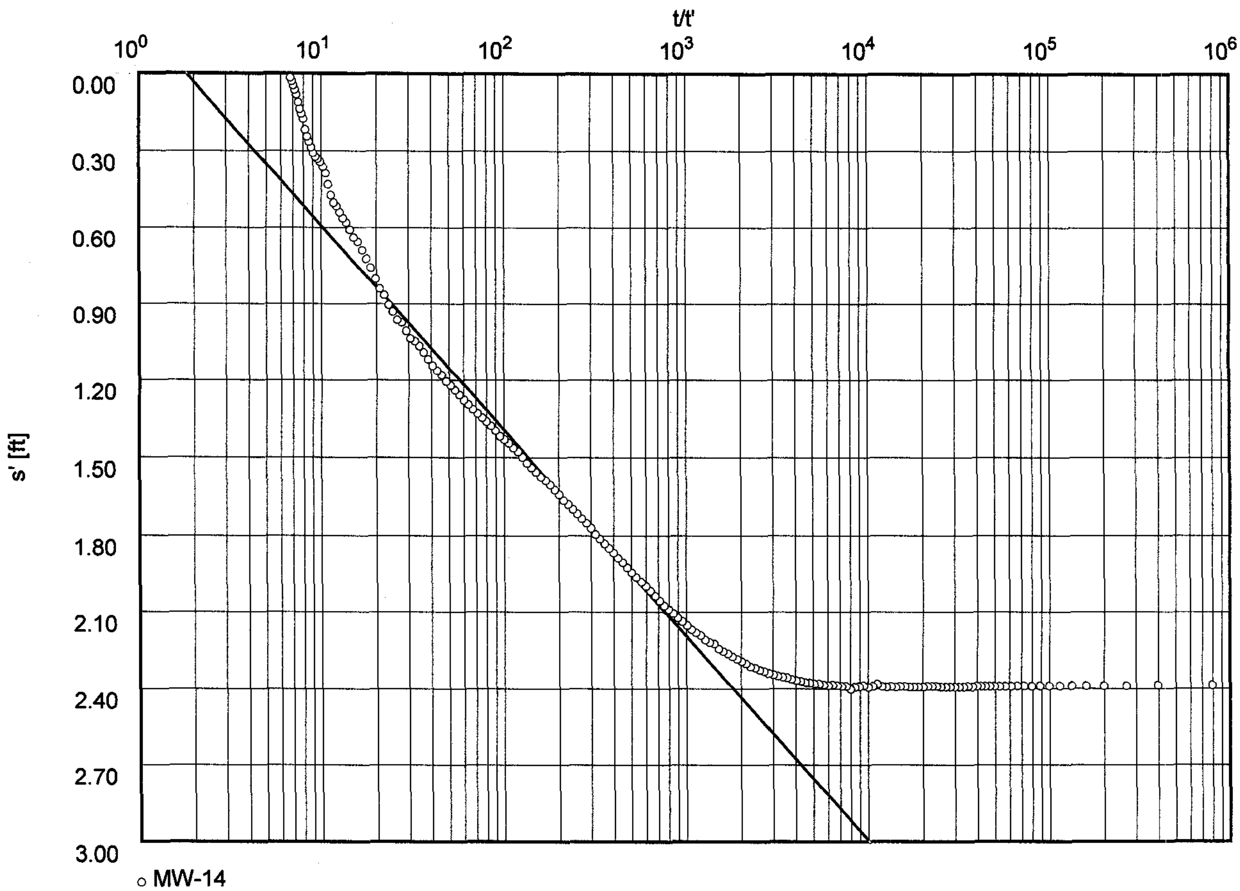
Transmissivity [ft²/d]: 1.82×10^4

Hydraulic conductivity [ft/d]: 1.40×10^2

Aquifer thickness [ft]: 130.00

SWFWMD Geohydrologic Data Section Brooksville, Florida 1-800-423-1476	Pumping test analysis Recovery method after THEIS & JACOB Confined aquifer	Date: 6-30-1999	Page 1
		Project: ROMP 9.5 IAS	
		Evaluated by: mtg	

Pumping Test No. LPZ (Recovery)	Test conducted on: 1-12-98
MW-14 (800' W)	
Discharge 425.00 U.S.gal/min	
	Pumping test duration: 2.75625 d



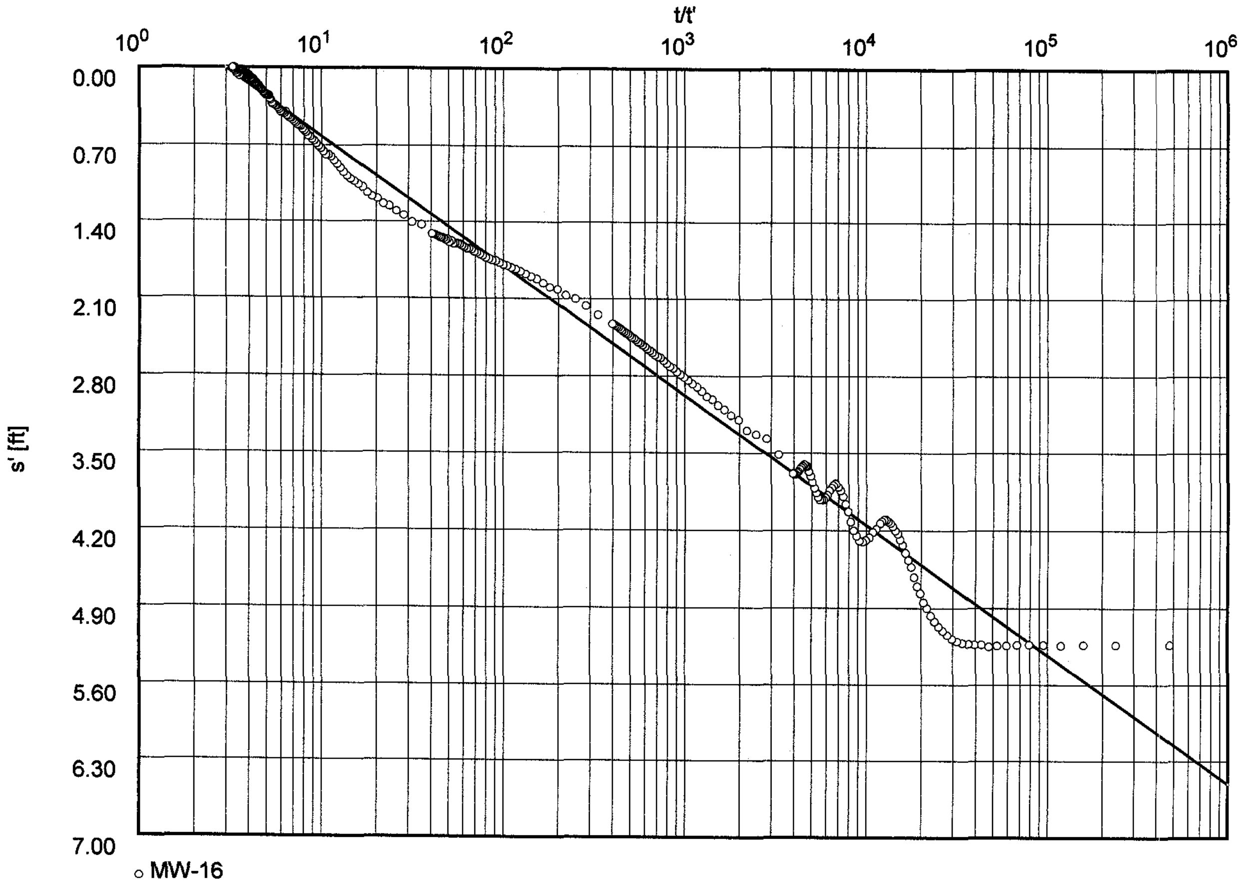
Transmissivity [ft²/d]: 1.86×10^4

Hydraulic conductivity [ft/d]: 1.43×10^2

Aquifer thickness [ft]: 130.00

SWFWMD Geohydrologic Data Section Brooksville, Florida 1-800-423-1476	Pumping test analysis Recovery method after THEIS & JACOB Confined aquifer	Date: 6-30-99	Page 1
		Project: ROMP 9.5	
		Evaluated by: mtg	

Pumping Test No. LPZ (Recovery)	Test conducted on: 1-12-98
MW-16 (100' S)	
Discharge 425.00 U.S.gal/min	
	Pumping test duration: 2.75625 d



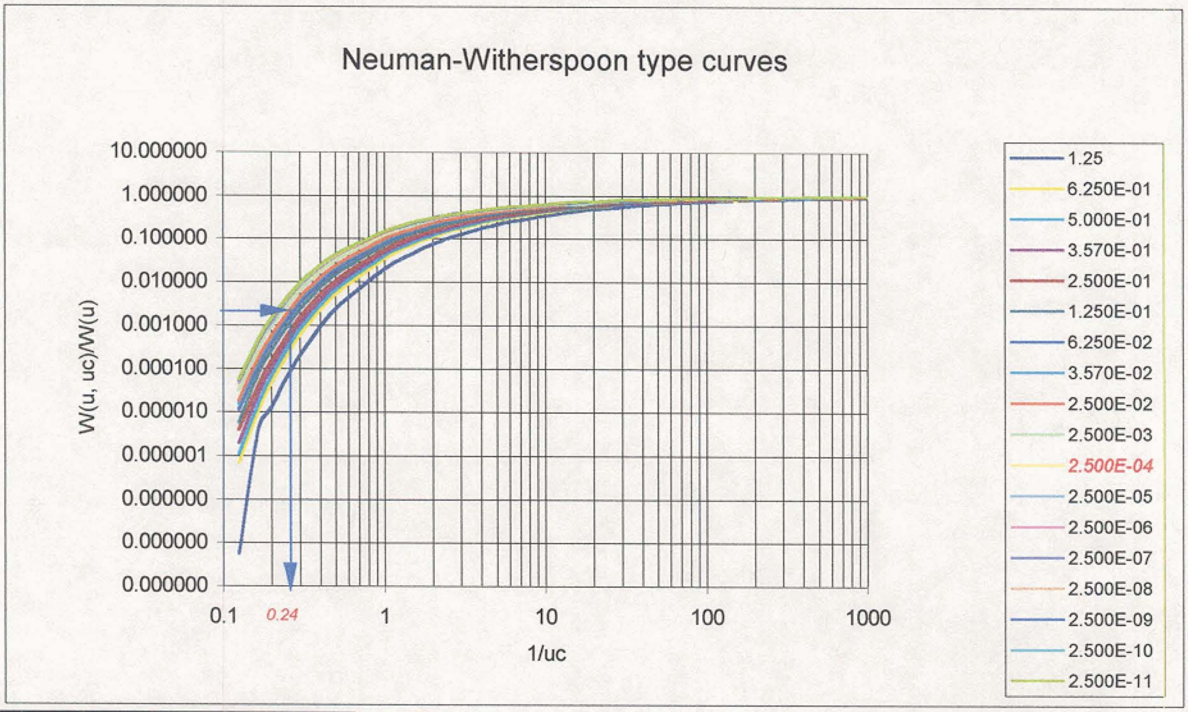
Transmissivity [ft²/d]: 1.27×10^4

Hydraulic conductivity [ft/d]: 9.78×10^1

Aquifer thickness [ft]: 130.00

IAS Drawdown Phase Spreadsheet Analysis

Neuman-Witherspoon Method
From *Analysis and Evaluation of Pumping Test Data* By, G.P. Kruseman and N.A. de Ridder
Semi-Confining Unit (B)



t=	70	min
t=	0.049	days
r=	100	ft
D=	130	ft
D'	123	ft
z=	10	ft

(1) Calculate T, S, and K, using another method (*used Hantush*).

T=	1.45E+04	ft2/d	MW-8
S=	1.61E-04		
K=	1.12E+02	ft/d	

(2) prepare a table of values of time t, drawdown in the aquifer s, drawdown in the aquitard s', and s'/s

(3) Pick an early time t from the table where drawdown is observable
At 70 minutes, s'/s is 0.0032

(4) Solve for u
u= $r^2S/4KDt$ 5.69E-04

(5) Match the value of s'/s on the $W(u,u_c)/W(u)$ axis of the type curve plot and knowing the value of u, read the value of $1/u_c$ from the x-axis of the plot
$1/u_c$ = 0.24

(6) Calculate hydraulic diffusivity
diffusivity = (1/uc)*(z^2/4t) 123 ft^2/day

(7) The Neuman-Witherspoon method is only valid if:
$t < 0.1(\text{diffusivity}*1/(D')^2)^{-1}$
t validity: $0.1(\text{diffusivity}*1/(D'^2))^{-1}$ = 12 days
Since t = 0.049 days, the test is valid (.049 days < 12 days)

t	s' (MW-9)	s (MW-8)	s'/s
50	0.006	-3.665	-0.0016
52	0.012	-3.684	-0.0033
54	0	-3.699	0
56	0	-3.708	0
58	-0.006	-3.728	0.00161
60	0.006	-3.733	-0.0016
62	-0.006	-3.747	0.0016
64	-0.006	-3.757	0.0016
66	-0.006	-3.762	0.00159
68	-0.019	-3.781	0.00503
70	-0.012	-3.786	0.00317
72	-0.019	-3.795	0.00501
74	-0.012	-3.805	0.00315
76	-0.019	-3.81	0.00499
78	-0.019	-3.815	0.00498
80	-0.025	-3.824	0.00654
82	-0.031	-3.834	0.00809
84	-0.025	-3.839	0.00651

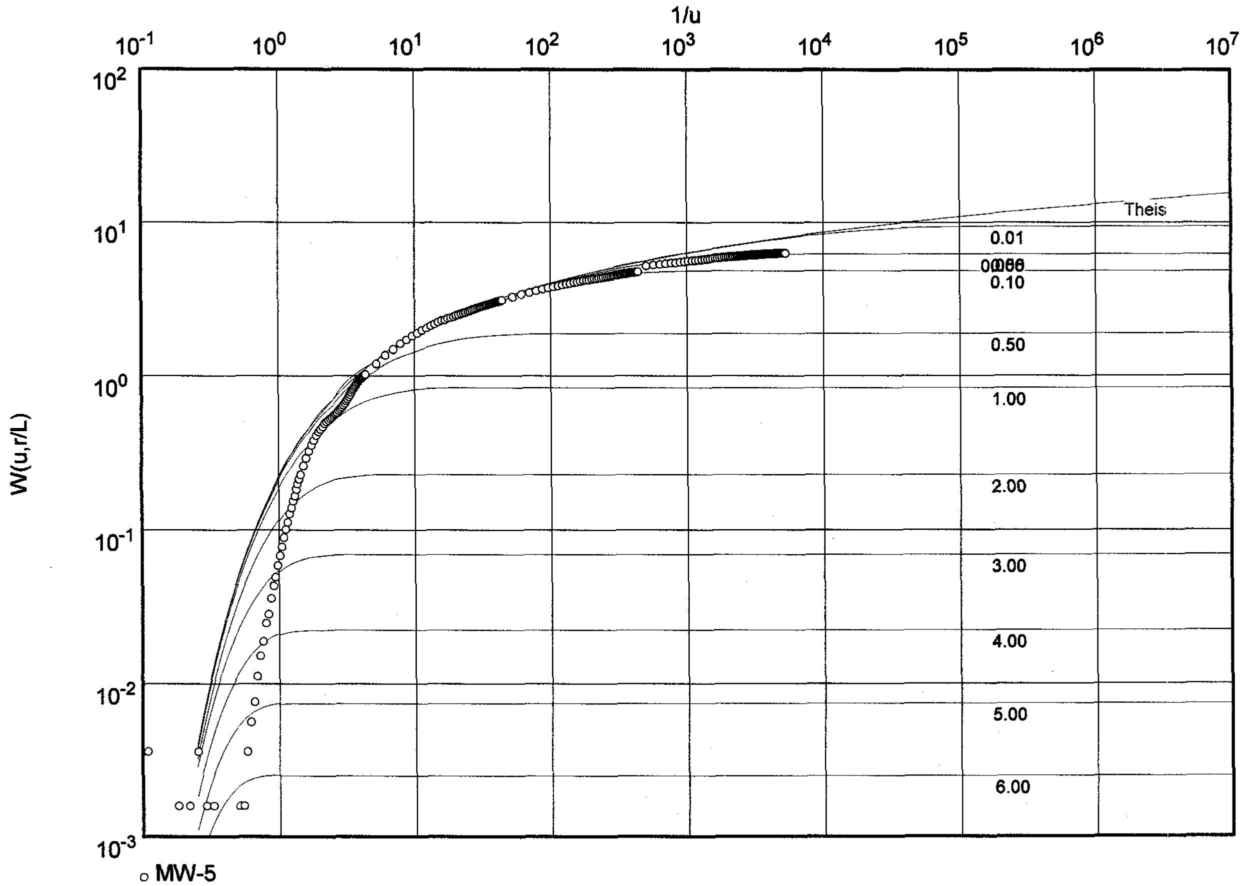
9.5n&wmw7.xls

Appendix E

UFA Curve Matches

SWFWMD Geohydrologic Data Section Brooksville, Florida 1-800-423-1476	Pumping test analysis HANTUSH's method Leaky aquifer, no aquitard storage	Date: 6-30-1999	Page 1
		Project: ROMP 9.5 IAS	
		Evaluated by: mtg	

Pumping Test No. UFA Drawdown	Test conducted on: 2-2-98
MW-5 (100' W)	
Discharge 800.00 U.S.gal/min	



Transmissivity [ft²/d]: 4.87×10^3

Hydraulic conductivity [ft/d]: 1.62×10^1

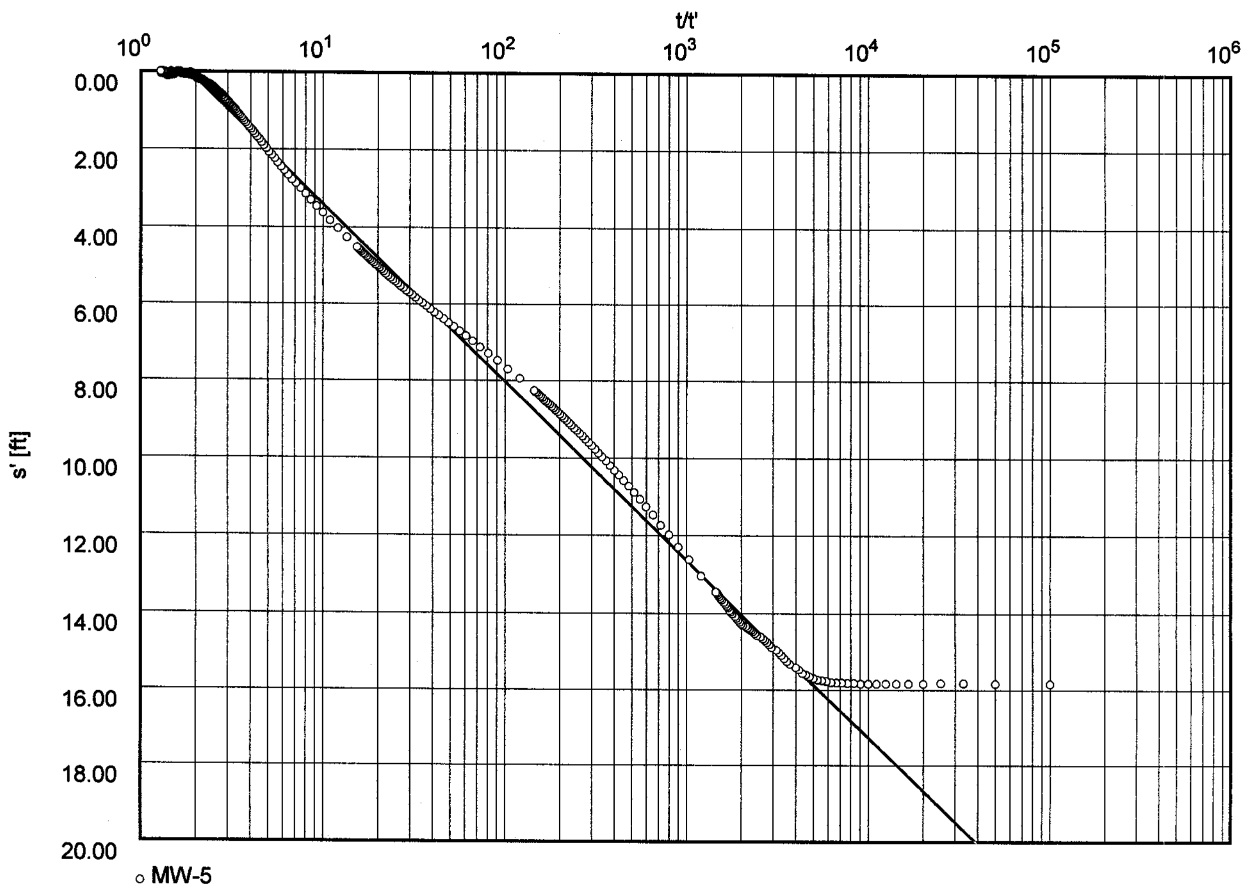
Aquifer thickness [ft]: 300.00

Storativity: 3.09×10^{-4}

Hydraulic resistance (c) [d]: 8.19×10^2

SWFWMD Geohydrologic Data Section Brooksville, Florida 1-800-423-1476	Pumping test analysis Recovery method after THEIS & JACOB Confined aquifer	Date: 6-30-1999	Page 1
		Project: ROMP 9.5 IAS	
		Evaluated by: mtg	

Pumping Test No. UFA (Recovery)	Test conducted on: 2-2-1999
MW-5	
Discharge 800.00 U.S.gal/min	
	Pumping test duration: 1.00000 d



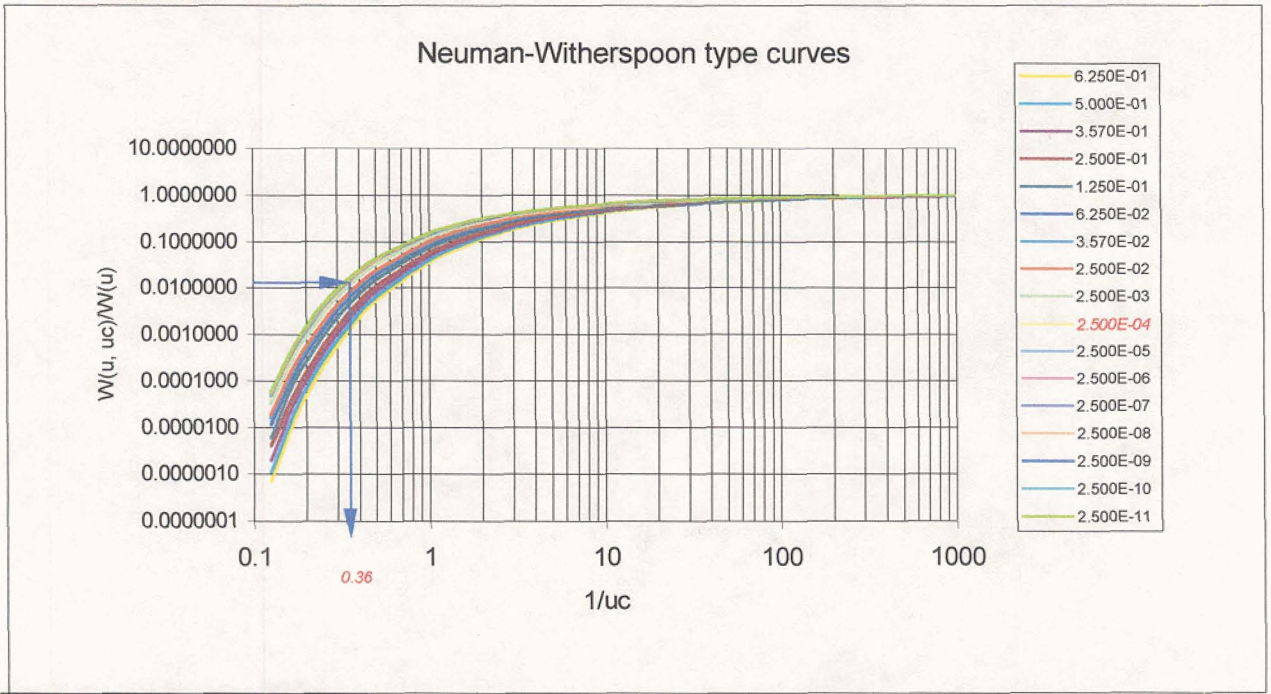
Transmissivity [ft²/d]: 6.09×10^3

Hydraulic conductivity [ft/d]: 2.03×10^1

Aquifer thickness [ft]: 300.00

UFA Drawdown Phase Spreadsheet Analysis

Neuman-Witherspoon Method
From *Analysis and Evaluation of Pumping Test Data* By, G.P. Kruseman and N.A. de Ridder
Semi-Confining Unit (C)



t=	1000	min
t=	0.694	days
r=	100	ft
D=	300	ft
D'	170	ft
z=	150	ft

(1) Calculate T, S, and K using another method (*used Hantush*).

T=	4.87E+03 ft2/d	MW-5
S=	3.09E-04	
K=	1.62E+01 ft/d	

(2) prepare a table of values of time t, drawdown in the aquifer s, drawdown in the aquitard s', and s'/s

(3) Pick an early time t from the table where drawdown is observable
At 1000 minutes, s'/s is 0.020

(4) Solve for u
u= $r^2S/4KDt$ 0.0002

(5) Match the value of s'/s on the $W(u,u_c)/W(u)$ axis of the type curve plot and knowing the value of u, read the value of $1/u_c$ from the x-axis of the plot
$1/u_c$ = 0.36

(6) Calculate hydraulic diffusivity
diffusivity = (1/uc)*(z^2/4t) 2916 ft^2/day

(7) The Neuman-Witherspoon method is only valid if:
$t < 0.1(\text{diffusivity}*1/(D')^2)^{-1}$
t validity: $0.1(\text{diffusivity}*1/(D'^2))^{-1}$ = 0.991 days
Since t = 0.694days (1000 min), the test is valid
(0.694 days < 0.991 days)

t	s' (MW-7)	s (MW-5)	s'/s
940.000	0.195	-15.702	-0.012
955.000	0.201	-15.721	-0.013
970.000	0.044	-15.73	-0.003
985.000	-0.169	-15.74	0.011
1000.000	-0.308	-15.749	0.020
1015.000	-0.421	-15.754	0.027
1030.000	-0.509	-15.754	0.032
1045.000	-0.591	-15.749	0.038
1060.000	-0.66	-15.763	0.042
1075.000	-0.723	-15.773	0.046
1090.000	-0.767	-15.768	0.049
1105.000	-0.83	-15.787	0.053
1120.000	-0.874	-15.801	0.055
1135.000	-0.918	-15.801	0.058
1150.000	-0.956	-15.801	0.061

9.5n&wmw7.xls