WEST MELBOURNE INJECTION WELL SYSTEM

INTERIM REPORT

CITY OF WEST MELBOURNE
WASTEWATER TREATMENT PLANT

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Section 1
INTRODUCTION

This interim report provides a summary of the drilling and testing of the deep injection well and annular monitoring tube system at the West Melbourne Wastewater Treatment Plant. The injection well was constructed in accordance with the regulations and specific conditions stipulated in the Class I Test/Injection Well Permit, No. UC05-102023 issued by the Florida Department of Environmental Regulation.

The data which follows provides the necessary mechanical integrity, hydraulic testing, water chemistry, and injection system monitoring data which is required prior to system start up. Following startup and operational testing, the final Hydrogeologic Report and O&M Manuals will be prepared with actual operating data included.

The overall injection system consists of a 14-inch injection well with a design capacity of 4.8 mgd, an effluent pumping station, a hydraulic surge control system, and control and monitoring instrumentation. The system design detail is summarized in Table 1-1.

Table 1-1
INJECTION SYSTEM DESIGN SUMMARY FOR THE WEST MELBOURNE WWTP

Effluent Injection Pumps

Number	3
Capacity (each)	860 gpm
Firm Capacity (two pumps)	1,720 gpm (2.5 mgd)

Pump Control Instrumentation

Pump sump water level sensors with high level alarm and automatic chlorination of effluent overflow to polishing ponds
Manual lead pump selector
Pump operation timer
Pump fail alarm

Surge Control System

Tank	1,500 gallon
Air Compressor	
Capacity	6.23 scfm
Operating Pressure	120 psig

Surge Control Instrumentation

Surge tank water level sensors with automatic air addition/ air vent logic
Surge tank high/low water level alarms
Air receiver low pressure alarm

Injection Well Detail

Pit Casing	202 ft (driven)
Surface Casing	370 ft
Intermediate Casing	1,637 ft
Injection Casing	1,980 ft
Annular Monitoring Tubes	
Shallow Zone	1,234-1,306 ft
Deep Zone	1,410-1,450 ft

Monitoring Instrumentation

Injection Flow -- 4 mgd max. flow element with 30 day circular chart recorder 0-5 mgd and totalizer.
Injection Pressure -- 30 day circular chart, 0-80 psig
Annular Monitoring Tubes
Shallow Zone -- Electronic water level sensor with 30 day circular chart recorder.
Deep Zone -- Electronic water level sensor with 30 day circular chart recorder.

Section 2
INJECTION WELL CONSTRUCTION

DRILLING AND TESTING CHRONOLOGY

The injection well drilling began on January 17, 1986, and was completed on July 21, 1986. A chronological description of the construction and testing is given below:

1. A 12¼-inch pilot hole was drilled to 420-feet using mud circulation. Caliper, gamma ray, and long and short normal electric (LSN) logs were run on the pilot hole, which was then reamed to a nominal 48-inch hole diameter using mud circulation.

2. A 40-inch diameter steel casing with a 0.5-inch wall thickness was installed to a depth of 370-feet. The casing was cemented to the surface in two stages using a total of 1,150 sacks of Type II cement with 4 percent bentonite.

3. A 12¼-inch pilot hole was drilled to 1,650 feet using mud circulation to a depth of 885-feet and reverse air circulation thereafter. Cores were recovered from depth intervals 1,386 - 1,396, 1,396--1,406, and 1,572-1,582-feet. Caliper, gamma ray, temperature, LSN, BHC sonic, and dual induction logs were run on the pilot hole. The pilot hole was then reamed to a nominal 38-inch diameter.

4. A 24-inch diameter steel casing with a 0.5-inch wall thickness was installed to a depth of 1,637-feet. During cementing, two annular monitoring tubes with screen and gravel pack were installed. The deep monitor screen is set from 1,438 to 1,448 feet with gravel pack placed from 1,410 to 1,450 feet. The shallow monitor screen is set from 1,270 to 1,280 feet with gravel pack placed from 1,234 to 1,306 feet. The casing was cemented in 19 stages, using a total of 600 sacks of Type II neat, 975 sacks of thixotropic, and 5,670 sacks of Type II with 4 percent bentonite.

5. A 12¼-inch pilot hole was drilled to 2,409-feet with cores recovered from depth intervals 1,701-1,705½, 1,980-1,990½, 1,917½-1,922, 1,928-1,938, 1,958-1,968, and 1,968-1,978-feet. Caliper, gamma ray, fluid resistivity, temperature, BHC sonic, and dual induction logs were run on the pilot hole. An open hole pump test was conducted for 3 hours at a rate of 3,300 gpm. A color TV survey was run through the injection interval. The pilot hole was then reamed to a nominal 22-inch diameter.

6. A cement bridge plug was placed at 1,981-feet.

7. A 14-inch diameter seamless carbon steel casing with a 0.50-inch wall thickness was installed to a depth of 1,980-feet. The casing was cemented to the surface with 4 cement stages. Cementing was completed using a total 400 sacks of Type II neat cement, 700 sacks of Type II with 2 percent bentonite, and 1,550 sacks of Type II with 4 percent bentonite.

8. The 14-inch casing was pressure tested for mechanical integrity.

9. The casing plug and bridge plug were drilled out and the borehole was cleaned out to total depth.

10. Final well inspection was completed by running a cement bond log, color video survey, caliper log, and temperature log.

11. An injection test was conducted at a rate of 3,300 gpm using saltwater from the lined storage pond.

12. The well head was completed and piping to the pump station installed.

Figure 2-1 is a well construction diagram that shows the casing depths, and the lithostratigraphic and hydrostratigraphic units encountered at the West Melbourne site. Confining strata are also indicated to show the distribution of low permeability clay, chalk, or dolomitic limestone to the highly permeable dolomitized zones. A copy of the lithologic log and core descriptions is presented in the appendix.

ANNULAR MONITORING TUBES

The Floridan aquifer is monitored by two separate monitoring tube and screen assemblies which have been gravel packed and cemented between the 40 and 24-inch injection well casings. The upper monitor tube produces water from the 1,234 to 1,306 foot interval. Water within this interval has a total dissolved solids of approximately 4,000 mg/l. Water monitored in this zone is within the established underground source of drinking water (USDW).

The deep monitor tube produces water from the 1,410 to 1,450 foot interval. This zone is isolated from the upper zone by 104 feet of soft chalky limestone with a vertical permeability as measured from core analysis of 1.5×10^{-4} cm/sec.

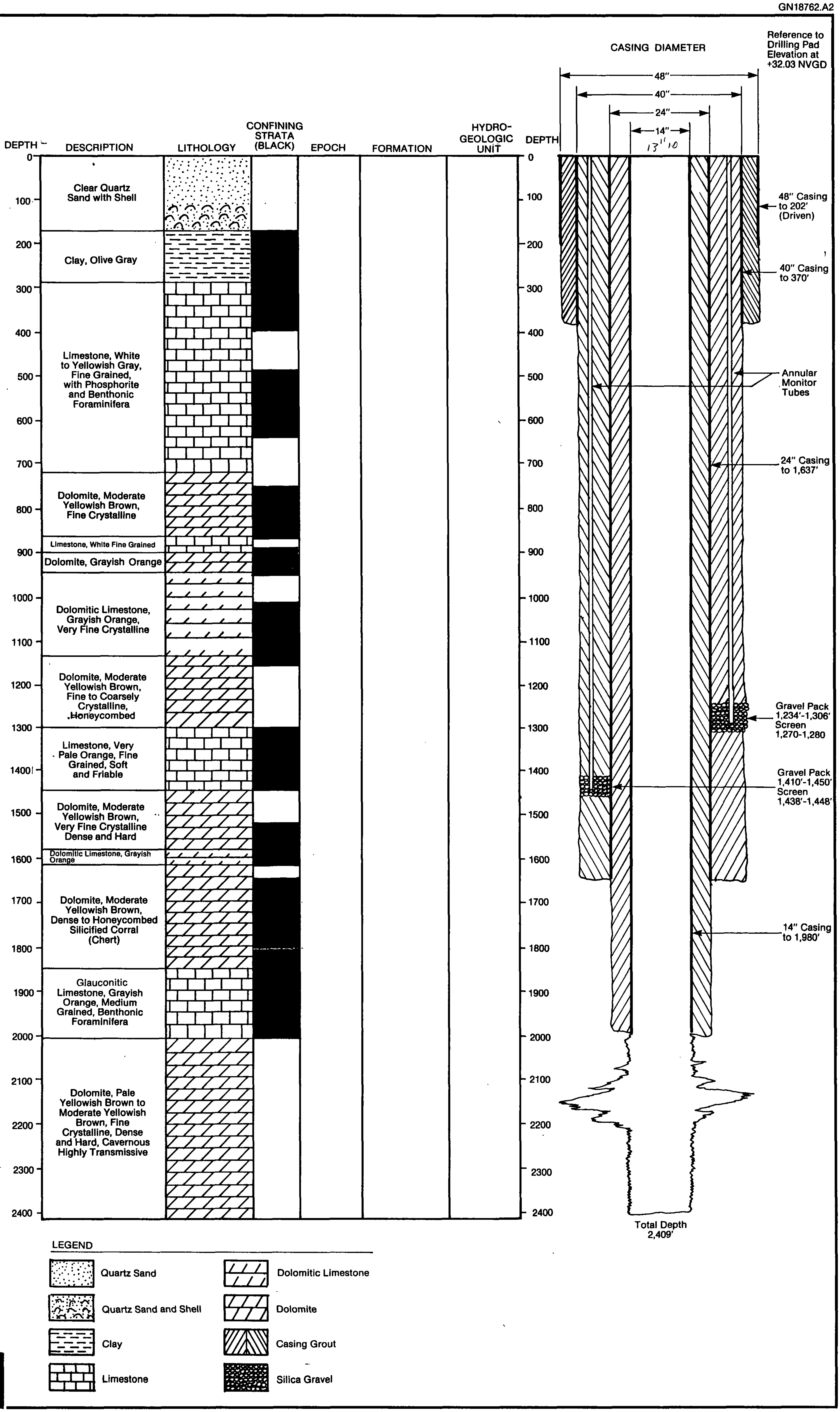

FIGURE 2-1.
West Melbourne WWTP Injection Well Diagram.

The deep monitor gravel pack interval isolates the first dolomitic lense below the limestone confining unit. Present water quality data indicates the TDS content is approximately 1,500 mg/l. Conductivity and chloride concentration have been periodically monitored on both monitor tubes since August. The upper monitoring zone has reached a stable background water quality, however, the lower monitoring tube is being continuously purged at ±3 gpm since it is unclear if the zone has reached stable background water quality. Table 2-1 presents the conductivity and chloride concentrations in the two zones that have been observed since August.

The lower zone water quality may not have reached natural background levels since a substantial amount of freshwater was introduced into the well during construction and testing. For example, freshwater used during the initial video survey to flush the well may have invaded the permeable and fractured rock underlying the confining limestone. Freshwater was also used during installation of the tube and screen assembly while placing the gravel pack which would directly effect the monitoring interval water quality. If the water presently being produced is the result of the addition of freshwater during construction, then purging the tube should return it to background conditions. This process may require a substantial period of time since the tube can only be pumped at approximately 3 gpm.

It is possible that the water being produced from the deep tube is the natural water quality, in which case it would represent conate water that has been trapped beneath confining limestone. Should this be the case, the present water quality will remain stable with time. In either case, the fractured dolomite directly below 1,450 is believed to produce water with TDS greater than 10,000 mg/l, based on the packer pumping tests and the geophysical logs.

GEOPHYSICAL LOGS

Geophysical logs were run on each stage of the pilot hole. The logs were used to evaluate the hydrogeologic parameters of the subsurface strata encountered. The appropriate casing setting depths were established and cement quantities calculated from these logs. A summary of the geophysical logs run on the injection well is presented in Table 2-2.

The cement bond and temperature logs run on the final injection casing are contained in the appendix.

Table 2-1
CHLORIDE AND CONDUCTIVITY PARAMETERS FOR THE ANNULAR MONITORING TUBES

	Lower Zone (1,410 - 1,450 ft)		Upper Zone (1,234 - 1,306 ft)	
Date	Conductivity umho/cm	Chloride mg/l	Conductivity umho/cm	Chloride mg/l
08/27/86	7,200	3,954	6,700	1,977
	7,900	4,295	6,500	1,658
08/29/86	(Redevelop by Surging, Acidization and Air Lift)		6,400	2,089
08/30/86			6,500	2,114
08/31/86			6,800	2,049
09/01/86			6,800	2,099
09/02/86			6,800	2,149
09/03/86			6,800	2,149
09/15/86	6,800	2,149		
	27,000	12,298		
	22,100	10,346		
	22,000	9,746		
	21,000	9,247		
	15,000	6,348		
	19,500	7,968		
09/16/86	18,000	7,097		
	12,000	5,298		
09/17/86	7,600	2,649		
	7,100	2,549		
	6,800	2,399		
09/18/86	6,200	1,899		
09/19/86	6,100	2,099	6,000	1,999
09/21/86	5,400	1,799		
09/22/86	4,460	1,499		
09/24/86	5,900	1,199	6,400	1,899
10/02/86	3,213	740	7,746	2,040

Table 2-1
CHLORIDE AND CONDUCTIVITY PARAMETERS FOR THE ANNULAR MONITORING TUBES
(Continued)

	Lower Zone (1,410 - 1,450 ft)		Upper Zone (1,234 - 1,306 ft)	
Date	Conductivity umho/cm	Chloride mg/l	Conductivity umho/cm	Chloride mg/l
10/03/86	2,754	690	7,345	2,140
10/07/86	2,200	681	5,900	1,948
10/08/86	2,190	633	5,900	1,899
10/09/86	2,200	633	5,890	1,996
10/10/86	2,200	650	6,800	2,149
10/11/86	2,190	600		
10/12/86	2,220	656		
10/13/86	---	693		
10/14/86	2,200	600		
10/15/86	2,230	625		
10/24/86	2,190	600		
10/27/86	2,200	650		

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Table 2-2
INJECTION WELL GEOPHYSICAL LOG SUMMARY

Date	Well Progress and Casing Depth	Type of Log or Survey Run	Purpose
1/21/86	Pit casing set to 48' below pad 12 1/4" pilot hole to 420'	LSN, GR, CAL	1. To evaluate the shallow water aquifer. 2. To establish the top of the Floridan aquifer. 3. To locate competent formation for the placement of the 40" casing.
4/8/86	40" surface casing set to 370' 12 1/4" pilot hole to 1,637'	LSN, GR, CAL, TEMP, FR, FM, SON, DIL	1. To evaluate the hydraulic characteristics of the upper Floridan aquifer. 2. To evaluate formation water quality for installation of monitor tubes. 3. To locate competent formation for placement of the 24' casing.
7/5/86	24" intermediate casing set to 1,637' 12 1/4" pilot hole to 2,409'	GR. CAL, TEMP, FR, SON, DIL, TV	1. To evaluate confining strata above injection zone. 2. Inspection of open hole prior to reaming and setting injection casing. 3. To locate competent formation for the placement of 14" casing. 4. To evaluate the injection zone.
7/15/86	14" casing set at 1,980' with bridge plug	TEMP	1. To locate the annular cement top after the first stage of cement on the 14" injection casing.
7/21/86	14" casing set at 1,980' open hole to 2,409'	CBL, TEMP, CAL	1. To confirm the adequacy of the cement outside of the injection casing. 2. Final inspection on casing and open hole injection zone.
7/23/86	As above	TV	1. Final visual inspection on casing and open hole injection zone.

Explanation

CAL - Caliper
DIL - Dual Induction Log
GR - Gamma Ray
LSN - Long and Short Normal Electric with Spontaneous Potential
FR - Fluid Resistivity
TEMP - Temperature
CBL - Cement Bond Log and Variable Density Log
FM - Flowmeter
SON - Borehole Compensated Sonic Log
TV - Color Video Survey

Section 3
HYDRAULIC TESTING

INJECTION WELL ROCK CORES

During the drilling of the 12-1/4-inch pilot hole, nine limestone cores were retrieved. The selected coring intervals were 1386-1396, 1396-1406, 1572-1582, 1701-1705½, 1980-1990½, 1971½-1982, 1928-1938, 1958-1968, 1968-1978- feet. The length of cores retrieved ranged from 3 to 10½ feet, using a 10-foot tungsten carbide tipped core bit or a diamond tipped core bit.

The cores were sent to the Ardaman and Associates laboratory for permeameter testing using a triaxial cell with a constant head pressure of about 95 psi. The permeability was measured both horizontally and vertically. Table 3-1 summarizes the testing results run on two of the cores. The lab results indicate that the core intervals are sufficiently impermeable to constitute confining material.

INFLATABLE PACKER TESTING

Inflatable packer tests were conducted on six intervals during the 1,650-foot section of the exploratory hole. The packer tests were used principally to determine aquifer water quality. The straddle packer assembly allowed the borehole to be isolated between two packers and pumped to obtain representative water from the isolated zone. Step drawdown tests were also conducted to obtain data on the zone's hydraulic characteristics.

Table 3-2 summarizes the results of the packer tests. The 10,000 mg/L TDS interface occurs between depths of 1,300 and 1,400 feet. However, fresher conate water may be trapped below the confining limestone at 1,420 feet.

Pumping test data was variable with respect to the observed rock material. Poor seating of the packer in the large diameter borehole or the interception of dolomite lenses are considered the major influencing factors. A total of 13 pump tests were attempted.

INJECTION WELL PUMP TEST ON 1,637- TO 2,409-FOOT ZONE

A pump test was conducted on the injection well 1,637 to 2,409-foot zone on July 7, 1986. The test was used in evaluating the hydraulic characteristics of the injection zone. A 12-inch vertical turbine pump was set in the injection well and pumped at a constant rate of 3,300 gpm.

Table 3-1
CORE ANALYSIS SUMMARY
WEST MELBOURNE INJECTION WELL

Depth Interval (Feet)	Permeability	Dry Density	Porosity
1386-1396	Vert. 1.5×10^{-4} cm/sec	118.4 lb/sq ft	30%
	Horiz. 7.2×10^{-4} cm/sec	114.8 lb/sq ft	32%
1572-1575	Vert. 6.8×10^{-6} cm/sec	133.7 lb/sq ft	21%
1701-1705½	Vert. 3.1×10^{-3} cm/sec	113.0 lb/sq ft	33%
	Horiz. 3.1×10^{-3} cm/sec	119.4 lb/sq ft	29%
1886-1890½	Vert. 4.9×10^{-6} cm/sec	124.5 lb/sq ft	26%
	Horiz. 2.2×10^{-6} cm/sec	129.2 lb/sq ft	23%
1917½-1920½	Vert. 1.3×10^{-6} cm/sec	123.4 lb/sq ft	27%
1928-1933	Vert. 3.3×10^{-4} cm/sec	104.6 lb/sq ft	38%
	Horiz. 1.4×10^{-3} cm/sec	99.9 lb/sq ft	41%
1958-1963	Vert. 3.7×10^{-5} cm/sec	117.2 lb/sq ft	30%
1968-1973	Rock Sheared Diagonally During Sub-coring. No Analysis Available.		30%

Core analysis performed by Ardaman and Associates, Orlando, Florida.

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Table 3-2
CITY OF WEST MELBOURNE
INJECTION WELL
PACKER PUMPING TEST AND DEPTH SAMPLE SUMMARY

Packer Interval (feet)	Pumping Test No. and Date	Pumping Rate (gpm)	Drawdown (ft)	Transmissivity gpd/ft	Specific Conductance[a] (μghos/cm)	Total Dissolved Solids (μg/L)	Static Water Level (Referenced to Pad Elev. 32.03')		Comments
							Start	Finish	
1,585-1,605	1 4/9	75	39.27	650	48,900	33,953	-3.93	-24.06	Water density increase in drill pipe
1,580-1,600	2 4/10	30	>80.37		49,400	34,300[a]	-25.97	-20.15	W.L. drawn below, transducer setting
1,580-1,600	3 4/10	8.5 13.5 20.0	26.96 45.28 74.97		-- -- --	-- -- --	-28.85 -- --	-- -- -23.53	Step Test
1,512-1,532	4 4/11	83	4.52		--	--	-16.62	--	Packer leaking, packer interval shortened
1,510-1,524	5 4/11	72	>116.68	166	--	--	-5.18	-5.54	W.L. drawn below, transducer setting
1,510-1,524	6 4/11	3.1	89.53	15	24,200	15,200[a]	-5.18	-4.78	
1,284-1,298	7 4/12	84	5.71		9,500	6,060[a]	-2.15	-0.53	
1,284-1,298	8 4/12	4.8	--		9,760	5,120[a]	-0.48	--	Transducer malfunction--No drawdown data
1,303-1,317	9 4/12	--	--		--	--	--	--	No test, packer leaking when set
1,301-1,315	10 4/12	83	2.25		9,630	5,280[a]	0.78	--	Transducer malfunction, steel tape measurem
1,309-1,319	11 4/13	87	--		6,680	4,638[a]	-11.25	--	Packer interval shortened, W.Q. test only
1,309-1,319	12 4/13	5	0.02		8,270	5,460[a]	0.51	--	Specific capacity test
1,426-1,436	13 4/13	86	6.59	5,100	15,520	10,240[a]	0.55	-3.23	More saline fluid in drill pipe at end of t Packer possibly leaking
1,430	4/8	--	--		11,710				Open borehole depth samples
1,490	4/8	--	--		36,500				Open borehole depth samples
1,540	4/8	--	--		40,500				Open borehole depth samples
1,600	4/8	--	--		48,300				Open borehole depth samples

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[a] Laboratory results.

After 3 hours of pumping the drawdown in the well was measured at 13.93 feet which yields a specific capacity of 237 gpm/ft. The static water level was measured on July 7, 1986 at 12:00 as 2.56 feet NVGD. The water temperature at the discharge point was 90°F and the specific gravity was measured at 1.023. All measurements were made on the native injection zone water after pumping out 680,000 gallons.

The major points of water entry are between 2,050 and 2,220 feet where the borehole intercepts the fractured and cavernous dolomites of the Oldsmar limestone.

INJECTION ZONE WATER QUALITY

A water sample was collected for laboratory analysis after the injection casing was set at 1,980 feet and the open hole was cleared to 2,409 feet. The sample was taken during the well pump out at 1,500 gpm prior to the final video well inspection. Table 3-3 presents the water analysis data presently available.

TEST INJECTION

The injection test was conducted using a vertical turbine pump set in the temporary lined storage pond which contained saltwater from earlier testing. A 12-inch steel pipeline was constructed from the pump to the injection well with a 12-inch gate valve set inline to adjust the flow as needed. Flow changes were also accomplished by increasing or decreasing the motor speed. A pitot tube was set inline downstream from the gate valve for flow measurement. The injection well was fitted with a 90° elbow which was connected to the temporary test pipeline. Fittings for pressure instrumentation and sampling were attached to the injection casing 2 feet above the drilling pad.

Injection pressure measurements were made using a 12-inch Heise gauge calibrated from zero to 60 psi with 0.1 psi increments. The pressure was also recorded throughout the test using a zero to 100 psi Foxboro 24-hour circular chart recorder.

The pretest static water level was 3.69 feet NVGD giving a difference in hydraulic head of more than 35 feet. It was anticipated that the wellhead would be on a vacuum at low injection rates which would require a piezometer tube for water level measurements. Therefore, an 80-foot steel pipe was installed in the well.

The injection test proceeded for 5 hours at rates of up to 3,300 gpm (flow velocity of 8.0 ft/sec). Wellhead pressure

Table 3-3
INJECTION ZONE WATER QUALITY
WEST MELBOURNE INJECTION WELL

Water Temperature	90°F
pH	7.35
Turbidity, NTU	2.8
Color, APHA Color Units	5
Sulfate	2,520 mg/L
Iron	0.90 mg/L
Total Dissolved Solids at 180°C	36,200 mg/P
Total Hardness	6,400 mg/L
Bicarbonate	146 mg/L (120 mg/L*)
Sodium	9,440 mg/L
Total Organic Carbon	2.38
Total Phosphorus	0.09 mg/L
Total Nitrogen	0.49 mg/L
Nitrate	0.03 mg/L
Organic Nitrogen	0.04 mg/L
Ammonia	0.42 mg/L
Conductivity at 25°C	48,100 uMHO/cm
Calcium	1,630 mg/L (4,070 mg/L*)
Magnesium	559 mg/L (2,330 mg/L*)
Carbon Dioxide	10 mg/L (24 mg/L*)
Carbonate	<0.1 mg/L (<0.1 mg/L*)
Potassium	600 mg/L
Chloride	18,790 mg/L
Specific Gravity	1.020
Sulfide	0.38 mg/L

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*As $CACO_3$.

ranged between 2 and 4 psig at rates near 3,300 gpm. Below approximately 3,000 gpm the well was on a vacuum due to the head differential.

Friction loss estimates correspond closely to the observed wellhead pressures. Using the Hazen and Williams empirical formula with C factor of 130 for pipe friction, all but approximately 1.5 psi of the observed wellhead pressure is attributable to friction losses within the casing. At the design injection rate, formation losses are negligible.

Once injection of treated effluent begins, the wellhead will remain pressurized due to the water density differences between the effluent and the native injection zone fluid. Static wellhead pressure is estimated to be less than 10 psig once the lighter effluent has been injected into the well. Operating injection pressures are estimated to be less than 30 psi.

CASING PRESSURE TEST

After cementing the 14-inch casing and allowing it to set for 48 hours, a casing pressure test was conducted. Three pressure decay curves were obtained from the test, with beginning and ending casing fluid temperatures recorded. Prior to testing, the casing was completely filled with water and all fittings were bled to ensure the complete removal of air. The test was conducted using a 0-100 psi Foxboro circular chart recorder and an 8-inch, 0-100 psi Helicoid pressure gage with 1 psi increments. The casing was pressurized three times to 100 psi and monitored until the pressure dropped to zero. The pressure drop took approximately 5 hours and during this time, the fluid temperature decreased 2 to 3 degrees.

The observed drop in casing pressure is directly related to the decrease in temperature of the fluid in the casing. As the fluid temperature decreases, the volume of the fluid and the casing diameter also decrease. The changes that occur are relatively small but have a very significant effect on the observed pressure since water is only slightly compressible. The following equation relates the decrease in casing volume and the contraction of water to the observed pressure change. Casing volume reduction as a result of decreased casing length is considered negligible.

$$\Delta P = \frac{1}{\beta V}\left(\alpha_W \Delta TV - \frac{\pi L}{4}\left[D_O^2 - (D_O - \alpha_S \Delta TD_O)^2\right]\right)$$

where:

ΔP = pressure change

β = Compressibility of water, 47,520,000 lb/sq ft

V = Fluid volume in casing

α_w = Coefficient of thermal expansion for water in the temperature range 80-100°F, 0.000182/°F

α_s = Coefficient of thermal expansion for steel = 6.5×10^{-6}/°F

ΔT = Temperature change

D_o = Original Casing I.D.

The above expression predicts a temperature change of 1.8°F will be accompanied by a 100 psi drop in casing pressure. For this system the calculated pressure/temperature ratio is 55.8 psi/°F. The measured test data closely matched this prediction. The pressure test data is summarized in Figure 3-1.

Three separate pressure tests were conducted. The first test was conducted to check the pressure instrumentation and verify that all fittings, piping, and welds were not leaking. This test provided the initial pressure decay curve that was used for evaluation and planning of the following pressure tests.

The second and third tests provided both temperature and pressure decays over time. Casing fluid temperature was measured at the start and finish of each test. Header pressure was continuously recorded over time.

The predicted pressure decays illustrated in Figure 3-1 were generated by multiplying the calculated decay of 55.8 psi/°F by the observed temperature/time ratio. The data collected during Test No. 2 and Test No. 3 yielded 38 psi/°F and 48 psi/°F, respectively. Both ratios were less than the calculated 55.8 psi/°F, indicating the casing is free from leaks.

To further verify the pressure test data, the pressure header was removed and a water level monitoring test was conducted. The water level in the casing was lowered to a depth of 110 feet from the top of the casing. Using a steel tape the water level was monitored over a period of 1½ hours. The water level in the casing will change with temperature and will follow this relationship.

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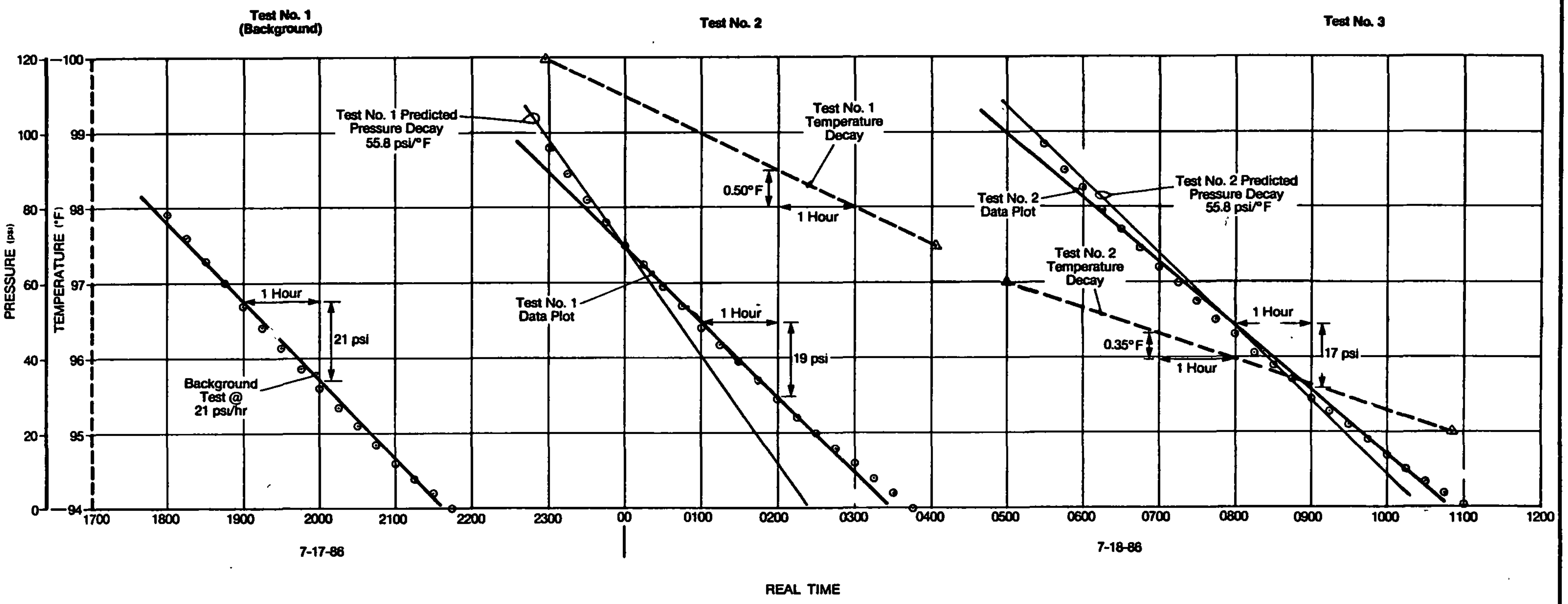

FIGURE 3-1.
West Melbourne Injection Well Pressure Test on the 14-Inch Injection Casing, July 17-18, 1986.

$$\frac{\Delta V}{V} = \alpha \Delta T$$

The above relationship predicts a 0.357 foot decrease in casing water level for a temperature reduction of 1°F. The results of the field test compare closely with this calculation. If the casing were leaking, the water level would have risen in the casing. Water level test data is presented in Table 3-4.

In summary, for the sealed casing system at 100°F and an initial pressure of 100 psi, pressure is predicted to drop with temperature by 55.8 psi/1°F. The free water surface in the unsealed casing system will drop by 0.357 ft/1°F. The observed behavior of the casing system matches closely to these predictions. The results of both test methods indicate the casing has exhibited mechanical integrity.

Table 3-4
WATER LEVEL TEST DATA SUMMARY FOR 14-INCH CASING MECHANICAL INTEGRITY TEST

Time	Hold	Wet	Water Level*	Change in Water Level
14:40	130.00	19.12	110.88	0
14:55	115.00	4.01	110.98	-0.10
15:25	115.00	3.96	111.04	-0.16
16:10	115.00	3.89	111.11	-0.23

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*Reference at top of casing.

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Section 4
MONITORING PROGRAM

MONITORING DATA COLLECTION AND REPORTING

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

Table 4-1 lists the monitoring data to be collected from the injection system.

MONITORING DATA MONTHLY REPORT

The data for the Monitoring Data Monthly Report are to be compiled on a daily basis using the injection flowmeter recorder chart, the injection pressure recorder chart, and the two annular monitoring tube recorder charts. The operator will send the monthly report, with the other treatment plant monthly forms, to the local FDER office. An example of the Monitoring Data Monthly Report Form is contained in the appendix.

ANNULAR MONITORING TUBE WATER QUALITY REPORT

Every month, water quality samples are to be collected from the two monitoring zones in the monitoring well. These samples are compared to the pre-injection water quality in order to detect any changes caused by migration of injected effluent should that occur. If effluent migration occurs, the monthly water samples should show a freshening trend from background chloride and specific conductance values.

The monthly water samples are collected as follows:

1. Open both monitoring zone 2-inch globe valves and turn on both the upper and lower zone submersible pumps. The water level in both monitoring recorders will drop significantly.

2. Pump the two zones until approximately 1.5 tubing volumes have been purged. The monitoring zone volumes are as follows:

Table 4-1
MONITORING DATA FOR THE INJECTION SYSTEM

Parameter	Equipment or Procedure	Data to be Submitted to FDER
Injection Flow Rate (gpm)	30-day circular chart recorder and totalizer in laboratory instrument panel	Total daily flow; monthly average flow; monthly maximum flow; monthly minimum flow
Injection Pressure (psig)	30-day circular chart recorder in laboratory instrument panel	Daily minimum and maximum pressure; monthly minimum and maximum pressure; monthly average minimum and maximum pressure
Water Quality of Injected Fluid	To be determined	To be determined
Water Elevation in the Lower Monitoring Zone-- 1,410-1,450 ft (ft of water)	24-hr circular chart recorder in wellhead panel	Daily minimum and maximum levels; monthly minimum and maximum levels
Water Elevation in the Upper Monitoring Zone-- 1,234-1,306 ft (feet of water)	24-hr circular chart recorder in wellhead panel	Daily minimum and maximum pressures; monthly minimum and maximum pressures
Injection Well Capacity	Inject @ 860 gpm; measure pressure	Specific injectivity index (quarterly)
Water Quality of the Two Monitoring Zones	Sample after pumping a minimum of 1.5 tubing volumes from both zones	Upper and Lower Zones: Specific conductance; chloride; temperature; fecal coliform; phosphorus, nitrogen (weekly until water quality stabilized, then monthly)

UPPER ZONE MONITORING TUBE

Tube Depth: 1,280 feet
Tube Volume: 21.38 ft³ (160 gallons)
Pumping Rate: 3 gpm

$$1\tfrac{1}{2} \text{ volumes} \times 160 \text{ gal} \times \frac{\text{min}}{3 \text{ gal}} = 80 \text{ min pumping}$$

LOWER ZONE MONITORING TUBE

Tube Depth: 1,448 feet
Tube Volume: 24.19 ft³ (181 gallons)
Pumping Rate: 3 gpm

$$1\tfrac{1}{2} \text{ volumes} \times 181 \text{ gal} \times \frac{\text{min}}{3 \text{ gal}} = 91 \text{ min pumping}$$

3. Measure temperature; collect two sample bottles from each zone and label appropriately.
4. Turn off sample pumps from both monitoring zone and close all sample valves. Check to ensure that monitoring pressures and water levels return to pretest levels.

The results of the analysis should be sent to the local FDER office with the regular monthly report.

NORMAL MONITORING PARAMETERS

Table 4-2 shows the monitoring parameters and values to be expected when the injection system is operating normally. If the actual values measured for any of the monitoring parameters vary from the normal range, immediate steps should be taken to identify and correct the cause.

Table 4-2 also lists corrective actions for the most common causes of abnormal values. If the operator cannot identify the problem, the Director of Public Works must be contacted.

QUARTERLY SPECIFIC INJECTIVITY TEST

Every quarter, a specific injectivity test must be run on the injection well, in accordance with Chapter 17.28, FAC. This test evaluates the injection capacity of the well to detect any changes over time caused by plugging or other flow-restricting conditions.

Table 4-2
INJECTION SYSTEM MONITORING PROGRAM--NORMAL VALUES AND TROUBLESHOOTING CHART

Parameter	Normal Range of Values		Suggested Corrective Action if Abnormal Monitoring Values are Encountered[a]
Injection Flow Rate (flow recorder)	1 - Pump 2 - Pumps 3 - Pumps	To Be Determined	1. Check injection pressure for abnormal values. 2. Check water level in pump sump. 3. Check flow path for closed or obstructed valves or fittings. 4. Check and clear clogged pressure line to sender. 5. Check and calibrate flow recorder if needed. 6. Check for electrical flow transmitter malfunction. 7. Notify plant operations manager. 8. Remove pump from service. 9. Inspect pump drop pipes for obstruction. 10. Inspect belts, shaft, bearings, and motor for wear or damage.
Injection Pressure (pressure recorder)	Minimum operating Maximum operating	To Be Determined	1. Look for leak in injection line or in check valves. 2. Check gauge to determine if electrical pressure sender is malfunctioning. 3. Repair and calibrate pressure recorder. 4. Pump station malfunction; see items 1-10 above. 5. Inspect and repair plugged or damaged injection well. 6. Notify plant operations manager.
Upper Monitoring Zone Water Level (water level recorder)	Min./Max.	To Be Determined	1. Check bleed valve; close if necessary. 2. Check pressure transducer; replace 3. Check pressure transmitter; repair and calibrate 4. Check water level recorder; repair and calibrate 5. Water quality change; see Monitoring Zone Water Quality, Items 1 and 2 below. 6. Notify plant operations manager.
Lower Monitoring Zone Water Level (water level recorder)	Min./Max.		
Upper Monitoring Zone Water Quality (monthly water sample)	phosphorus nitrogen conductivity chloride coliform	To Be Determined	1. Resample to verify laboratory values. 2. Notify plant operations manager of possible effluent migration into monitoring zones.
Lower Monitoring Zone Water Quality (monthly water sample)	conductivity chloride coliform nitrogen phosphorus	To Be Determined	
Injected Fluid Water Quality	Suspended Solids mg/L: 0-20 Specific Conductance µmhos/cm: 500 to 700		1. Check process control and correct as necessary.

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[a] Corrective actions listed are not necessarily exhaustive or in appropriate sequence for all conditions.

The test is run as follows:

1. Manually operate one injection pump.

2. Once the rate is established at 860 gpm, measure injection pressure with the pressure recorder installed in the instrument panel.

3. Turn the pump off while carefully watching the pressure recorder. After the pressure has stabilized (approximately 5 minutes), record the shut-in pressure or static head.

4. Subtract the shut-in pressure from the injection pressure measured at the rate of 860 gpm and divide the pressure difference into 860 gpm. The resulting number, reported as gpm/psig, is the specific injectivity index.

At the completion of the test, return the pump controls to the AUTO position.

LITHOLOGIC LOG AND CORE DESCRIPTIONS

Lithologic Log and Core Descriptions
West Melbourne Injection Well

DEPTH	
0-10	QUARTZ SAND, clear, coarse, angular, fair sorting, shell (pinkish gray 5 Y R 8/1), humate rich clay (olive black 5 Y 2/1)
10-20	As Above
20-30	As Above
30-40	As Above
40-50	As Above
50-60	As Above
60-70	As Above
70-80	As Above
80-90	As Above
90-100	As Above
100-110	As Above
110-120	QUARTZ SAND, clear coarse, angular, poor sorting, shell (pinkish gray 5 YR 8/1)
120-130	As Above
130-140	As Above
140-150	As Above
150-160	As Above
160-170	As Above
170-180	CLAY, olive gray 5 Y 3/2, highly plastic, phosphatic
180-190	As Above
190-200	As Above
200-210	CLAY, olive gray 5 Y 3/2, loose, phosphatic, calcareous
210-220	As Above
220-230	As Above

230-240	CLAY, light olive gray 5 Y 5/2, Plastic, phosphatic
240-250	As Above
250-260	As Above
260-270	As Above
270-280	As Above
280-290	As Above
290-300	LIMESTONE, yellowish gray 5 Y 8/1, fine grained, carbonate mud matrix, 10% muldic porosity, phosphorite, friable
300-310	As Above
310-320	As Above
320-330	As Above
330-340	As Above
340-350	As Above
350-360	LIMESTONE, white N9, fine grained, carbonate mud matrix, 10% moldic porosity, minor amount of phosphorite, friable
360-370	As Above
370-380	As Above
380-390	As Above
390-400	As Above
400-410	As Above
410-420	As Above
420-430	FRAGMENTAL LIMESTONE, white N9 to yellowish gray 5 Y 7/2, <5% quartz sand, highly permeable, 90% mollisk shell, <10% gastropod shell, <1% benthonic foraminifera
4230-440	No sample
440-450	SKELETAL LIMESTONE, white N9 to very light gray N8, grains 0.18 to 1.25 mm, very low inter particle porosity, 80% benthonic foraminifera, hard

	Fossills - (Cell #1)
450-460	As Above
460-470	As Above
470-480	As Above
	LIMESTONE, YELLOWISH gray 5 Y 8/1, very fine crystalline (<0.08 mm), 10% moldic porosity, low interparticle porosity, fossils obscure due to dolomitization, hard
480-490	FRAGMENTAL LIMESTONE, white N9 to very pale orange 10 YR 8/2, grains <6 mm, 40% shell fragments, 40% benthonic foraminifera
	Fossils - (Cell #2)
490-500	SKELETAL LIMESTONE, white N9 to very light gray N8, grains 0.18 to 1.25 mm, very low interparticle porosity, 80% benthonic foraminifera, hard
	LIMESTONE, yellowish gray 5 Y 8/1, very fine crystalline, 10% moldic porosity, low intercrystall porosity, fossils obscure due to dolomitization, hard
	Fossils - (Cell #2)
500-510	SKELETAL LIMESTONE, white N9 to very light gray N8, grains 0.18 to 1.25 mm, very low inter particle porosity, 80% benthonic foraminifera, hard
	Fossils - (Cell #2)
510-520	SKELETAL LIMESTONE, white N9 to very light gray N8, grains 0.18 to 1.25 mm, very low inter particle porosity, 80% benthonic foraminifera, hard
	LIMESTONE - yellowish gray 5 Y 8/1, very fine crystalline, 10% moldic porosity, low intercrystal porosity, fossils obscure due to dolomitization, hard
	Fossils - (Cell #2)
520-530	CALCAREOUS CLAY, light olive gray 5 Y 6/1
	Fossils - (Cell #2)

530-540	As Above
540-550	As Above
550-560	As Above
560-570	As Above
	Fossils - (Cell #3)
570-580	SKELETAL LIMESTONE, white N9 to very light gray N8, grains 0.18 to 1.25 mm, very low interparticle porosity, 80% benthonic foraminifera, hard
	Fossils - (Cell #3)
580-590	As Above
590-600	As Above
600-610	SKELETAL LIMESTONE, white N9 to yellowish gray 5 Y 7/2, 20% moldic porosity, skeletal grains 0.25 to 1.00 mm, shell fragments, benthonic foraminifera, <5% quartz sand, hard
	Fossils - (Cell #4)
610-620	As Above
620-630	As Above
630-640	As Above
640-650	As Above
	Fossils - (Cell #5)
650-660	As Above
660-670	As Above
670-680	SKELETAL LIMESTONE, white N9 to yellowish gray 5 Y 7/2, 20% moldic porosity, skeletal grains 0.25 to 1.00 mm, shell fragments, benthonic foraminifera, <5% quartz sand, hard
	DOLOMITIC LIMESTONE, moderate yellowish brown 10 YR 5/4, crystals > 0.62 mm, low intercrystal porosity, 20% vuggy porosity ($\geq$ 1.0 mm Dia.), moderately hard
	Fossils - (Cell #6)

680-690	As Above Fossils - (Cell #7)
690-700	LIMESTONE, white N9, very fine grained 0.125 to 0.177 mm, larger benthonic foraminifera, shell fragments, low inter-particle porosity, < 5% vuggy porosity (< 0.5 mm Dia.), hard Fossils - (Cell #8) DOLOMITE, yellowish gray 5 Y 8/1, fine crystalline (0.062 mm), honeycombed and very sucrosic, < 5% vuggy porosity (< 0.5 mm Dia.), soft to moderately hard
700-710	As Above
710-720	As Above
720-730	As Above
730-740	DOLOMITE, yellowish gray 5 Y 8/1 to light olive gray 5 Y 6/1, microcrystalline to very fine crystalline, soft and friable, 15% quartz sand (≥ 0.25 mm Dia.) Fossils - (Cell #9)
740-750	DOLOMITE, yellowish gray 5 Y 8/1 to light olive gray 5 Y 6/1, microcrystalline to very fine crystalline, soft and friable, 15% quartz sand (≥ 0.25 mm Dia.) LIMESTONE, white N9, very fine grained (0.125 - 0.177 mm), larger benthonic foraminifera, shell fragments, low interparticle porosity, < 5% vuggy porosity (0.175 mm) Fossils - (Cell #9)
750-760	As Above Fossils - (Cell #10)
760-770	As Above
770-780	As Above
780-790	As Above
790-800	As Above

800-810	As Above
810-820	As Above
	Fossils - (Cell #11)
820-830	DOLOMITE moderate yellowish brown 10 YR 5/4, very fine crystalline (< 0.088 mm), moderate intercrystal porosity, 10% vuggy porosity (0.125 to 0.50 mm), hard
830-840	DOLOMITIC LIMESTONE, grayish orange 10 YR 7/4, fine crystalline (< 0.062 mm), 10% vuggy porosity (0.177-1.00 mm) friable
	Fossils - (Cell #12)
840-850	As Above
850-860	As Above
860-870	As Above
	BEGIN REVERSE AIR SAMPLES AT 880'
880-890	LIMESTONE, white N9, very fine grained (< 0.062 mm), very low interparticle porosity, low permeability, < 5% vuggy porosity (< 0.5 mm), friable
	Fossils - (Cell #13) Abundant weathered *Dictyoconus americanus*
895	DOLOMITE, dark yellowish brown 10 YR 4/2, fine crystalline (0.088 - 0.125 mm), moderately sucrosic, 40% vuggy porosity (< 5mm Dia.), moderate to high interparticle porosity, hard
900-910	LIMESTONE, white N9, very fine grained (< 0.062 mm), very low interparticle porosity, low permeability, < 5% vuggy porosity (< 0.5 mm), friable
	Fossils - (Cell #13)
910-920	DOLOMITE, grayish orange 10 YR 7/4, fine crystalline (0.088 to 0.125 mm), moderate intercrystal porosity, vugs 3 mm and smaller
920-930	As Above

930-940	LIMESTONE, white N9, very fine grained (< 0.062 mm), very low interparticle porosity, low permeability, < 5% vuggy porosity (< 0.5 mm), friable Fossils - (Cell #14)
940-950	LIMESTONE, very light gray N8, very fine crystalline, low intercrystal porosity, < 5% moldic porosity, molds < 0.5 mm (*Textularia* ?), soft and chalky Fossils - (Cell #15)
950-960	As Above DOLOMITE, moderate yellowish brown 10 YR 5/4, fine crystalline, sucrosic, 40% intercrystal porosity, moderately hard
960-970	As Above (950-960)
970-980	DOLOMITE, moderate yellowish brown 10 YR 5/4, very fine crystalline to moderately sucrosic, crystals solution vugs < 1.0 mm, hard
980-990	LIMESTONE, very pale orange 10 YR 8/2, granular, grains < 1.0 mm, high interparticle porosity, 10% moldic porosity, soft Fossils - (Cell #16) DOLOMITE, moderate yellowish brown 10 YR 5/4, fine crystalline (< 0.125 mm), sucrosic, 25% interparticle porosity, < 5% vuggy porosity (< 2.0 mm Dia.)
990-1000	DOLOMITE, moderate yellowish brown 10 YR 5/4, fine crystalline (< 0.125 mm), sucrosic, 25% interparticle porosity, < 5% vuggy porosity (< 2.0 mm Dia.)
1000-1010	LIMESTONE, very pale orange to moderate yellowish brown, granular (foraminiferal-0.8 mm - 0.125 mm), moderate interparticle porosity, friable Fossils - (Cell #17)
1010-1020	DOLOMITE, very pale orange 10 YR 8/2 to pale yellowish brown 10 YR 6/2, fine crystalline (< 0.125 mm), low intercrystal porosity, < 15% vuggy porosity (< 1.5 mm Dia.) moderately hard

1020-1030	As Above
1030-1040	As Above
1040-1050	DOLOMITE, very pale orange 10 YR 8/2 to pale yellowish brown 10 YR 6/2, fine crystalline (< 0.125 mm) low interparticle porosity, < 15% vuggy porosity (< 1.5 mm Dia.) moderately hard
	LIMESTONE, white N9, very fine crystalline, very low interparticle porosity, no molds or vugs visible, chalky, soft
	Fossils - (Cell #18)
1050-1060	As Above
1060-1070	DOLOMITIC LIMESTONE, grayish orange 10 YR 7/4, very fine crystalline (< 0.088 mm), low intercrystal porosity, 25% moldic porosity, 70% cones, hard
1070-1080	As Above
	Fossils - (Cell #19)
1080-1090	No samples
1090-1100	As Above
	Fossils - (Cell #20)
1100-1110	As Above
	Fossils - (Cell #20)
1110-1120	As Above
1120-1130	As Above
1130-1140	As Above
1140-1150	DOLOMITE, dark yellowish brown 10 YR 4/2, microcrystalline, very low intercrystal porosity, no visible moldic or vuggy porosity, very dense, very hard
1150-1160	DOLOMITE, dark gray N3 to olive gray 5 Y 4/1, fine crystalline (< 0.177 mm), finely sucrosic, low interparticle porosity, < 5% vuggy porosity (2 mm Dia.)

1158	DOLOMITE, dark yellowish brown 10 YR 4/2, very fine crystalline (< 0.062 mm), low interparticle porosity, dense, hard, very few molds or vugs
1160-1170	DOLOMITE, moderate yellowish brown, 10 YR 5/4, fine crystalline (< 0.177 mm), sucrosic, 40% interparticle porosity, friable.
1170-1180	DOLOMITE, dark yellowish brown 10 YR 4/2, microcrystalline, dense, hard, < 5% moldic porosity (*Dictyoconus*)
1180-1190	DOLOMITE, grayish orange 10 YR 7/4, microcrystalline, dense, hard < 1% moldic porosity
1190-1200	DOLOMITE, pale yellowish brown 10 YR 6/2, microcrystalline dense hard, < 5% moldic porosity, hard
1200-1210	DOLOMITE, dark yellowish brown 10 YR 4/2, microcrystalline, dense hard, < 5% moldic porosity
1210-1220	DOLOMITE, moderate yellowish brown 10 YR 5/4, fine crystalline (< 0.177 mm), sucrosic, moderate intercrystal porosity, < 10% moldic porosity, cones preserved as white limestone with little or no dolomitization, moderately hard
1225	DOLOMITE, moderate yellowish brown 10 YR 5/4, fine crystalline (< 0.177 mm), highly sucrosic and honeycombed, high intercrystal porosity 50% moldic porosity, moderately hard
1220-1230	As Above
1230-1240	DOLOMITE, pale yellowish brown 10 YR 6/2, microcrystalline, dense hard, < 5% moldic porosity, hard
1240-1250	DOLOMITE, moderate yellowish brown 10 YR 5/4, fine crystalline (< 0.177 mm) highly sucrosic and honeycombed, high intercrystal porosity, 50% moldic porosity, moderately hard
	Fossils - (Cell #21)
1250-1260	As Above

1258	As Above Fossils - (Cell #22)
1260-1270	DOLOMITE, moderate yellowish brown 10 YR 5/4, crystal size < 0.350 mm, sucrosic, honeycombed, high intercrystal porosity, high degree of moldic porosity, friable to moderately hard DOLOMITE, pale yellowish brown 10 YR 6/2, microcrystalline, dense, hard, < 5% moldic porosity.
1270-1280	As Above
1280-1290	As Above
1290-1300	LIMESTONE, very pale orange 10 YR 8/2, very fine grained (< 0.088 mm), low interparticle porosity, chalky, < 2% moldic porosity, moderately hard Fossils - (Cell #23)
1300-1310	LIMESTONE, very pale orange 10 YR 8/2, fine grained 0.177 - 0.250 mm, moderate interparticle porosity, < 5% moldic porosity, soft and friable Fossils - Cell #24
1310-1320	As Above
1320-1330	As Above
1330-1340	As Above
1340-1350	As Above
1350-1360	Coring interval no sample
1360-1370	Coring interval no sample
1370-1380	Coring interval no sample
1380-1390	Coring interval no sample
1390-1400	As Above
1400-1410	As Above
1410-1420	As Above
1410-1420	As Above

1420-1430	As Above
1430-1440	As Above
1440-1450	DOLOMITE, moderate yellowish brown 10 YR 5/4, fine crystalline (< 0.177 mm), very low to moderate intercrystal porosity, sucrosic texture near solution vugs, 10% vuggy porosity, dense and hard to sucrosic and friable in areas of solution activity
1450-1460	As Above
1460-1470	As Above
1470-1480	As Above
1480-1490	As Above
1490-1500	As Above
1500-1510	As Above
1510-1520	As Above
1520-5030	As Above
1530-1540	As Above
1540-1550	DOLOMITE, moderate yellowish brown 10 YR 5/4, microcrystalline, dense, very hard, < 5% moldic porosity
1550-1560	DOLOMITE, moderate yellowish brown, fine crystalline (0.088 - 0.125 mm), sucrosic, honeycombed, 30% vuggy porosity, very hard
1560-1570	As Above
1570-1580	As Above
1580-1590	DOLOMITE LIMESTONE, grayish orange 10 YR 7/4, fine crystalline (0.088 - 0.125 mm), moderate to high intercrystal porosity, < 2% moldic porosity, soft
1590-1600	DOLOMITIC LIMESTONE, grayish orange 10 YR 8/2, granular (0.350 to 0.710 mm), high interparticle porosity, < 2% moldic porosity, soft
	Fossils - (Cell #25)

1600-1610	DOLOMITIC LIMESTONE, moderate yellowish brown 10 YR 5/4, fine crystalline 0.088 - 0.125 mm, sucrosic, high intercrystal porosity, 15-30% vuggy porosity, soft Fossils - (Cell #25)
1610-1620	As Above
1620-1630	DOLOMITE, moderate yellowish brown 10 YR 5/4, fine crystalline (0.088 - 0.125 mm), sucrosic, high intercrystal porosity, 20% vuggy porosity, moderately hard
1630-1640	DOLOMITE, moderate yellowish brown 10 YR 5/4, fine crystalline (< 0.125 mm), moderate intercrystal porosity, dense, hard, 5-20% vuggy porosity.
1640-1650	DOLOMITE, moderate yellowish brown 10 YR 5/4, fine crystalline (< 0.125 mm), high intercrystal porosity, honeycombed, sucrosic, soft and friable
1650-1660	DOLOMITE, moderate yellowish brown 10 YR 5/4, medium crystalline (0.250 - 1.125 mm), sucrosic, high interparticle porosity, 5-25% moldic porosity, hard
1660-1670	As Above
1670-1680	DOLOMITE moderate yellowish brown 10 YR 5/4, medium crystalline (0.250 - 0.125 mm), sucrosic, high interparticle porosity, 5-25% moldic porosity, hard CHERT, light gray N7 to olive gray 5 Y 3/2, microcrystalline, conchoidal fracture, no visible porosity, very hard
1680-1690	As Above
1690-1700	As Above
1700-1710	As Above
1710-1720	As Above
1720-1730	As Above
1730-1740	As Above
1740-1750	As Above

1750-1760	DOLOMITE LIMESTONE, pale yellowish brown 10 YR 6/2, < 0.125 mm dolomite crystals, spar matrix, low interparticle porosity, hard
1760-1770	As Above
1770-1780	As Above
1780-1790	DOLOMITIC LIMESTONE, pale yellowish brown 10 YR 6/2, very fine grained, low interparticle porosity, hard CHERT, moderate brown 5 YR 3/4, microcrystalline, no visible porosity, chonchoidal fracture, very hard
1790-1800	As Above
1800-1810	As Above
1810-1820	As Above
1820-1830	As Above
1830-1840	LIMESTONE, pale yellowish brown 10 YR 6/2, medium grained (0.088 - 0.177 mm), moderate interparticle porosity, friable, soft LIMESTONE, yellowish gray 5 Y 8/1, microcrystalline, very low intercrystal porosity, conchoidal fracture, hard
1840-1850	As Above
1850-1860	GLAUCONITIC LIMESTONE, very pale orange 10 YR 8/2, medium grained (< 0.250 mm), low interparticle porosity, no visible moldic porosity, soft; glauconite crystals, dusky green 5 6 3/2, crystal size 0.125 - 0.177 mm CHERT, dark yellowish brown 10 YR 4/2, microcrystalline very low porosity, hard
1860-1870	As Above
1870-1880	As Above
1880-1890	As Above
1890-1900	As Above

1900-1910	LIMESTONE, grayish orange 10 YR 7/4, granular (benthonic foraminifera 0.710 - 0.350 mm), high interparticle porosity, 25% moldic porosity, soft, friable
1910-1920	Core interval no sample
1920-1930	Core interval no sample
1930-1940	Core interval no sample
1940-1950	GLAUCONITIC LIMESTONE, very pale orange 10 YR 8/2, granular (0.50 mm foraminifera), grains 0.125 mm, high interparticle porosity, minor dolomitization, soft
	SILICEOUS LIMESTONE, dark gray N3, very fine grained (< 0.125 mm) with foraminifera (< 0.50 mm) moderate interparticle porosity, 5% moldic porosity, hard
1950-1960	LIMESTONE, grayish orange, 10 YR 7/4, coarse grained limestone (< 1.00 mm), very high interparticle porosity, spar matrix, friable and soft
1960-1970	As Above
1970-1980	As Above
1980-1990	As Above
1990-2000	LIMESTONE, very pale orange 10 YR 8/2, fine grained (< 0.177 mm), moderate interparticle porosity, soft and friable, weathered cones
	CHERT, greenish gray 56 6/1 to yellowish gray 5 Y 7/2, microcrystalline, no visible porosity hard
2000-2010	As Above
2010-2020	As Above
2020-2030	As Above
2030-2040	As Above
2040-2050	DOLOMITE, pale yellowish brown 10 yr 6/2 to moderate yellowish brown 10 YR 5/4, fine crystalline (0.088 - 0.125 mm to 0.125 - 0.177 mm), sucrosic, very low to very high intercrystal porosity, 5 - 40% moldic porosity, very hard

2050-2060	As Above
2060-2070	DOLOMITE, grayish brown 5 YR 3/2, fine crystalline (0.088 - 0.125 mm), high intercrystal porosity, 5 - 40% moldic porosity, hard
2070-2080	DOLOMITE, pale yellowish brown 10 YR 6/2 to moderate yellowish brown 10 YR 5/4, fine crystalline (0.088 - 0.125 mm) to sucrosic (0.125 - 0.177 mm), very low to very high intercrystal porosity, 5 - 40% moldic porosity, very hard
2080-2090	DOLOMITE, pale yellowish brown 10 YR 6/2, very fine crystalline (0.062 to 0.088 mm), very low intercrystal porosity, < 2% visual porosity, dense, hard
2090-2100	As Above
2100-2110	As Above
2110-2120	As Above
2120-2130	As Above
2130-2140	DOLOMITE, dusky brown 5 YR 2/2, fine crystalline (0.088 to 0.125 mm), low intercrystal porosity, < 2% visual porosity, dense, hard
2140-2150	DOLOMITE, pale brown 5 YR 5/2 to pale yellowish brown 10 YR 6/2, fine crystalline (0.125 to 0.177 mm), low intercrystal porosity, < 2% visual porosity, dense, hard
2150-2160	As Above
2160-2170	As Above
2170-2180	As Above
2180-2190	As Above
2190-2200	DOLOMITE, very pale orange 10 YR 8/2 to pale yellowish brown 10 YR 6/2, microcrystalline, no visual porosity, dense, very hard
2200-2210	As Above
2210-2220	As Above
2220-2230	As Above

2230-2240	As Above
2240-2250	DOLOMITE, pale yellowish brown 10 YR 6/2, microcrystalline, no visual porosity, dense, hard
2250-2260	DOLOMITE, moderate yellowish brown 10 YR 5/4 to medium dark gray N4, microcrystalline, no visible porosity, brecciated appearance, dense, hard
2260-2270	As Above
2270-2280	As Above
2280-2290	As Above
2290-2300	DOLOMITE, pale yellowish brown 10 YR 6/2, microcrystalline, no visual porosity, dense, hard
2300-2310	As Above
2310-2320	As Above
2320-2330	As Above
2330-2340	As Above
2340-2350	DOLOMITE, grayish brown 5 YR 3/2, very fine crystalline (0.062 to 0.088 mm), < 2% visual porosity, dense, hard
2350-2360	DOLOMITE, yellowish gray 5 YR 8/1 to medium gray N5, fine crystalline (0.088 to 0.125 mm), < 2% visual porosity, dense, hard
2360-2370	As Above
2370-2380	DOLOMITE, pale yellowish brown 10 YR 6/2, fine crystalline (0.088 to 0.125 mm), low intercrystal porosity, < 2% visual porosity, dense, hard
2380-2390	As Above
2390-2400	As Above

Core No. 1 1396'-1386'	FORAMINIFERAL LIMESTONE, grayish orange 10 YR 7/4, coarse grained < 0.50 mm, high interparticle porosity, 10% moldic porosity, moderately hard
Core No. 2 1396'-1406'	FORAMINIFERAL LIMESTONE, very pale orange 10 YR 8/2, coarse grained < 0.50 mm, moderate interparticle porosity, 10% moldic porosity moderately hard
Core No. 3 1572'-1575'	LIMESTONE, very pale orange, medium grained 250 to 350 mm, low interparticle porosity, spar matrix, < 5% moldic porosity, moderately hard
Core No. 4 1701'-1705 1/2	DOLOMITE, moderate yellowish brown 10 YR 5/4, fine crystalline 0.177 - 0.250 mm, moderate intercrystal porosity, 20% moldic porosity
Core No. 5 1880-1890 1/2	GLAUCONITIC LIMESTONE, very pale orange 10 YR 8/2, very fine grained < 0.125 mm, low interparticle porosity, no visual porosity, dense, hard, green glauconite crystals 0.177 to 0.250 mm
Core No. 6 1917 1/2-1920' 1/2	LIMESTONE, pale yellowish brown 10 YR 6/2, fine grained 0.125 to 0.177 mm, low interparticle porosity, < 5% moldic porosity, moderately hard
Core No. 7 1928-1933	FORAMINIFERAL LIMESTONE, grayish orange 10 YR 7/4, coarse grained, < 0.50 mm, high interparticle porosity, 10% moldic porosity, moderately hard
Core No. 8 1958-1963	GLAUCONITIC LIMESTONE, grayish orange 10 YR 7/4 to yellowish gray 5 YR 8/1, medium grained 0.250 to 0.350 mm, low interparticle porosity, 10% moldic porosity, interbedded with siliceous limestone (very pale orange 10 YR 8/2)
Core No. 9 1968-1973	LIMESTONE, very pale orange 10 YR 8/2, fine grained 0.125 - 0.177 mm, low interparticle porosity, < 5% moldic porosity, chalky, dense, moderately hard

CEMENT BOND LOG
AND
FINAL TEMPERATURE LOG

Catalog **Underground Injection Control**
Profile **Permitting_Authorization**
County **BREVARD**
District **CD**
Facility-Site ID **16640 - WEST MELBOURNE, WWTP, CITY OF**
Document Date **10-01-1986**
Received Date **11-01-1986**
Document Type **ENGINEERING REPORTS**
Contractor ID
PSD Number
Permit Type **CONSTRUCTION**
Facility Type **CLASS I**
Application Number
Permit Number

Document Subject ***CB or Temp* Log IW-1 *Log Date* Interim *Eng* Rpt Oct 1986**

MONITORING DATA
MONTHLY REPORT FORM

Sample Form 1
WEST MELBOURNE WASTEWATER TREATMENT PLANT
Deep Injection and Annular Monitoring Tube System
West Melbourne, Florida

MONITORING DATA MONTHLY REPORT
Month ____________, 19___
Compiled By ____________

Day of Month	Plant Effluent		Injection Well							Monitoring Tubes		Injected Effluent		Collected By	Remarks
	Average Flow from Totalizer (mgd)	Peak Flow (mgd)	Totalizer Reading (mgd)	Total Flow (mgd)	1 Pump Minmium Flow (gpm)	Maximum Flow (gpm)	One-Pump Minimum Operating Pressure (psig)	Maximum Operating Pressure (psig)	Average Pressure (psig)	Upper Zone Head (ft msl)[a]	Lower Zone Head (ft msl)[a]	Suspended Solids (mg/l)	Specific Conductance (µmhos/cm)		
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
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27															
28															
29															
30															
31															
TOTAL															
MAXIMUM															
MINIMUM															
AVERAGE															

SPECIFIC INJECTIVITY TEST Date ________ 19 ______ By ____________

Injection Rate (gpm)	Total Pressure (psig)	-	Shut-In Pressure (psig)	=	Specific Pressure (psig)	Specific Injectivity Index (gpm/Specific Pressure psig)
860	____________	-	____________	=	____________	____________gpm/psig

[a] Upper Zone: Chart Reading + ____ = ft msl
Lower Zone: Chart Reading + ____ = ft msl