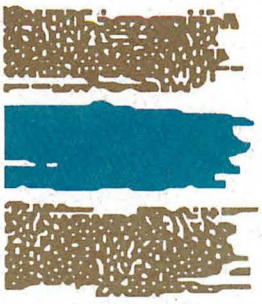
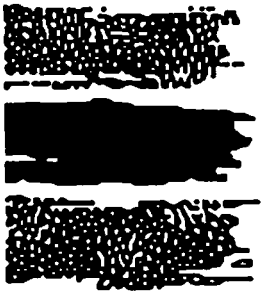


EDWARDS UNDERGROUND
WATER DISTRICT

Report 93-11

South Medina County Observation Well Project



EDWARDS UNDERGROUND
WATER DISTRICT

South Medina County
Observation Well
Project

Prepared by:

Field Operations Division
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SOUTH MEDINA COUNTY OBSERVATION WELL PROJECT

INTRODUCTION

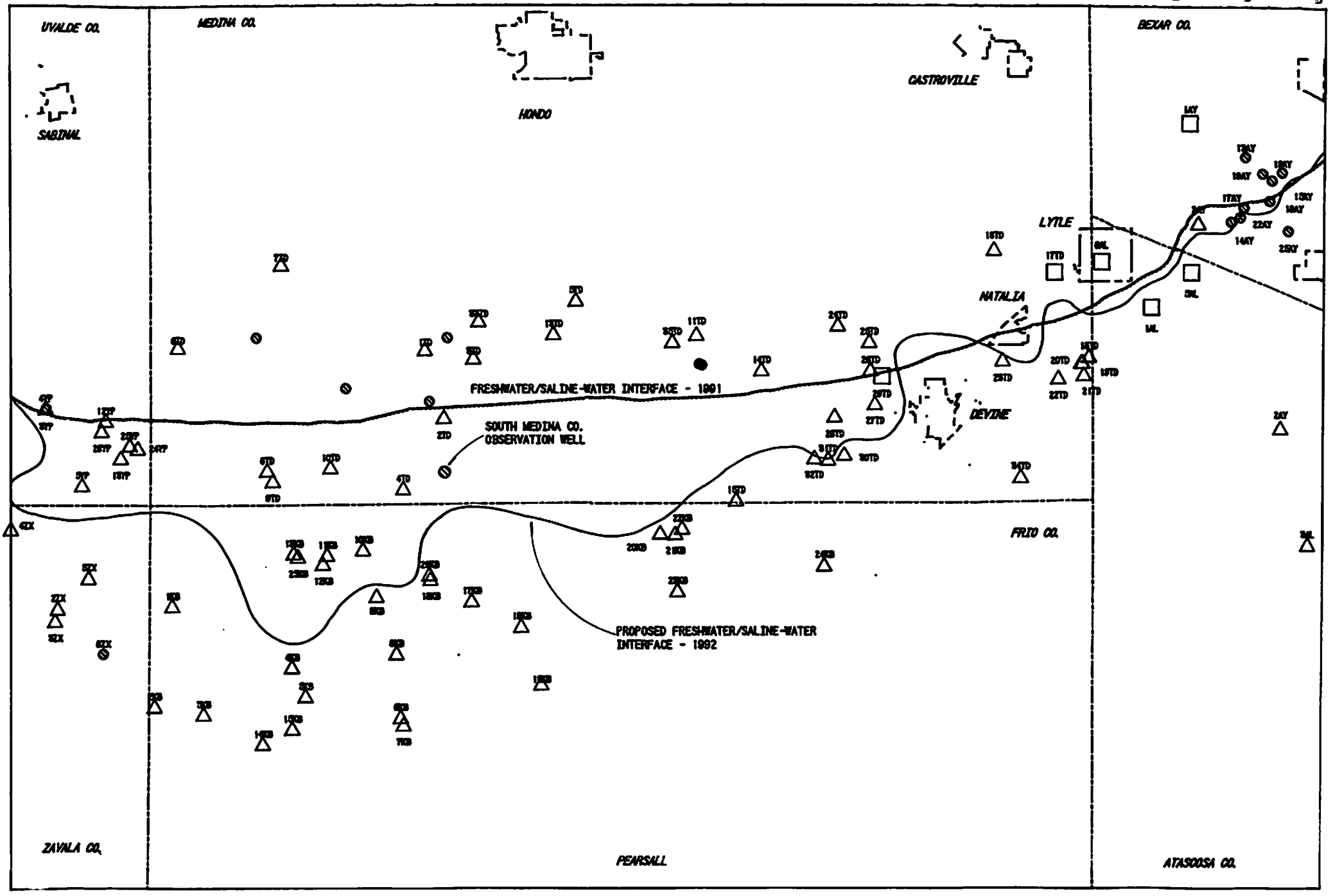
In 1992, the Board of Directors of the Edwards Underground Water District released Report No. 92-03, written by Mr. Alvin L. Schultz. The report summarizes the results of a study designed to better define the freshwater/saline-water interface between San Antonio and Uvalde, Texas. Mr. Schultz utilized the evaluation of water quality data calculated from geophysical logs in order to determine that the freshwater/saline-water interface in this area is actually located further south than previously mapped. Based on the results of the study, a location was chosen to evaluate Mr. Schultz's conclusions by drilling and testing an Edwards aquifer observation well in an area where the current and proposed interfaces were several miles apart. The well location was also chosen in an area with good geophysical log control, but with very little measured water quality data available.

The referenced observation well location is in southwest Medina County (Figure 1), approximately four and one-half miles southwest of Yancey, Texas. The well is located approximately three miles south of the currently mapped interface.

DRILLING OPERATIONS

Driller's Inc., contractor for the project, began drilling operations on July 11, 1993. The drillsite was cleared and leveled, and the drilling rig was moved in and rigged up. The well was spudded on July 17, 1993. District staff analyzed drill cuttings throughout the drilling operation to evaluate changes in lithology and to determine the correct depth for setting and cementing casing in the top of the Cretaceous Georgetown formation, just above the Edwards aquifer porosity. In addition, geophysical logs were run at casing point and again at total depth to provide additional data for evaluation of the geologic and hydrologic properties of the aquifer at this location. Formation tops encountered in the well are listed in Table 1.

Analysis of drill cuttings and geophysical logs indicate that the top of the Georgetown formation was encountered at approximately 2600 feet below land surface. Samples and drilling rate change indicate that porosity in the Edwards section was first encountered 2677 feet below land surface. Drill cuttings were collected and analyzed approximately every 30 feet from land surface down to the top of the Georgetown, and every 10 feet from that point to total depth of 3410 feet. The well reached total depth on August 14, 1993. Flow tests were conducted at ten intervals in the Edwards aquifer to evaluate flow rate and water quality. In addition, two packer tests were conducted to test specific intervals in the aquifer. Water samples from each of the flow and packer tests were sent to a local lab for analysis.



LEGEND

WELLS WITH MEASURED WATER SAMPLE

ABANDONED OIL AND GAS EXPLOATORY WELLS WITH GEOPHYSCIAL LOGS.

0 5 10

SCALE IN MILES

FIGURE 1
LOCATION MAP

TABLE 1

SOUTH MEDINA COUNTY OBSERVATION WELL

FORMATION TOPS - DEPTH FROM KELLY BUSHING & (SUBSEA ELEVATION)

	Cuttings	Logs
Anacacho	1746(-1073)	1750(-1077)
Austin	2050(-1377)	2046(-1373)
Eagleford	2360(-1687)	2364(-1691)
Buda	2453(-1780)	2444(-1771)
Del Rio	2516(-1843)	2530(-1857)
Georgetown	2605(-1932)	2611(-1938)
Edwards Porosity	2670(-1997)	2688(-2015)
Glen Rose	3401(-2728)	3404(-2731)

Drill Cuttings Evaluation

Analysis of drill cuttings from the well indicate that the Edwards section is predominantly light colored, clean limestone and granular dolomitic limestone. This is indicative of an area through which fresh water in the aquifer has circulated, developing secondary porosity through chemical reaction with the dolomites and limestones of the Edwards group. Drilling penetration rates also show the porous nature of the section encountered at this location. Most of the Edwards section was drilled at a rate of less than one minute per foot, with very few intervals of slow penetration. Very few marker beds were noted in the drill cuttings analysis. A possible correlative zone to the Regional Dense member was encountered between 2987' and 3004'. Below this interval, cuttings began to show increasing amounts of calcite, both as vein fillings and free crystals. This suggests the presence of vugular porosity as well as healed fractures and open jointing in the Edwards section. The bottom 100 feet of the section was primarily dense, microcrystalline limestone, with six to twelve percent porosity indicated by geophysical logs.

A drilling break and porous zone seen on geophysical logs from 3404 to 3408 feet correlate to the top of the Glen Rose formation, as seen in oil and gas well logs utilized in Mr. Schultz's 1992 study (personal communication, 1993). Based on this data, the decision was made to complete the well at a total depth of 3410 feet, as seen in geophysical logs.

Geophysical Log Evaluation

Calculated water quality data from geophysical logs in the Edwards aquifer section of the well is comparable to values seen in the fresh water portion of the aquifer. Formation temperatures varied from 110 degrees F. at 2690 feet to over 120 degrees measured at total depth.

Log porosity values in the Edwards porous zones vary from 20 to 30 percent, with resistivities in these zones varying from 724 to 450 ohm-meters. Utilizing the methodology described in Reports 92-03 and 93-06 (Table 2), calculated values for conductivity in the Edwards porous zones range from 724 uS/cm in the upper zone (2690 - 2808 feet) to 503 uS/cm at 3291 feet (calculations and results sheet from Mr. Schultz, 1993). Total dissolved solids (TDS) values in this portion of the aquifer generally calculate to be approximately 70% of the value for specific conductance (Ct). The values calculated for the project well range from 352 to 507 mg/L based on this percentage. Based on the generally accepted value of 1000 mg/L representing the upper limit of fresh water, the calculated data from the well falls well into the fresh water range (Table 3).

Hydrologic Test

Ten packer tests were conducted during drilling operations in the Edwards aquifer porous section. Data from these tests, which consisted of a flow period of at least two

TABLE 2

METHODOLOGY

C_a = Specific Conductance in μS/cm from geophysical logs

$C_a = 10000/R_{wa}$

$R_{wa} = R_t/F = \emptyset^2 R_t$

where: $F = 1/\emptyset^2$

$\emptyset$ - from porosity sensitive logs such as Sonic, Density, Neutron, or a combination

R_{wa} - converted to 77 deg F from formation temperature

TABLE 3 - South Medina County Observation Well No. 1
Geophysical Log Analysis

Well 37-TD	Op fr	Op to	Dt	Por S	Por N	Por D	Por C	Rt	Rwa	FMT	Ca	Ca-ft		Ca	Flow Test	Ct	Packer Test	Ct	Ca
	2690	2700	74	0.22	0.26	0.18	0.22	200	9.68	110	739	7395	from 2690						
	2705	2744	84	0.31	0.30	0.21	0.26	150	9.75	111	732	28567							
	2800	2808	82	0.29	0.27	0.28	0.28	140	10.59	112	667	5334	to 2808	724	#1	796			
	2822	2834	65	0.15	0.21	0.18	0.20	325	12.36	112	570	6835							
	2850	2865	67	0.17	0.22	0.18	0.20	360	13.00	113	540	8094							
	2876	2892	70	0.19	0.25	0.17	0.21	240	15.88	113	440	7046							
	2910	2924	70	0.19	0.27	0.20	0.24	250	13.25	114	525	7354	to 2924	620	#2	575			
	2962	2984	77	0.25	0.32	0.22	0.27	250	18.23	114	380	8350	to 2984	581	#3	515			
	3006	3020	79	0.26	0.30	0.18	0.24	180	14.40	115	478	6689							
	3020	3040	82	0.29	0.32	0.21	0.27	180	12.64	115	543	10867	to 3040	568	#4	527			
	3050	3072	83	0.30	0.36	0.24	0.30	210	18.90	116	362	7966					from 3040		
	3072	3092	77	0.25	0.33	0.18	0.26	205	13.33	116	512	10240	to 3092	541	#5	539			
	3104	3120	79	0.26	0.32	0.21	0.27	205	14.40	117	472	7556							
	3120	3150	70	0.19	0.28	0.16	0.22	280	13.55	117	501	15020							
	3150	3168	75	0.23	0.30	0.19	0.25	280	16.81	117	402	7240	to 3168	524	#6	559			
	3168	3176	76	0.24	0.30	0.19	0.25	300	18.01	118	375	2997							
	3176	3200	66	0.16	0.24	0.15	0.20	400	15.21	118	443	10634							
	3200	3220	64	0.14	0.22	0.15	0.19	450	15.40	118	436	8727	to 3220	509	#7		to 3231	453	445
	3250	3268	72	0.21	0.27	0.20	0.24	280	15.46	119	432	7776					from 3232		
	3282	3291	77	0.25	0.27	0.18	0.23	300	15.19	119	438	3943	to 3291	503	#8	448			
	3291	3298	83	0.30	0.30	0.23	0.27	275	19.31	119	344	2409							
	3298	3308	64	0.21	0.21	0.14	0.18	400	12.25	119	542	5422					to 3406	447	444
	3323	3327	70	0.15	0.15	0.15	0.15	220	4.95	120	1338	5351	to 3327	510	#9	477	Por. <.18-low perm.		
	3404	3410	73	0.18	0.18	0.18	0.18	25	0.81	121	8098						Glen Rose Fm.-low perm.		

hours followed by a shut-in period to measure hydrostatic pressure in the well is shown in Table 4. Flow rate was measured by determining the amount of time necessary to fill a container of known capacity. Flow rates increased with each test, from an initial flow rate of 13 gal/min in the upper 140 feet of porous Edwards limestone tested, to a rate of almost 300 gal/min during the last flow test, at a depth of 3410 feet. Water temperature measured at the surface during this last flow test was approximately 113 degrees F. Hydrostatic pressure at the end of the last flow test was measured at 51 psi, indicating a calculated hydrostatic head of approximately 123 feet above ground level, based on shut-in pressure readings at the surface.

Two packer tests were conducted to isolate zones in the aquifer for hydrologic testing. A packer assembly was installed in the drill string to seal off a portion of the Edwards section for flow and water quality testing. Flow rate was measured through drill pipe for the section below the packers, while flow from the section above the packers was measured from the annulus. Water quality samples were obtained from both upper and lower zones for lab analysis. The first packer test was run with the lower packer set at 3042 feet. The lower zone tested was from 3042 to 3231 feet. The second packer test was conducted after the well reached total depth and drill cuttings, drill time data, and geophysical logs had been analyzed for zones of interest. The second test was conducted with the lower packer set at 3230 feet, to evaluate the zone from 3230 to 3410 feet. This zone appeared to have low porosity and permeability, as seen in cuttings, flow tests, and geophysical logs. Since the zone includes the transitional change from the Edwards to Glen Rose, it was determined that if a sudden deterioration in water quality was encountered in this section, that the well would be plugged back to the last fresh water zone in the Edwards section. Water samples from the lower section (3230 to 3410 feet) and the upper section (2623 to 3230 feet) evaluated in the final packer test were sent for water quality analysis.

Water Quality Analyses

Results of the water quality analyses indicate that every sample obtained during the flow and packer tests was found to contain total dissolved solids well below 1000 mg/L. Conductivity values measured in the various samples correlated well with the calculated values from geophysical logs. The lowermost zone tested in the final packer test had measured conductivity of 447 uS/cm indicating that water quality in the bottom of the well was still good. As seen Table 4, only sulfate concentrations were found to be slightly above EPA secondary maximum contaminant levels (MCL's).

Additional samples from the two packer tests were analyzed for metals. Results of those analyses (Table 5) conducted by San Antonio Testing Labs, indicate that all metals concentrations were below detectable limits except for chromium. Levels of chromium were found to be 0.010 and

TABLE 4 - Water Quality Analyses

SAMPLE NO.	DATE	DEPTH (FT)	pH (STD UNITS)	COND. (uS/cm)	FLOURIDE (mg/L)	CHLORIDES (mg/L)	SULFATE (mg/L)	TOTAL DISS. SOLIDS (mg/L)	TOT. ALK. (mg/L)	TEMP (°C)	EST. FLOW RATE (GPM)	SHUT-IN PRESS (PSI)
1	7/26	2822	7.75	796	<.1	74.8	181	466.5	266	39	13.6	40.5
2	7/26	2932	7.67	575	<.1	55.8	28.4	311.8	250	--	40	--
3	7/26	2978	7.66	515	<.1	55.8	42.8	313.2	286	43	40	42
4	7/26	3043	7.61	527	<.1	41.5	166	367.8	237	43	75	43
5	7/27	3104	7.51	539		16.7	262		221	43.5	100	47
6	7/27	3168	7.49	559	<.1	10.9	324	410.2	207	43.5	100	47
7	7/27	3231	7.29	481	<.1	12.8	300	359.2	207	43.5	220-260	48.5
	7/30	3231	7.59	511	3.77	41.4	14.9	356	256	43.5	220-260	48.5
	8/1	3231	7.60	492	3.29	37.1	7.14	382.8	247	43.5	220-260	48.5
	8/4	3231	7.50	486	.13	18.5	65.6	366.7	221	43.5	220-260	48.5
	8/6	3231	7.53	543	.48	36.6	50.9	389.3	252	43.5	220-260	48.5
8	8/6	3291	7.54	448	<.1	14.1	72.3	363	203	44.5	286	45.5
9		3356	8.18	477	<.1	19.0	68.3	349	276	45	280	46
10		3410	7.53	473	<.1	16.6	79.9	351	210	44	290	N/A
PKR1-U		2673-3042	7.11	417	<.1	17.0	68.3	226	165	40	97.1	51
PKR1-L		3042-3231	7.72	453	<.1	12.8	82.1	340	200	40	33.0	45.5
PKR2-U		2623-3230	7.72	474	<.1	16.5	85.3	374	212	44	225*	51
PKR2-L		3230-3410	7.57	447	<.1	17.1	63.3	298	204	42	33.7	47.25
FF		3410	7.52	462	<.1	16.8	78.2	354	206	44	300	51

* Flow Rate With 18 PSI Discharge Pressure

TABLE 5 - METALS ANALYSES

SAMPLE ID: Packer Test #1

PARAMETER		RESULTS (mg/L)	MDL (mg/L)	REFERENCE (Method No.)	DATE ANALYZED
Arsenic	(As)	<0.005	0.005	206.2	08-24-93
Barium	(Ba)	<0.1	0.1	208.1	08-20-93
Cadmium	(Cd)	<0.005	0.005	213.1	08-20-93
Chrome	(Cr)	0.025	0.005	218.1	08-20-93
Lead	(Pb)	<0.002	0.002	239.1	08-19-93
Mercury	(Hg)	<0.002	0.002	245.1	08-24-93
Selenium	(Se)	<0.005	0.005	270.2	08-23-93
Silver	(Ag)	<0.005	0.005	272.1	08-20-93

SAMPLE ID: Packer Test #2

PARAMETER		RESULTS (mg/L)	MDL (mg/L)	REFERENCE (Method No.)	DATE ANALYZED
Arsenic	(As)	<0.005	0.005	206.2	08-24-93
Barium	(Ba)	<0.1	0.1	208.1	08-20-93
Cadmium	(Cd)	<0.005	0.005	213.1	08-20-93
Chrome	(Cr)	0.01	0.005	218.1	08-20-93
Lead	(Pb)	<0.002	0.002	239.1	08-19-93
Mercury	(Hg)	<0.002	0.002	245.1	08-25-93
Selenium	(Se)	<0.005	0.005	270.2	08-23-93
Silver	(Ag)	<0.005	0.005	272.1	08-20-93

M.D.L.: Method Detection Limit

mg/L: Milligrams per Liter

Test Methods: Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020, Rev. March 1993
Standard Methods for the Examination of Water and Wastewater, 17th Ed. 1989

0.025 ug/L, which is still well below the EPA's current MCL of 0.05 ug/L. The EPA has recently proposed to raise the MCL on chromium to 0.10 ug/L. The samples were collected at the surface through the packer test equipment, and may represent contamination inside the drill pipe or the packer test equipment.

Conclusions

The South Medina County well encountered fresh water, as defined by measured total dissolved solids, throughout the Edwards aquifer section to total depth of the well. Analyses of the water samples obtained from different depths indicate fairly uniform quality, with the highest TDS values occurring in the uppermost zone tested. This suggests that any wells drilled in this area should drill at least 200-250 feet of Edwards porosity to obtain good quality water. Sulfate concentration in the water can be lowered by aeration. Significance of detectable chromium found in the well will need to be further evaluated.

The South Medina County Observation Well is completed with the entire Edwards aquifer section open for future monitoring and testing. A pressure transducer is being installed to monitor hydrostatic pressure changes in the aquifer at this location. Future testing should include a pumping test conducted at a pumping rate far in excess of 300 gal/min in order to produce measurable drawdown and subsequent recovery. Water quality samples should be obtained on a quarterly to semi-annual basis to evaluate changes in quality as aquifer levels fluctuate. If water quality changes are noted, discrete intervals should be sampled in the well.

The final conclusion of this project is that the freshwater/saline-water interface in this portion of the Edwards aquifer is located to the south of the South Medina County Observation Well. Refinement of the calculated data from Report 92-03, utilizing measured versus calculated data from this project, should better define the interface in western Medina and Frio counties. The data and conclusions will also be forwarded to the Texas Natural Resources Conservation Commission with the recommendation that the position of the freshwater/saline-water interface should be re-evaluated in light of the new data made available by this project.