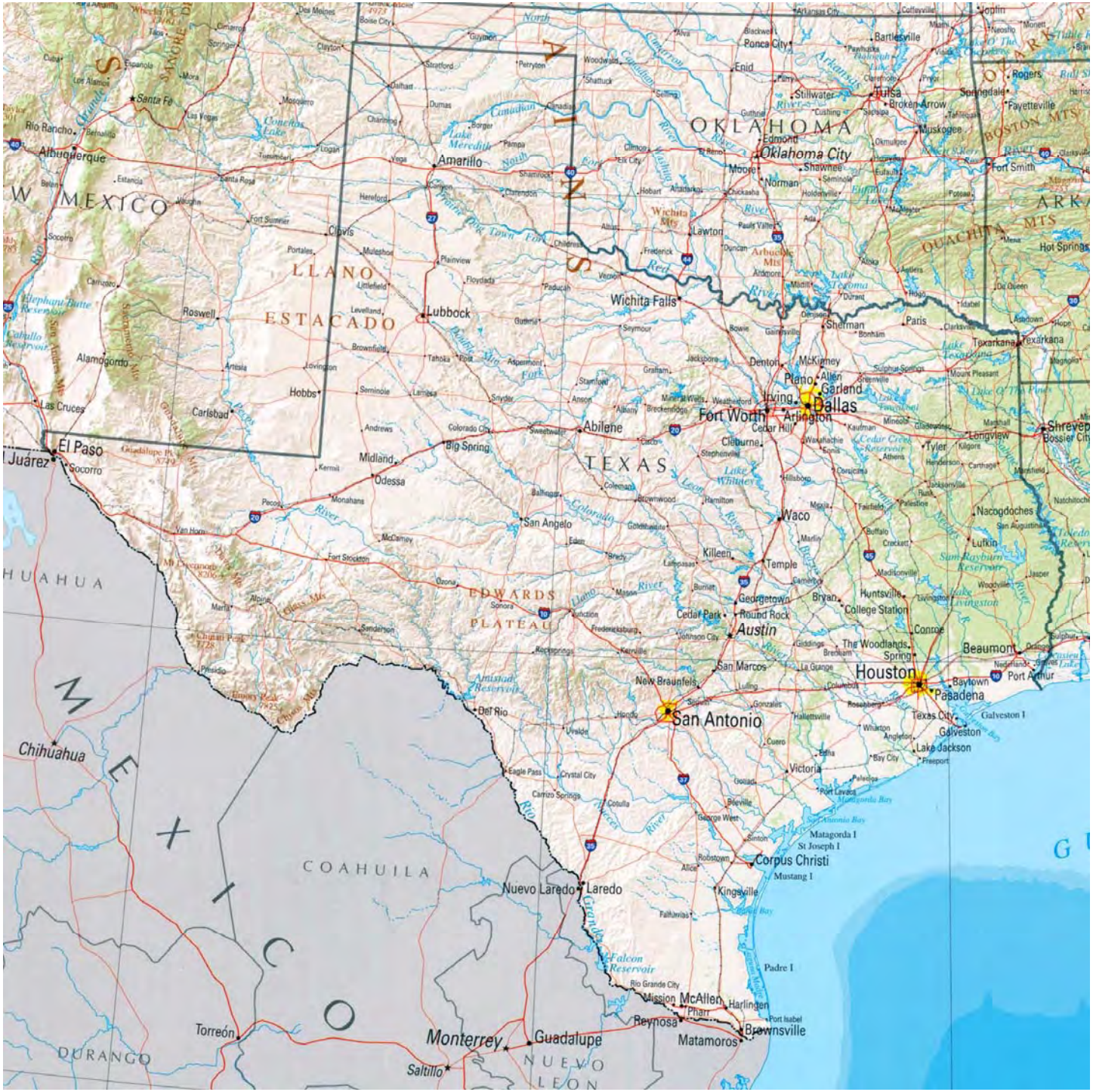
A Cursory Review of the Pressure Effects

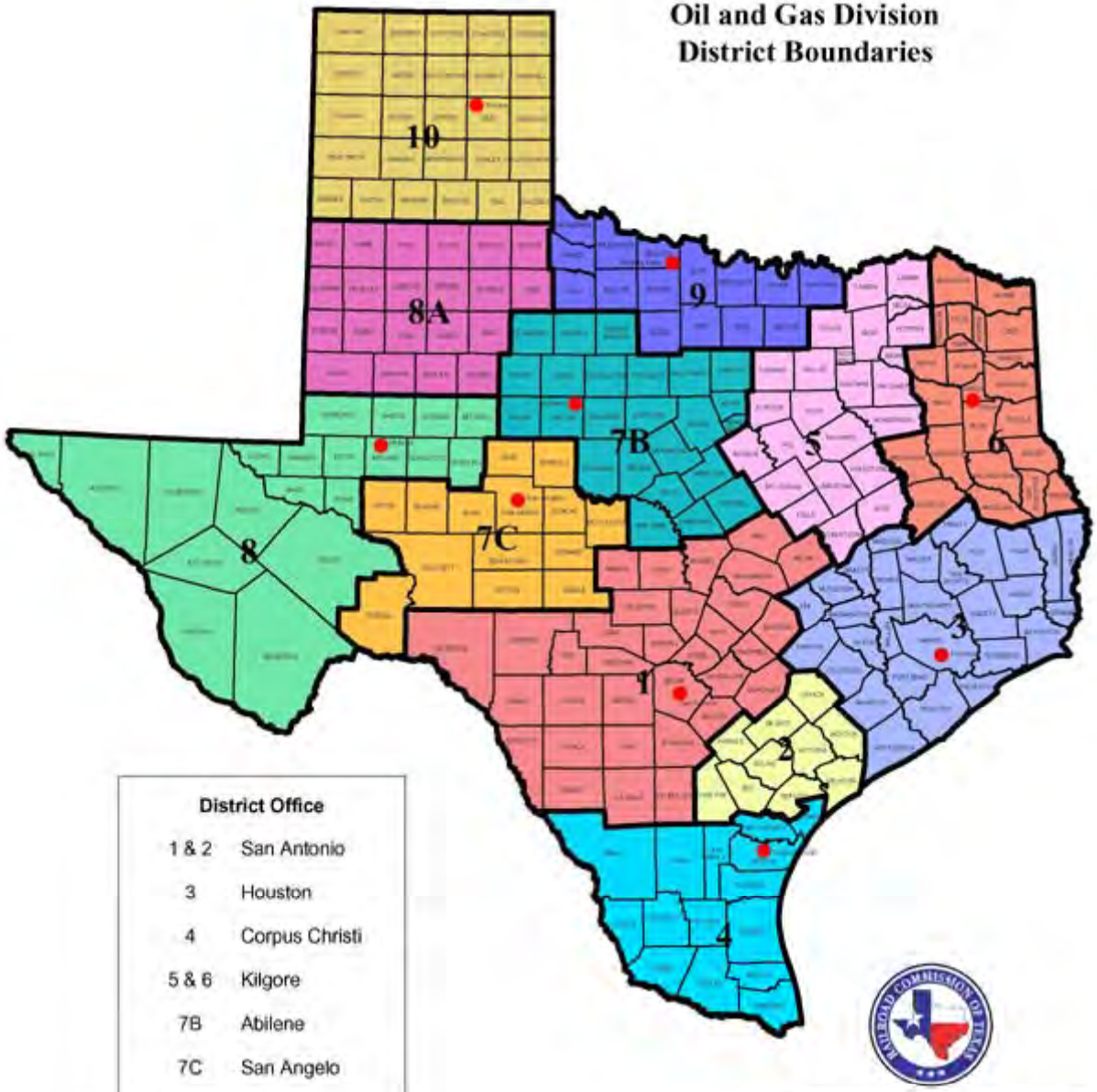
Induced by Ground Water Production

From the Goliad Aquifer

At the City of Victoria’s Public Water Supply System


OKLAHOMA
TEXAS
NEW MEXICO
LLANO ESTACADO
EDWARDS PLATEAU
COAHUILA
NUEVO LEON
DURANGO
Oklahoma City
Tulsa
Amarillo
Lubbock
Wichita Falls
Abilene
Fort Worth
Dallas
Arlington
Austin
San Antonio
Houston
Pasadena
Beaumont
Corpus Christi
Laredo
Nuevo Laredo
Monterrey
Saltillo
Chihuahua
Torreón
Guadalupe
Brownsville
McAllen
Waco
Temple
Killeen
Midland
Odessa
El Paso
Juárez
Albuquerque
Santa Fe
Roswell
Clovis
Hobbs
Carlsbad
Alamogordo
Las Cruces
Del Rio
Victoria
Texarkana
Shreveport
Tyler
Longview
Nacogdoches
Lufkin
Sherman
Denton
Plano
Garland
Irving
Bryan
College Station
Huntsville
Conroe
The Woodlands
Galveston
Lake Jackson
Port Arthur
Baytown
Texas City
Kingsville
Harlingen
Reynosa
Matamoros
Mission
Pharr
Port Isabel
Padre I
Mustang I
Matagorda I
St Joseph I
Galveston I
Falcon Reservoir
Amistad Reservoir
Lake Meredith
Lake Texoma
Lake Whitney
Sam Rayburn Reservoir
Lake Livingston
Cedar Creek Reservoir
Toledo Bend Reservoir
Elephant Butte Reservoir
Caballo Reservoir
Conchas Lake
Wichita Mts
Arbuckle Mts
Ouachita Mts
Boston Mts
Guadalupe Pk 8749
Chisos Mts
Davis Mts
Glass Mts
Sacramento Mts
Sangre de Cristo Mts
Rio Grande
Pecos River
Canadian River
Red River
Brazos River
Colorado River
Trinity River
Neches River
Sabine River
Nueces River
Arkansas River
Cimarron River
Gulf of Mexico

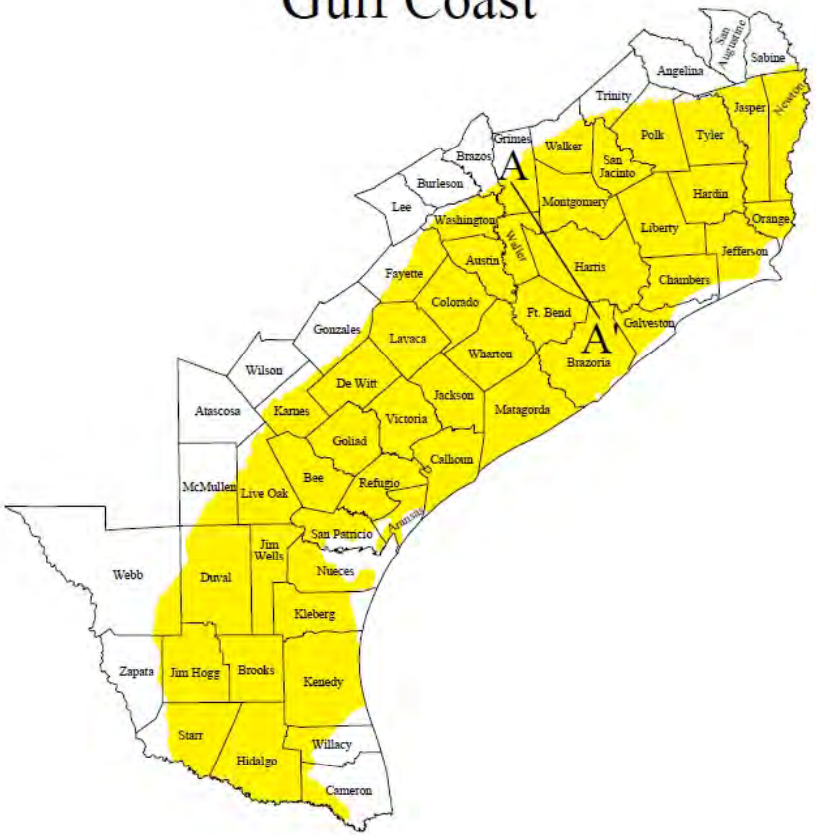
Oil and Gas Division District Boundaries

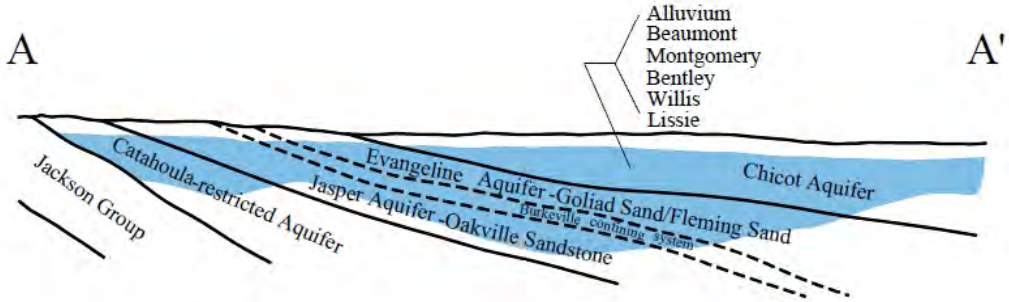


District Office	
1 & 2	San Antonio
3	Houston
4	Corpus Christi
5 & 6	Kilgore
7B	Abilene
7C	San Angelo
8 & 8A	Midland
9	Wichita Falls
10	Pampa

RAILROAD COMMISSION of TEXAS
Oil and Gas Division

Gulf Coast

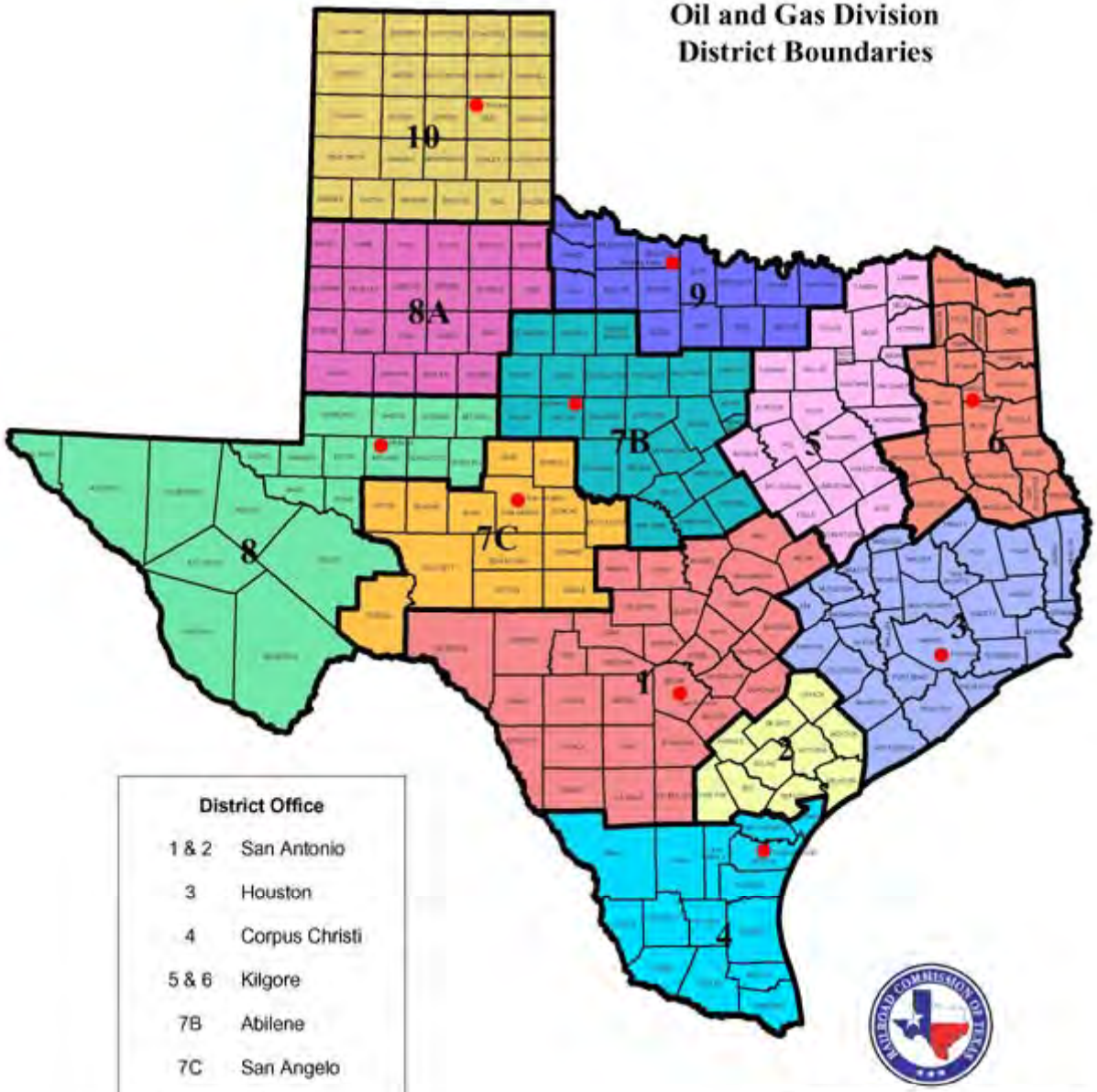




Modified from Baker, 1979

Tilden
Three Rivers
Simmons
MCMULLEN
George West
Beeville
Cadiz
Orangedale
BEE
Blanconia
Ryanville
Vidauri
REFUGIO
Humble Camp
Chase Field N.A.S.
Clareville
Refugio
Woodsboro
Dinero
Olmos
Skidmore
Papalote
Holiday Beach
Copano Vil.
Lamar
Fulton Mansion
Fulton
Rockport
Palm Harbor
Estes
Millsville
Aransas Pass
FREE FERRY
Port Aransas
Ingleside
Corpus Christi
Corpus Christi N.A.S.
Corpus Christi St. Univ.
Mustang Island S.P.
Chapman Ranch
Petronila
NUECES
Bonnie View
Bayside
St. Paul
Argenta
Tynan
Mt. Lucas
Lake Corpus Christi
Lagarto
LIVE OAK
Clegg
Mathis
Sinton
W. Sinton
SAN PATRICIO
Sodville
Taft
Odem
Gregory
Portland
Edroy
San Patricio
Calallen
Rabb
Violet
Bluntzer
Banquete
Robstown
San Juan
Driscoll
Palo Alto
Bishop
Kings Ranch
Kingsville N.A.S.
Kingsville
El. 66 ft.
Texas A&I Univ.
King Ranch
Ricardo
KLEBERG
Loyola Beach
Riviera Beach
Riviera
Sarita
Los Olmos
Laguna Salado
KENEDY
Laguna Madre
Laguna Largo
Cayo Del Grullo
Baffin Bay
Griffins Pt.
PADRE ISLAND NATIONAL SEASHORE
Loma Alta
Annarose
Pernitas Pt.
Wesley Seale Dam
Lake Corpus Christi S.
Seven Sisters
Rancho de la Parita
Midway
Wade
Sandia
Orange Grove
Alfred
Lipantitlan St. Hist. Site
DUVAL
JIM WELLS
Freer
Rosita
San Diego
Alice
Agua Dulce
Rancho Alegre
Ben Bolt
Palito Blanco
Guajillo
Benavides
San Jose
Realitos
Concepcion
Cruz Calle
Rios
Ramirez
Sejita
Premont
Falfurrias
Nueces Bay
Aransas Bay
Corpus Christi Bay
Mission Bay
Copano Bay
Aransas Pass
ARANSAS N.W.R.
Goose Island S.P.
SAN

Oil and Gas Division District Boundaries



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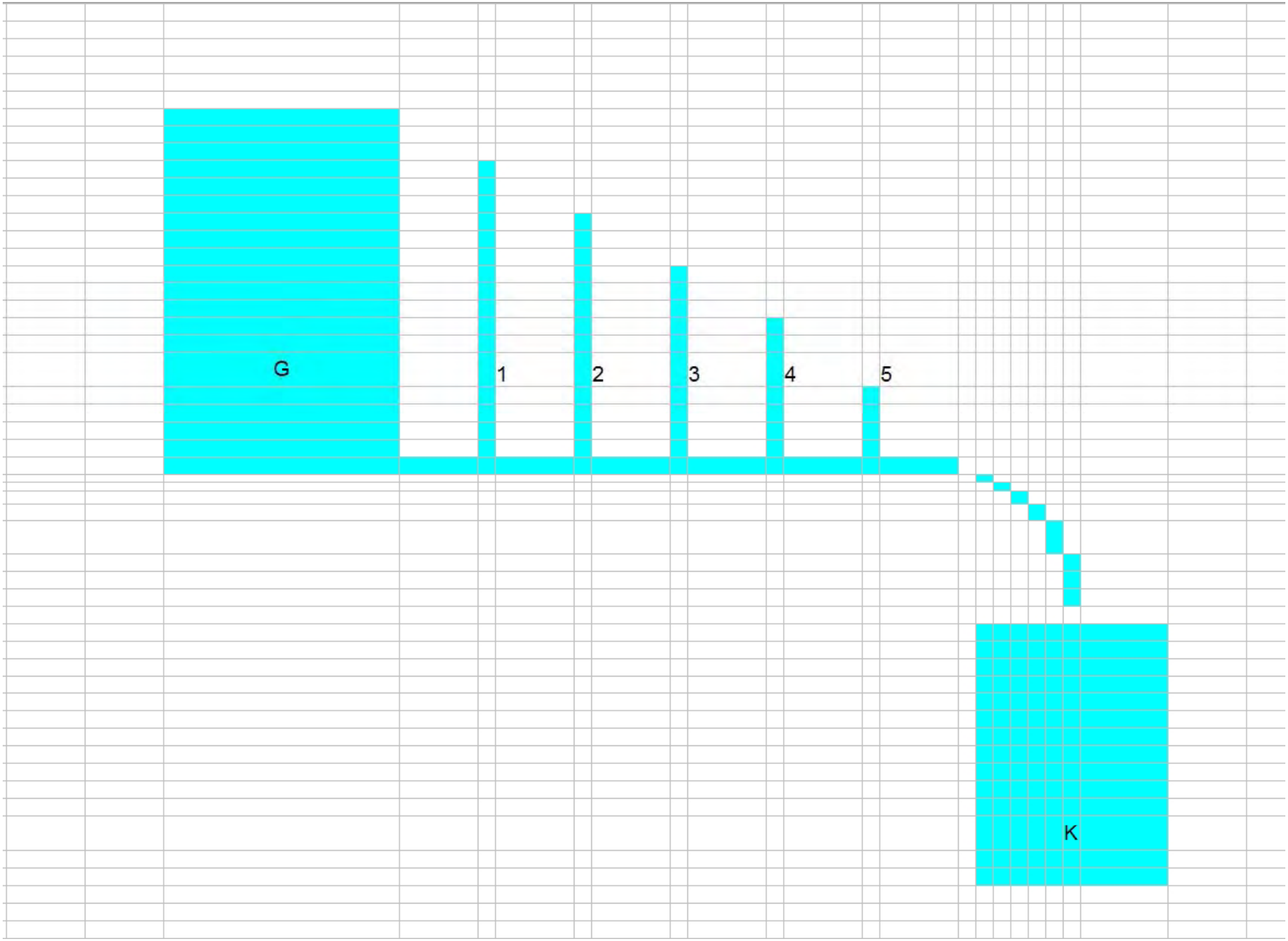
RAILROAD COMMISSION of TEXAS
Oil and Gas Division


G
1
2
3
4
5
K

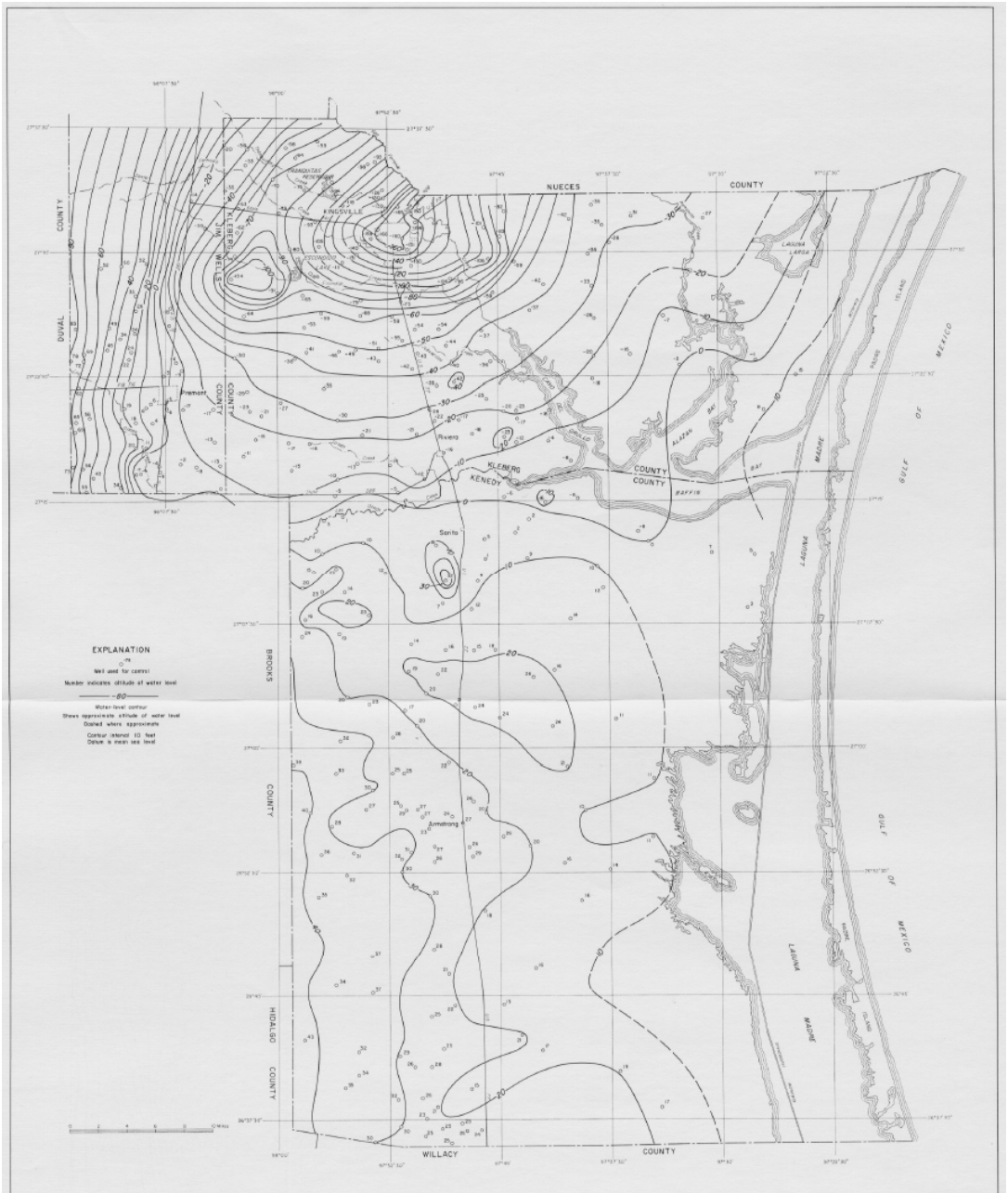
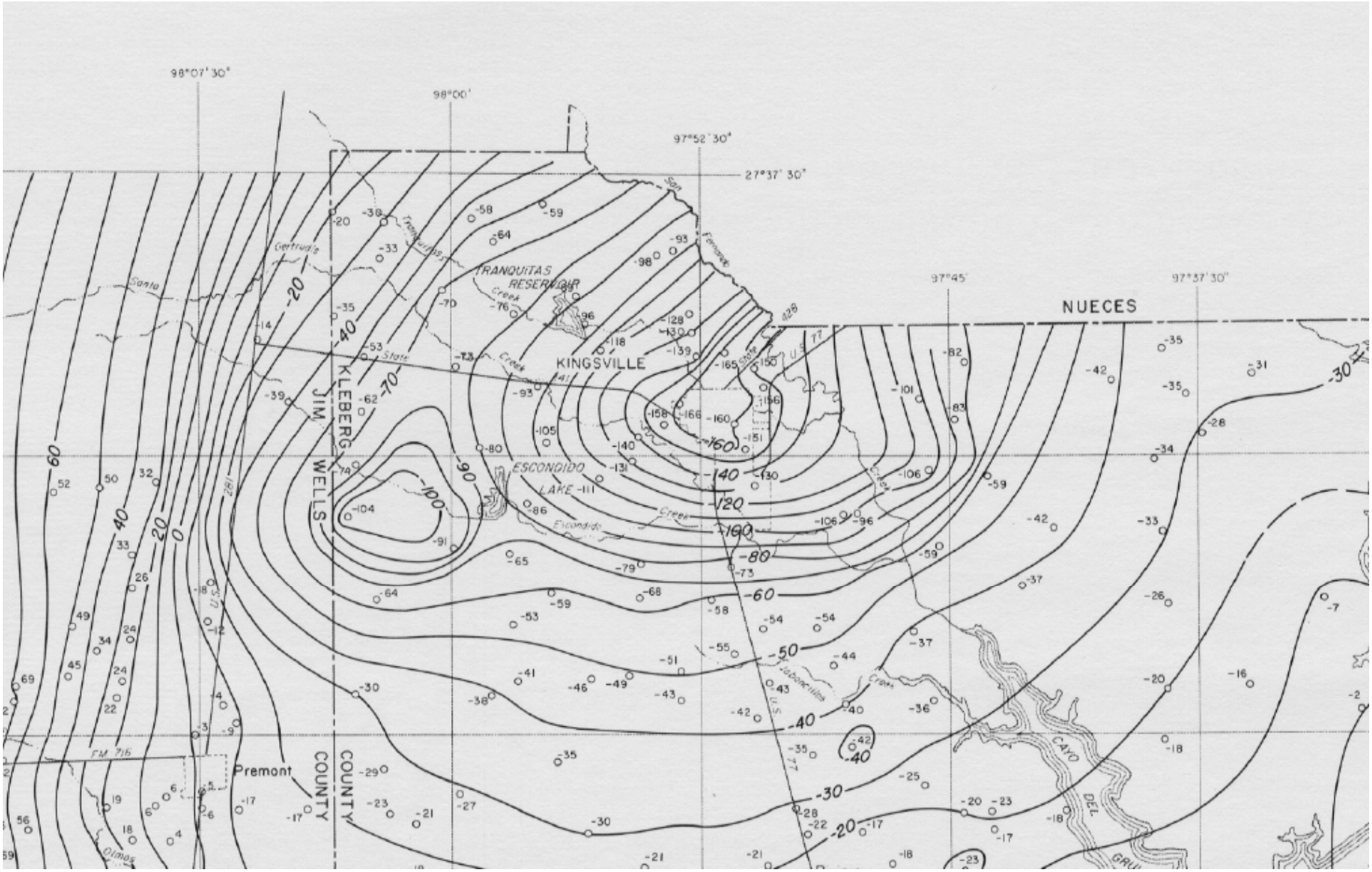
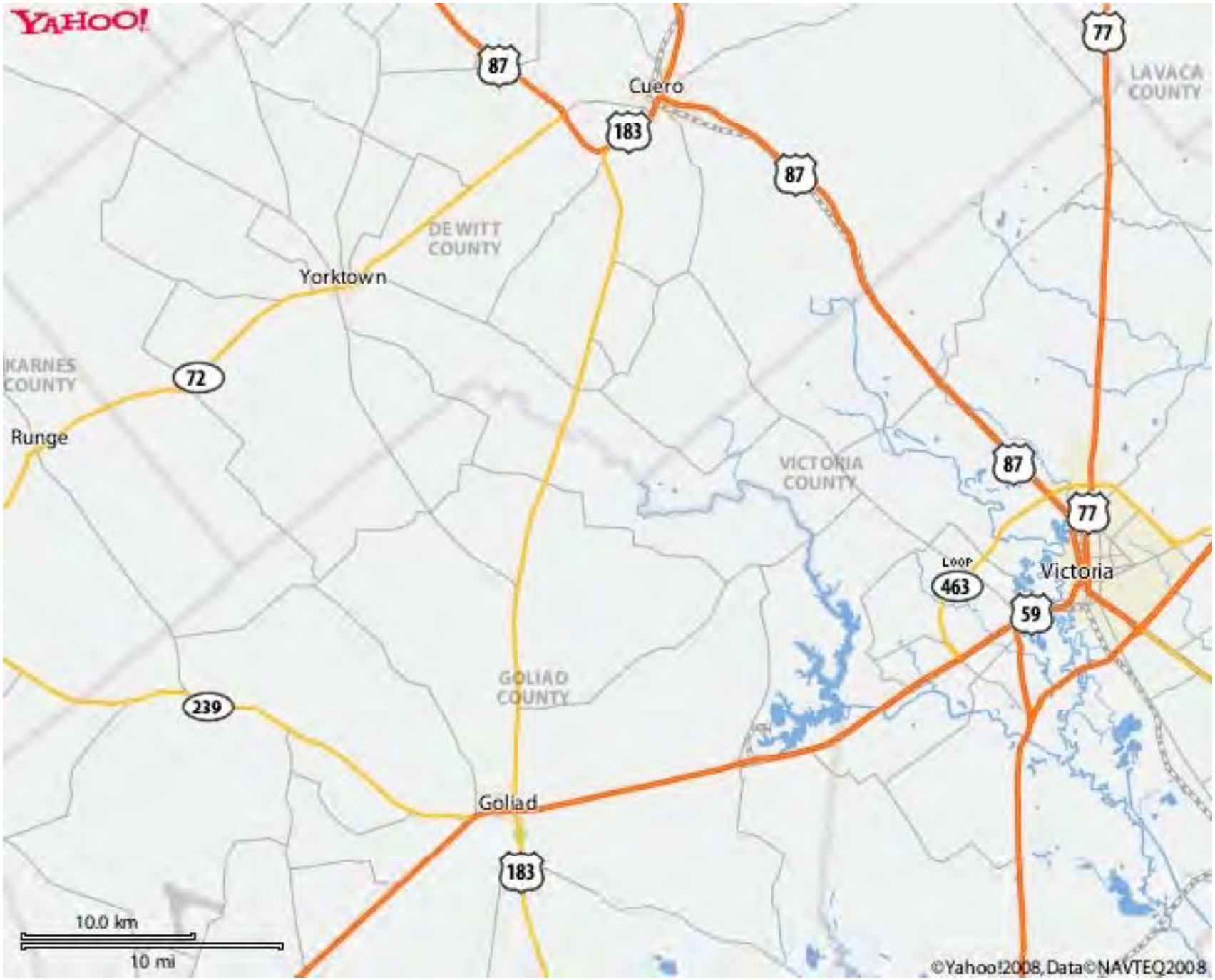
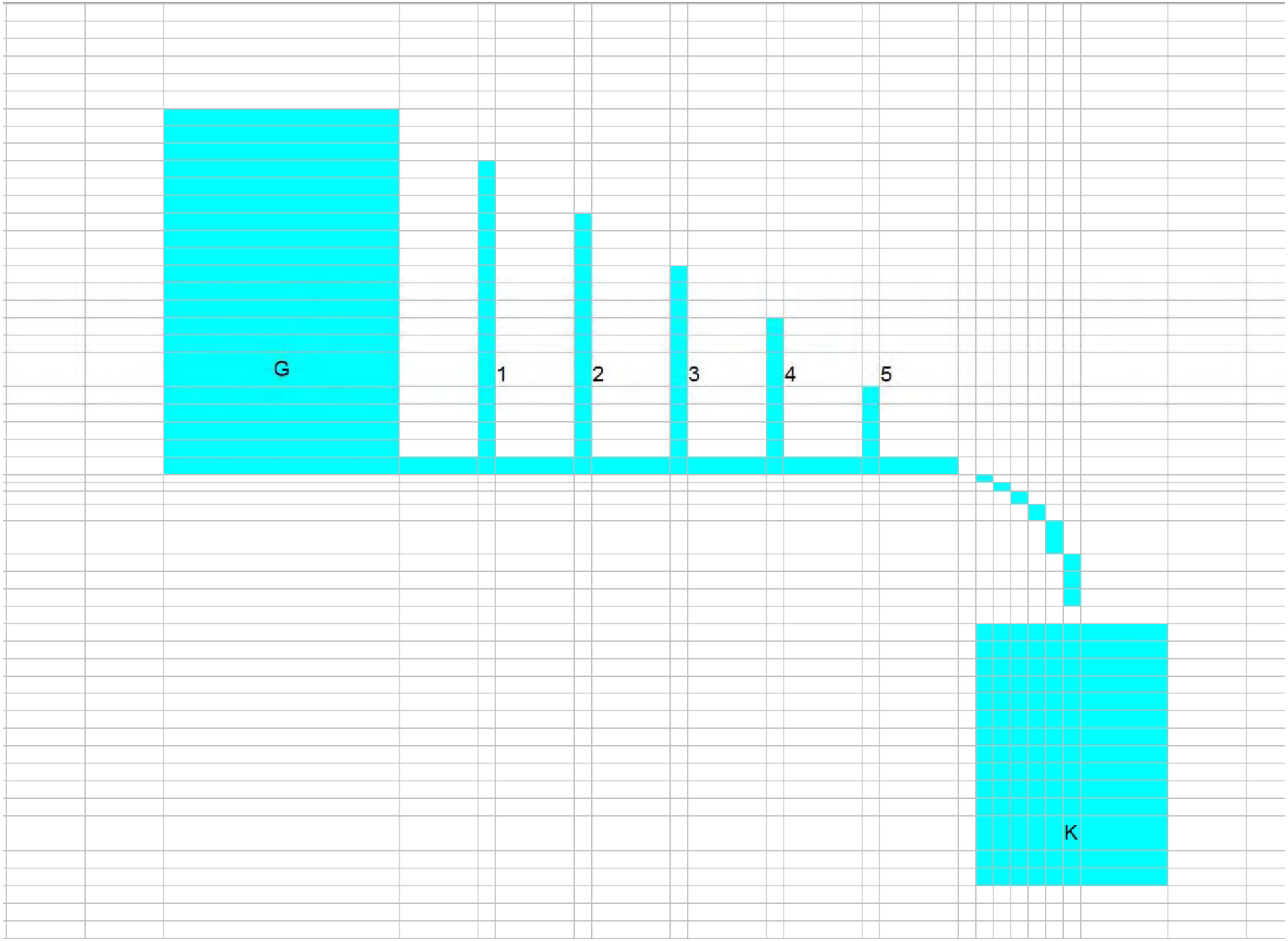


Figure 8
Approximate Altitude of Water Levels
in Wells in the Goliad Sand, 1968-69

Base from U.S. Geological Survey
topographic quadrangles

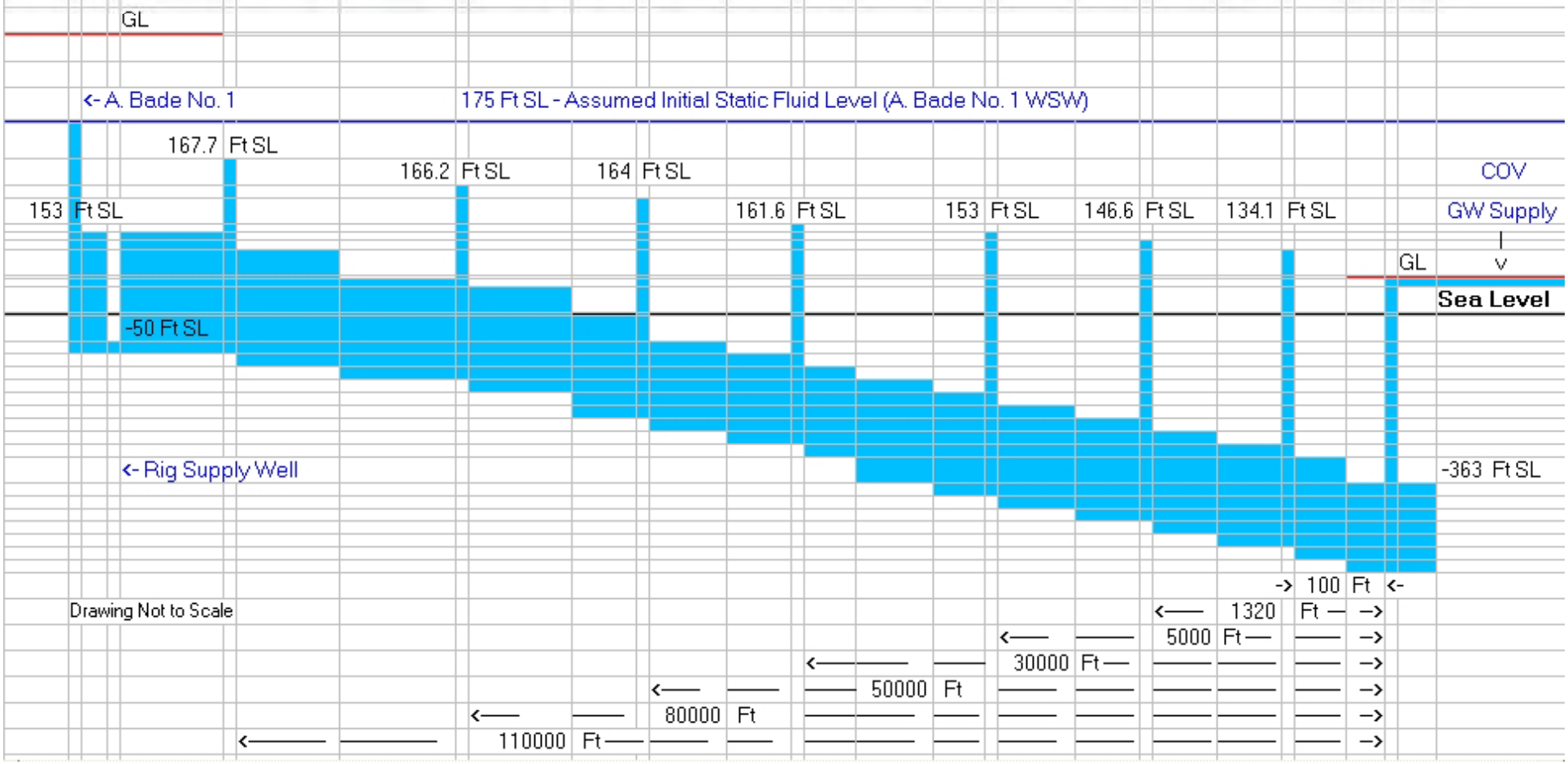

98°07'30"
98°00'
97°52'30"
27°37'30"
97°45'
97°37'30"
NUECES
KLEBERG
JIM WELLS
COUNTY
COUNTY
KINGSVILLE
TRANQUITAS RESERVOIR
ESCONDIDO LAKE
Premont
CAYO DEL GRUS
Santa Gertrudis Creek
Tranquitas Creek
Escondido Creek
Jaboncillos Creek
State 141
State 77
U.S. 77
U.S. 281
FM 716
State 428

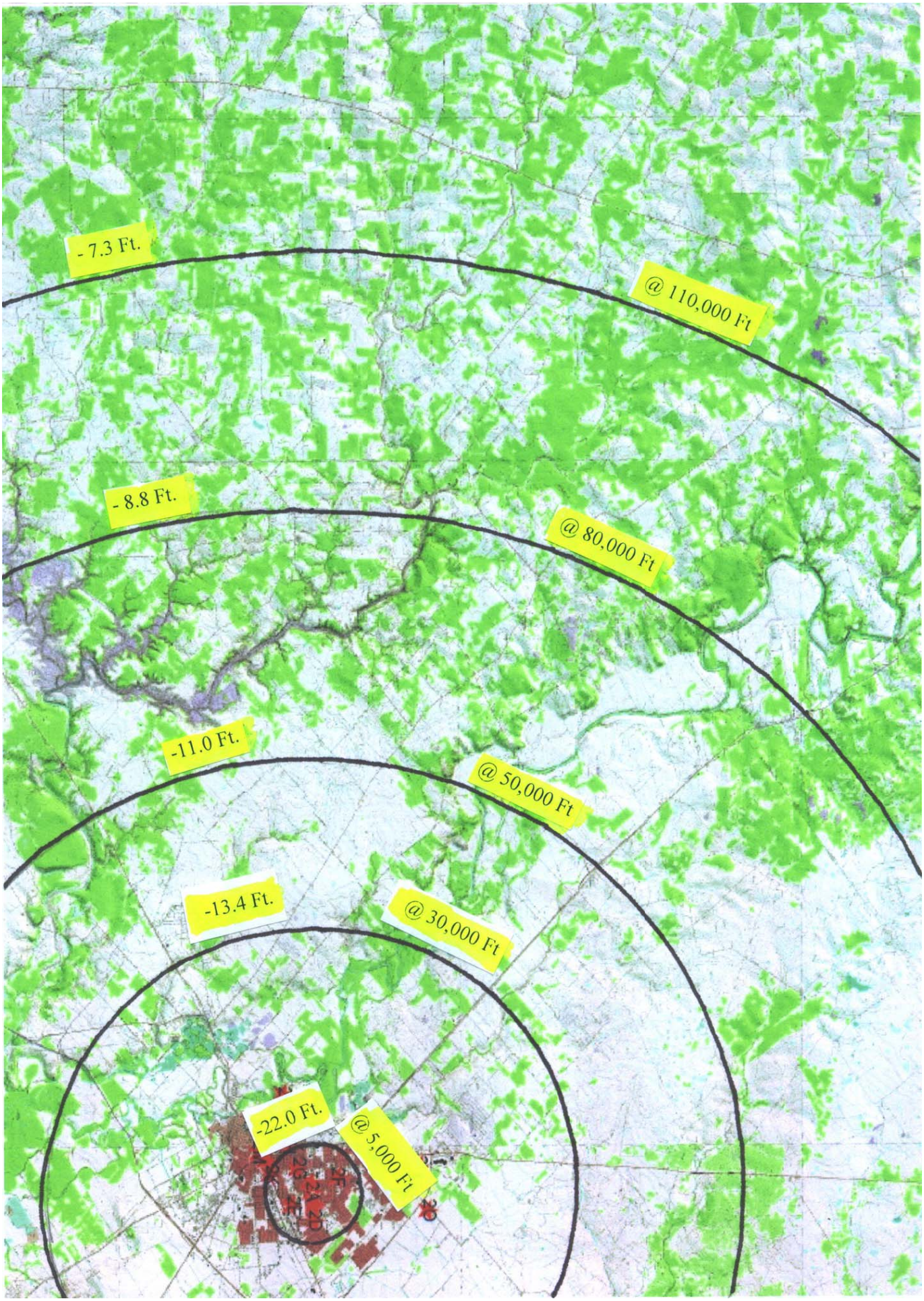

YAHOO!
87
Cuero
183
87
77
LAVACA COUNTY
DE WITT COUNTY
Yorktown
KARNES COUNTY
72
Runge
VICTORIA COUNTY
87
77
LOOP
463
Victoria
59
GOLIAD COUNTY
239
Goliad
183
10.0 km
10 mi
©Yahoo!2008, Data©NAVTEQ2008


G
1
2
3
4
5
K

Preliminary Aquifer Drawdown Analysis for City of Victoria (COV) Ground Water Supply System

Model Results For 50 Years of Operation at 1000 Ac-Ft/Yr Water Production Rate




- 7.3 Ft.
@ 110,000 Ft
- 8.8 Ft.
@ 80,000 Ft
-11.0 Ft.
@ 50,000 Ft
-13.4 Ft.
@ 30,000 Ft
-22.0 Ft.
@ 5,000 Ft

In the aquifer, the Pressure at a distance r from the well is given by:

$$p = p_e + \frac{q\mu B_o}{14.16\ kh} Ei\left[\frac{-r^2}{4\ \eta t}\right]$$

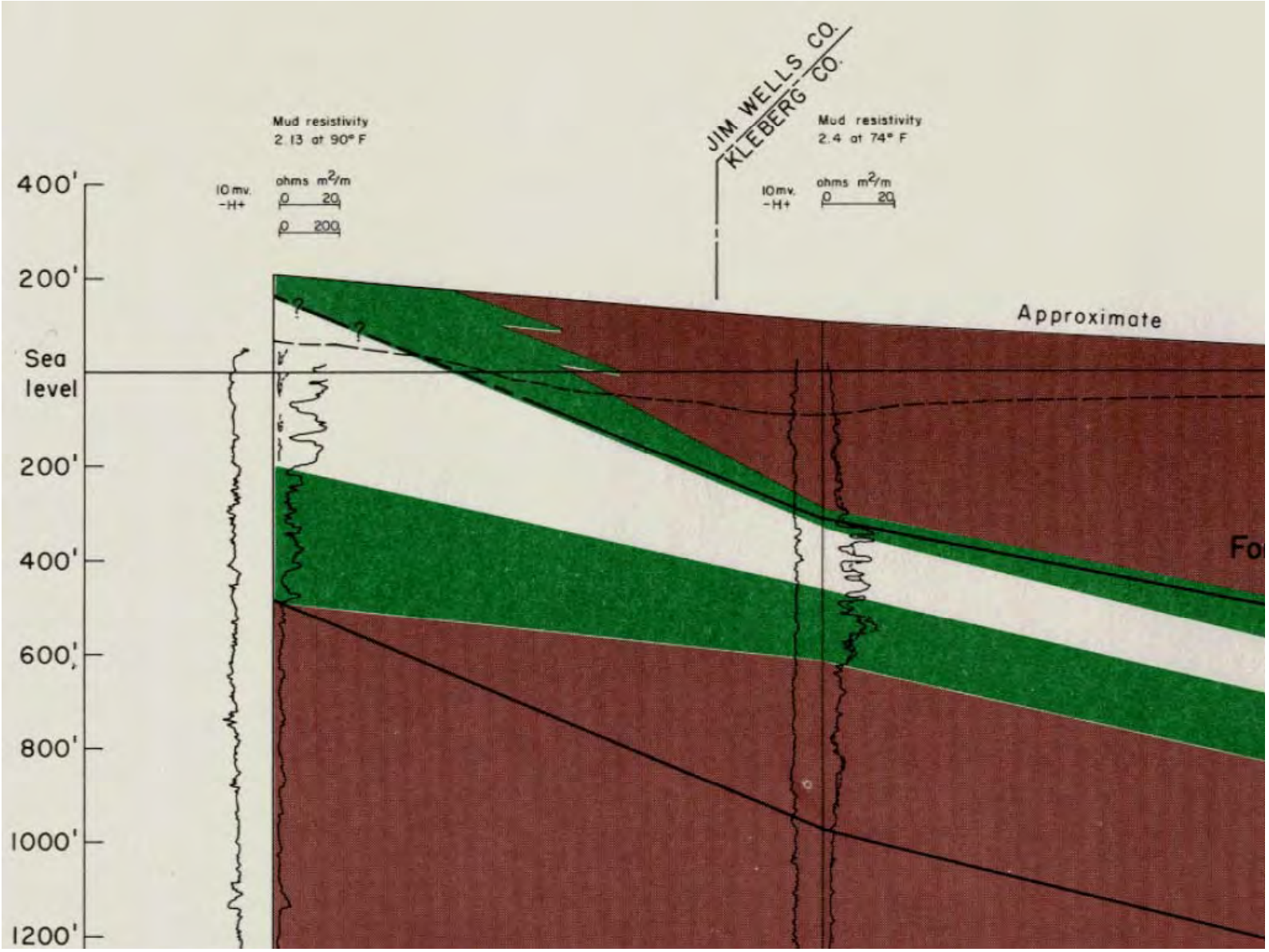
The parameters within the square brackets give the value of x in the series below

The Diffusivity Coefficient was computed using:

$$\eta = \frac{6.32\ k}{\mu c_e \phi h c} =$$

$$Ei(-x) = \ln x + 0.5772 - x + \frac{x^2}{2 \times 2!} - \frac{x^3}{3 \times 3!} + \frac{x^4}{4 \times 4!} - \cdots \frac{x^n}{n \times n!}$$

The Exponential Integral Ei was computed with the above series expanded to x^5



The permeable interval in the Goliad sand was estimated as 230 feet thick

Goliad Aquifer Supply Rate for Kingsville

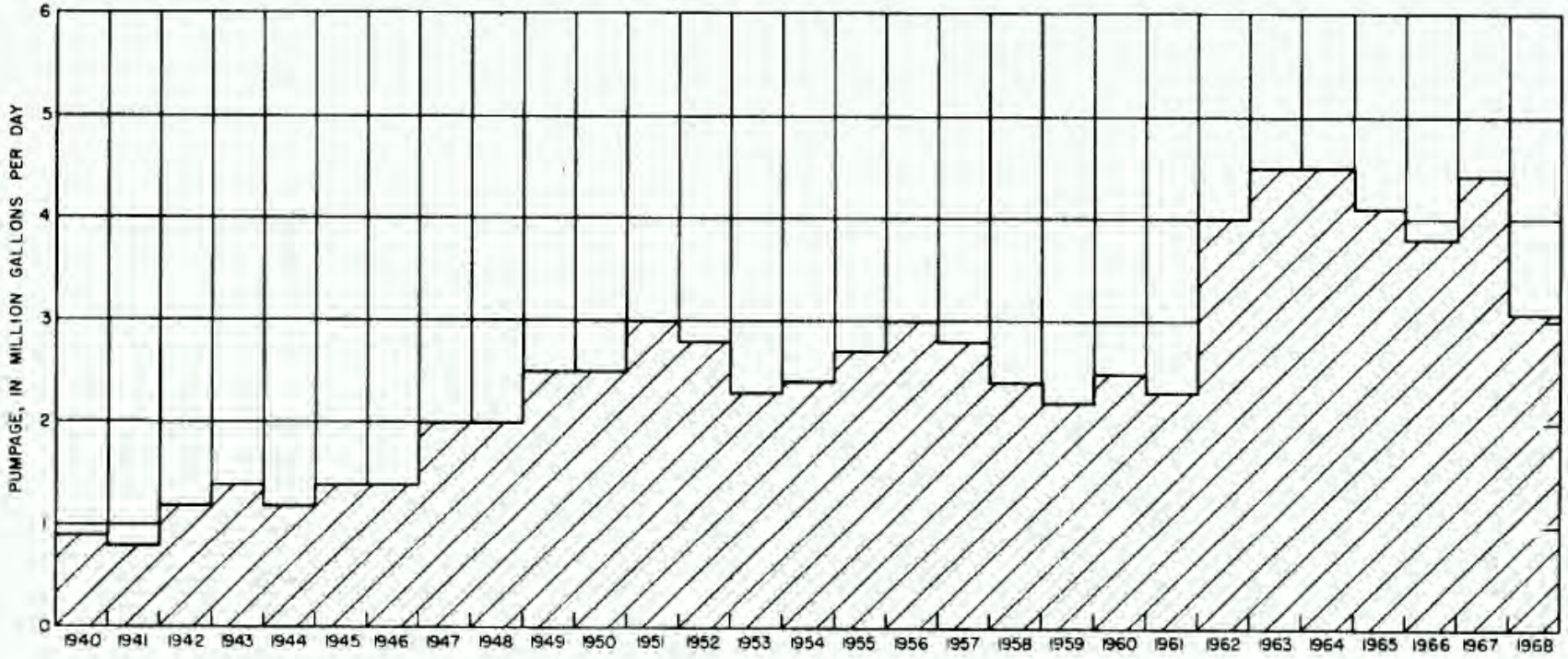


Figure 7.—Average Daily Pumpage of Ground Water for Public Supply by the City of Kingsville, 1940-68

Average Water Production Rate of Roughly 3 MMGals/Day Over 30 Years

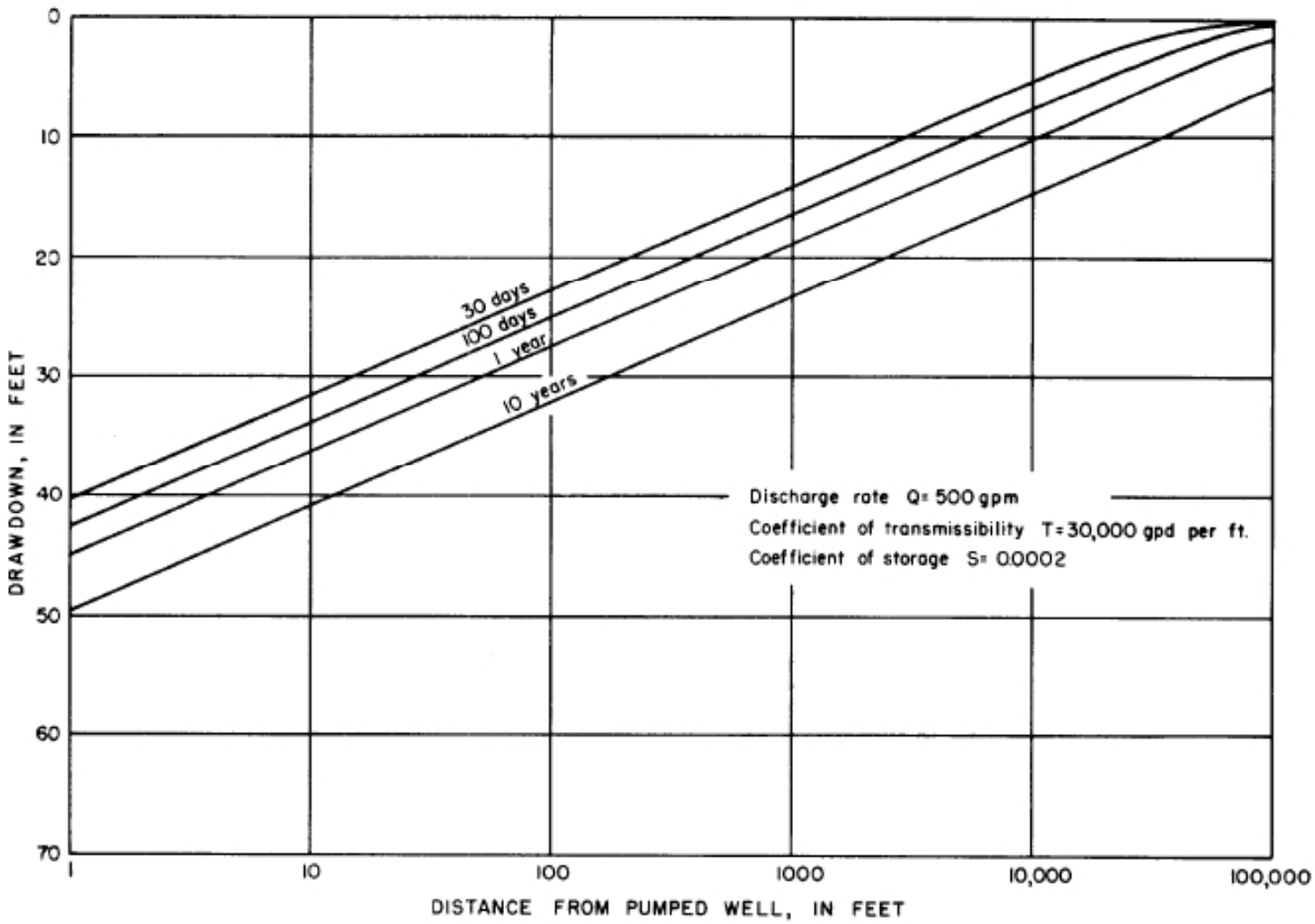
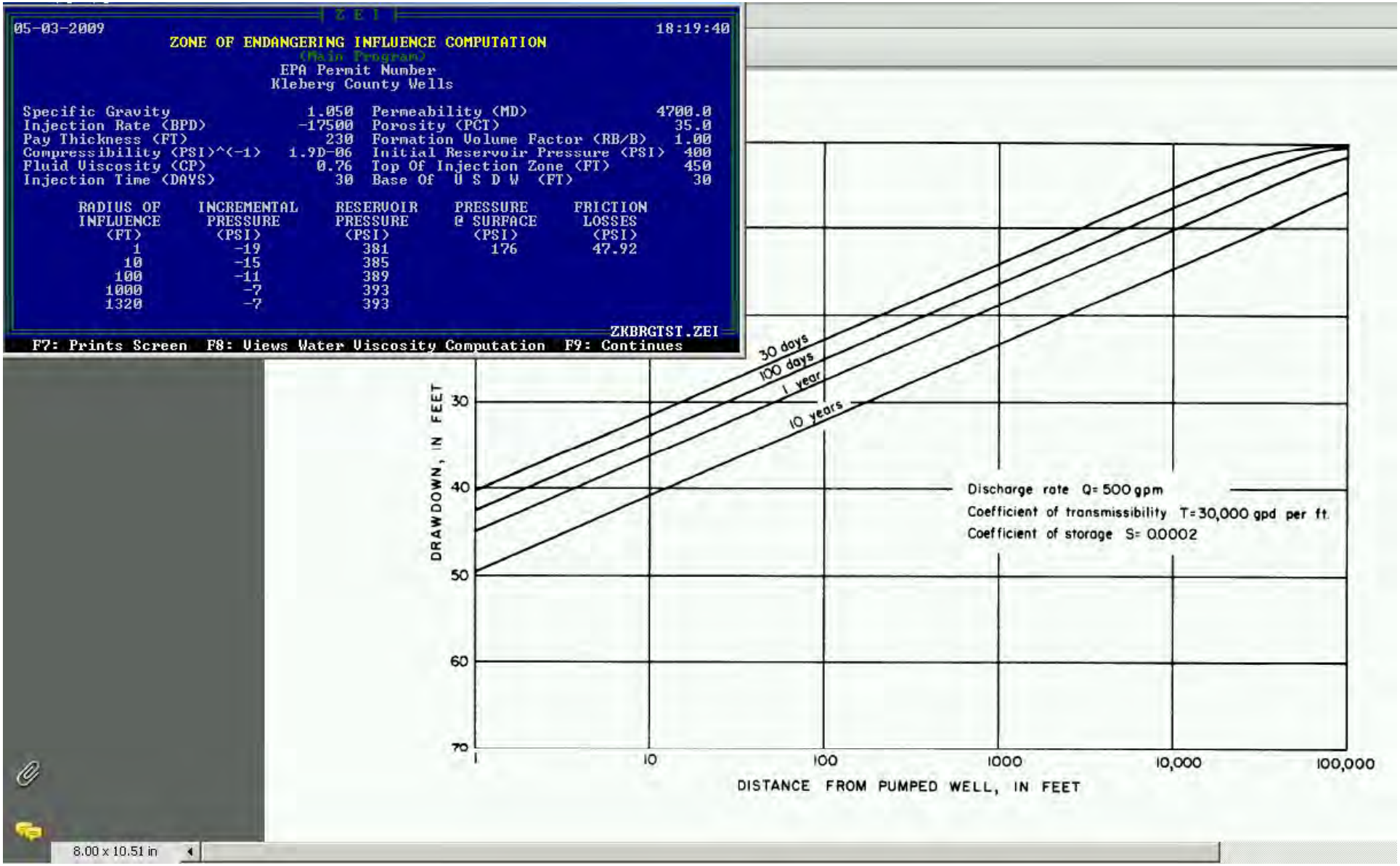
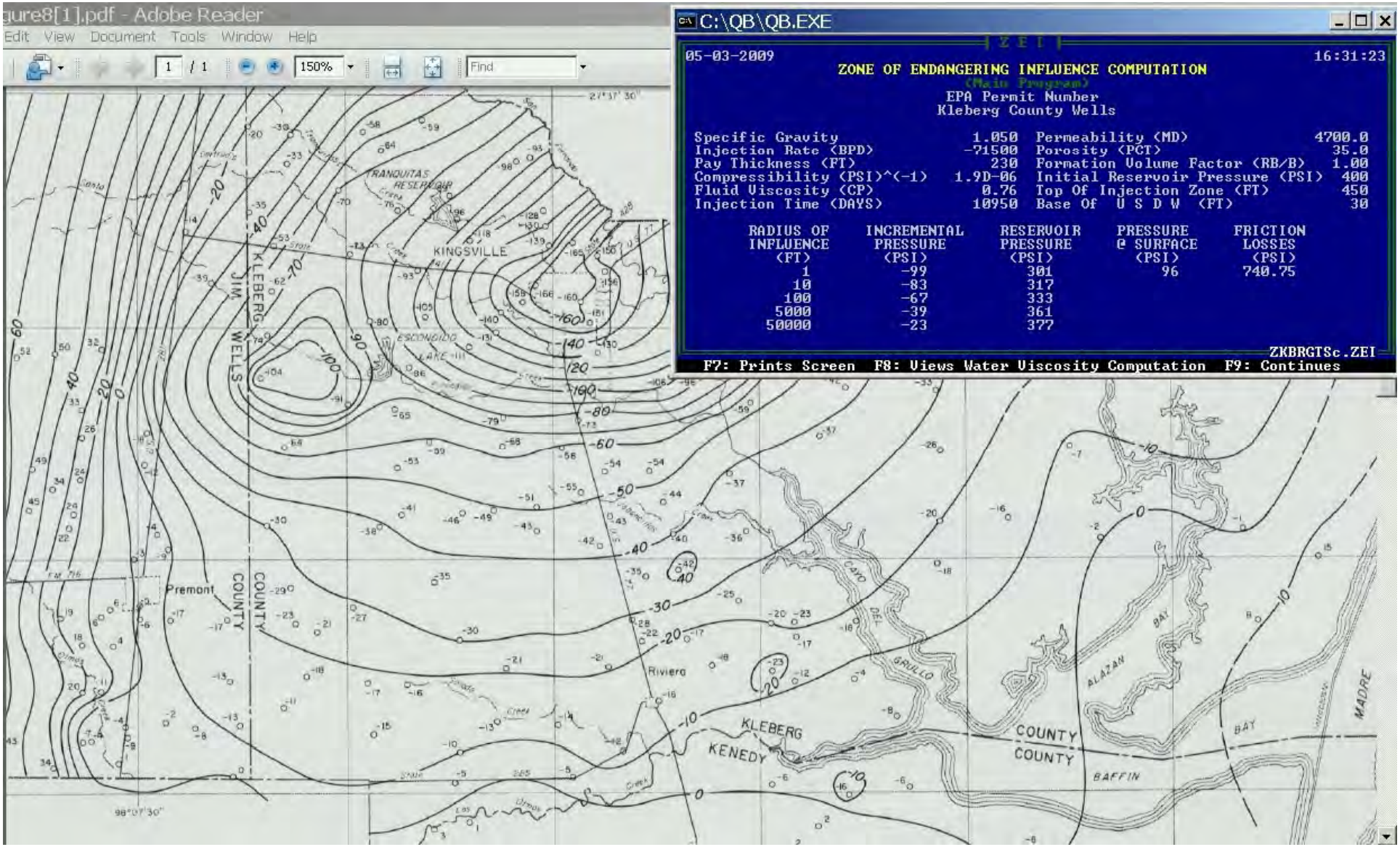


Figure 6.—Relation of Drawdown to Time and Distance as a Result of Pumping Under Artesian Conditions

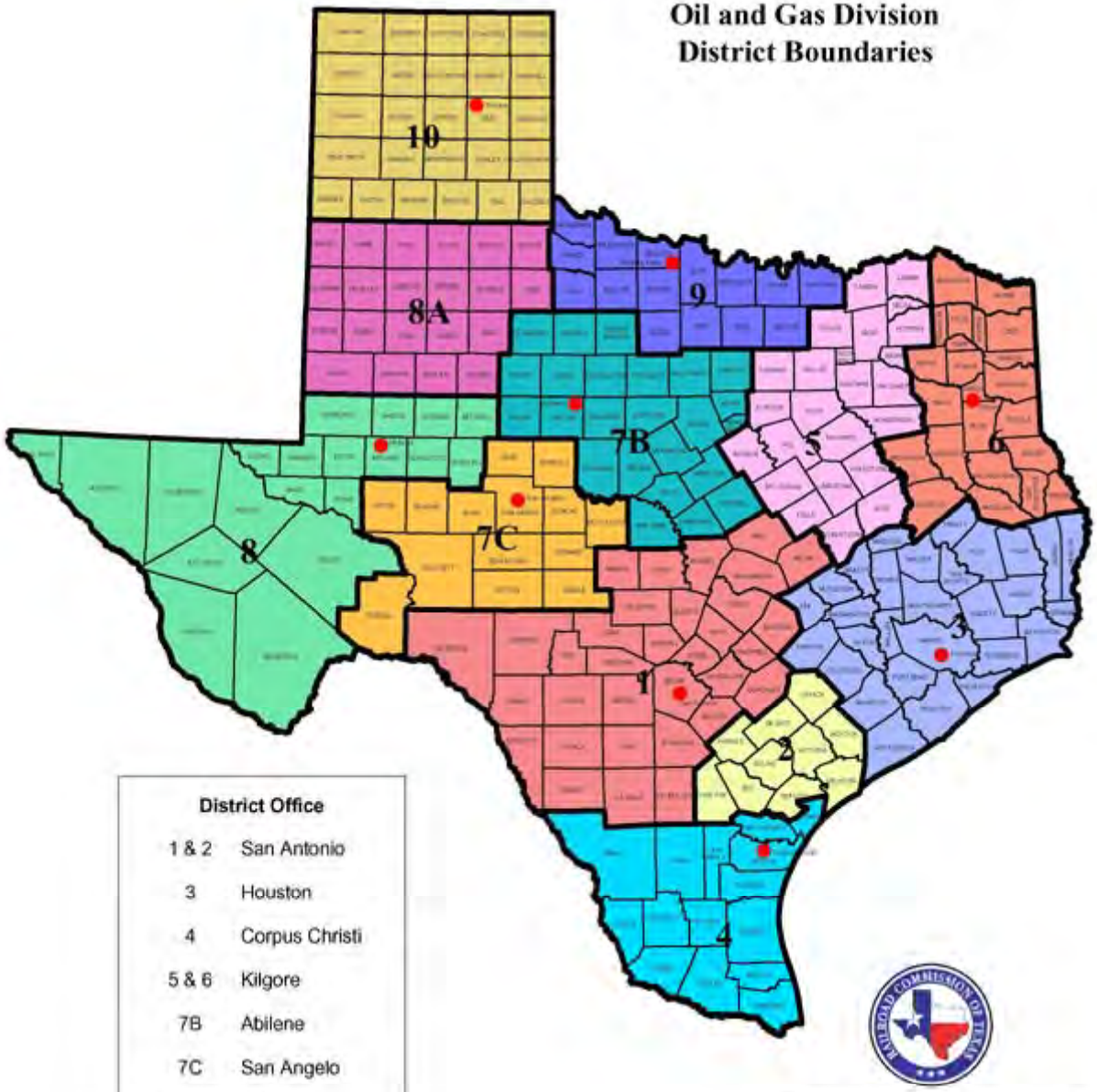


The Drawdown Test in TWDB's paper No. 173 indicates a value of k=4700 md



The estimated pressure Drawdown @ r=50,000 ft approaches the mapped value

Oil and Gas Division District Boundaries



District Office	
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7B	Abilene
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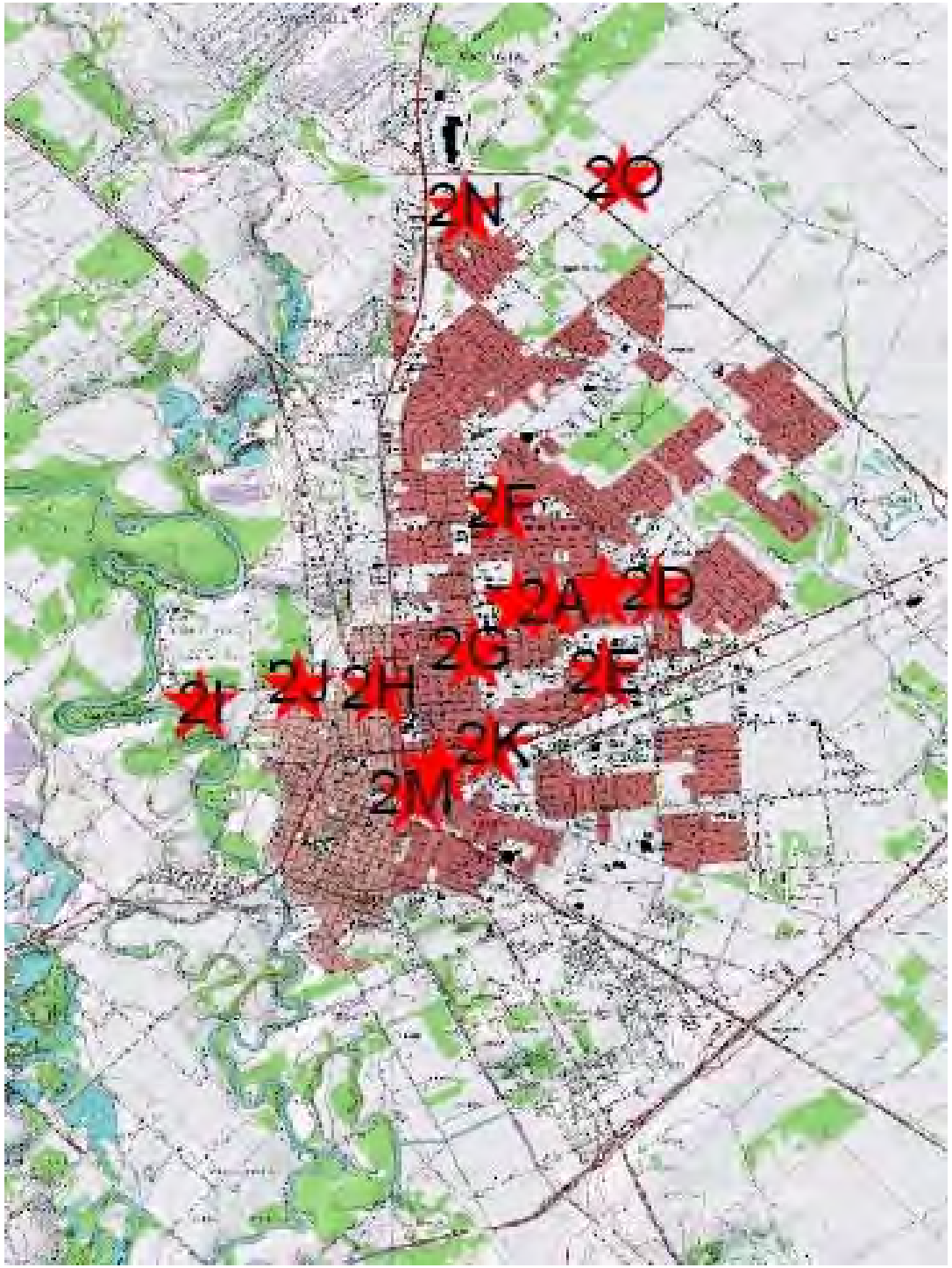
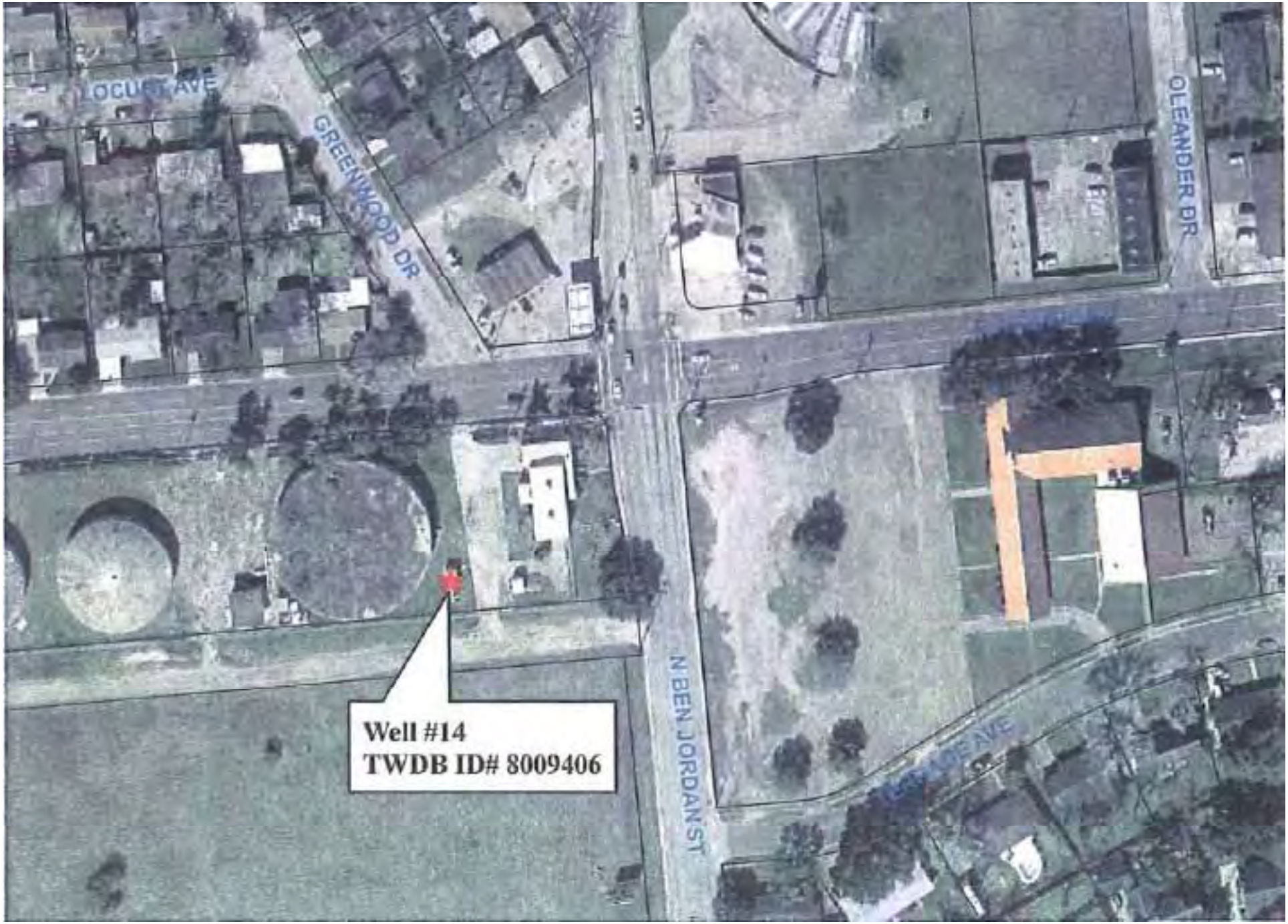
RAILROAD COMMISSION of TEXAS
Oil and Gas Division


2N
2O
2F
2A
2B
2G
2E
2H
2K
2M


LOCUST AVE
GREENWOOD DR
OLEANDER DR
N BEN JORDAN ST
Well #14
TWDB ID# 8009406

THE LAYNE TEXAS COMPANY, LTD.

HOUSTON -:- DALLAS

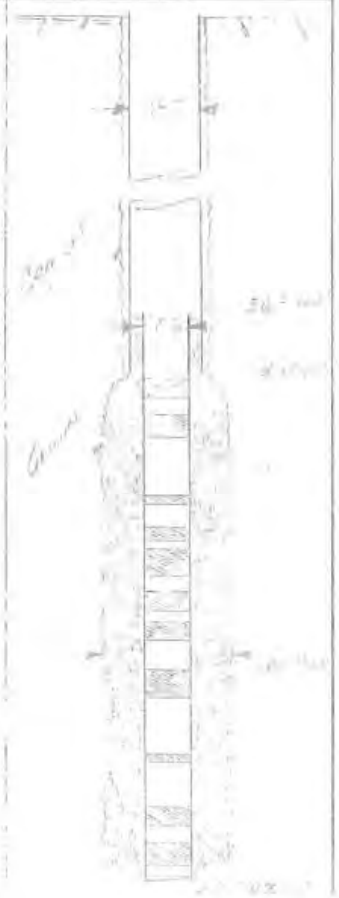
MATERIAL SETTING

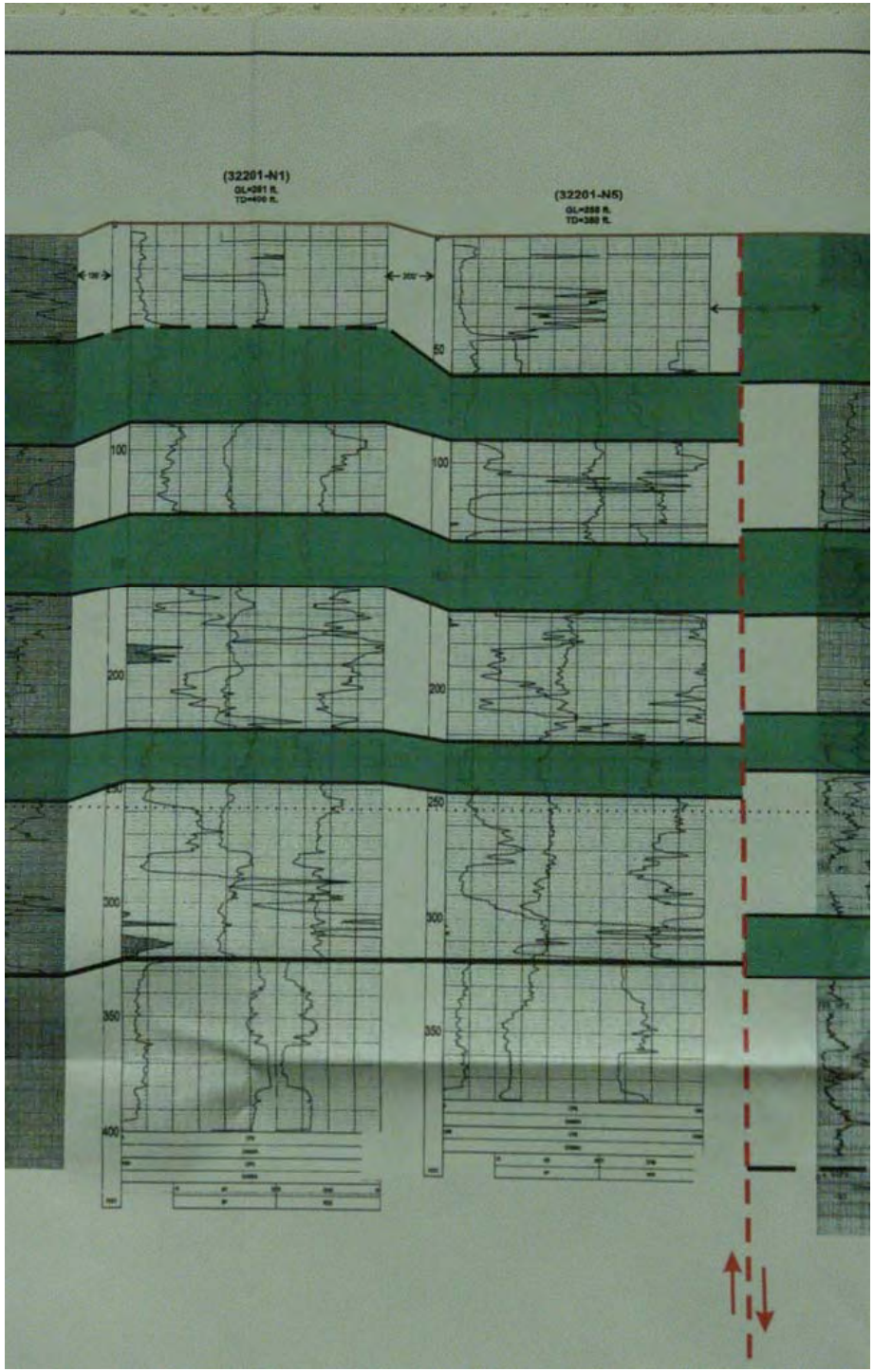
REPORT NO. 3339
S O 2345-53
PAGE 1 OF 1
FILE NO. 1847
DATE 9/18/53

CUSTOMER LOCATION	WELL DATA
FOR CITY OF VICTORIA	NAME WELL SAME WELL NO. 14
LOCATION WELL VICTORIA	ELEVATION DATUM
SURVEY FIELD	TYPE WELL GRAVEL-WALL
COUNTY VICTORIA STATE TEXAS	SURFACE CASING CEMENTED YES NO. SACKS 765
OTHER LAND MARKS	SIZE HOLE UNDERREAMED 30" DEPTH 435-1017'
	GRAVEL TYPE FILTER NO. CU. YDS. 150
	TYPE SCREEN S.S. W.W. GAGE .050
	DRILLER O. GUTZMANN RIG NO. 2-SPEC.
	OTHER

DEPTH	LENGTH	SIZE, KIND, WEIGHT MATERIAL
0 / 1.0'		18"OD CASING EXTENDS 1' ABOVE SURFACE
0		SURFACE
368.44'		TOP OF 10-3/4"OD LAPS 66.56' INTO 18" O.D.
435.00'	436.00'	18" O.D. SURFACE CASING
442.49'	74.05'	10-3/4" O.D. BLANK PIPE
464.49'	22.00'	10-3/4"OD S.S. W.W. SCREEN .050 GA.
483.64'	19.15'	10-3/4" O.D. BLANK PIPE
509.65'	26.01'	10-3/4" O.D. SCREEN
578.87'	69.22'	10-3/4" O.D. BLANK PIPE
589.72'	10.85'	10-3/4" O.D. SCREEN
613.95'	24.23'	10-3/4" O.D. BLANK PIPE
629.85'	15.90'	10-3/4" O.D. SCREEN
639.02'	9.17'	10-3/4" O.D. BLANK PIPE
669.92'	30.90'	10-3/4" O.D. SCREEN
687.20'	17.28'	10-3/4" O.D. BLANK PIPE
709.95'	22.75'	10-3/4" O.D. SCREEN
722.63'	12.68'	10-3/4" O.D. BLANK PIPE
745.00'	22.37'	10-3/4" O.D. SCREEN
779.12'	34.12'	10-3/4" O.D. BLANK PIPE
810.32'	31.20'	10-3/4" O.D. SCREEN
874.55'	64.23'	10-3/4" O.D. BLANK PIPE
884.55'	10.00'	10-3/4" O.D. SCREEN
933.55'	49.00'	10-3/4" O.D. BLANK PIPE
955.55'	22.00'	10-3/4" O.D. SCREEN
974.83'	19.28'	10-3/4" O.D. BLANK PIPE
1000.00'	25.17'	10-3/4" O.D. SCREEN
1015.00'	15.00'	10-3/4" O.D. BLANK PIPE
1017.00'	2.00'	10-3/4" O.D. SET NIPPLE, B.P. VALVE & W.W. PLUG

SKETCH



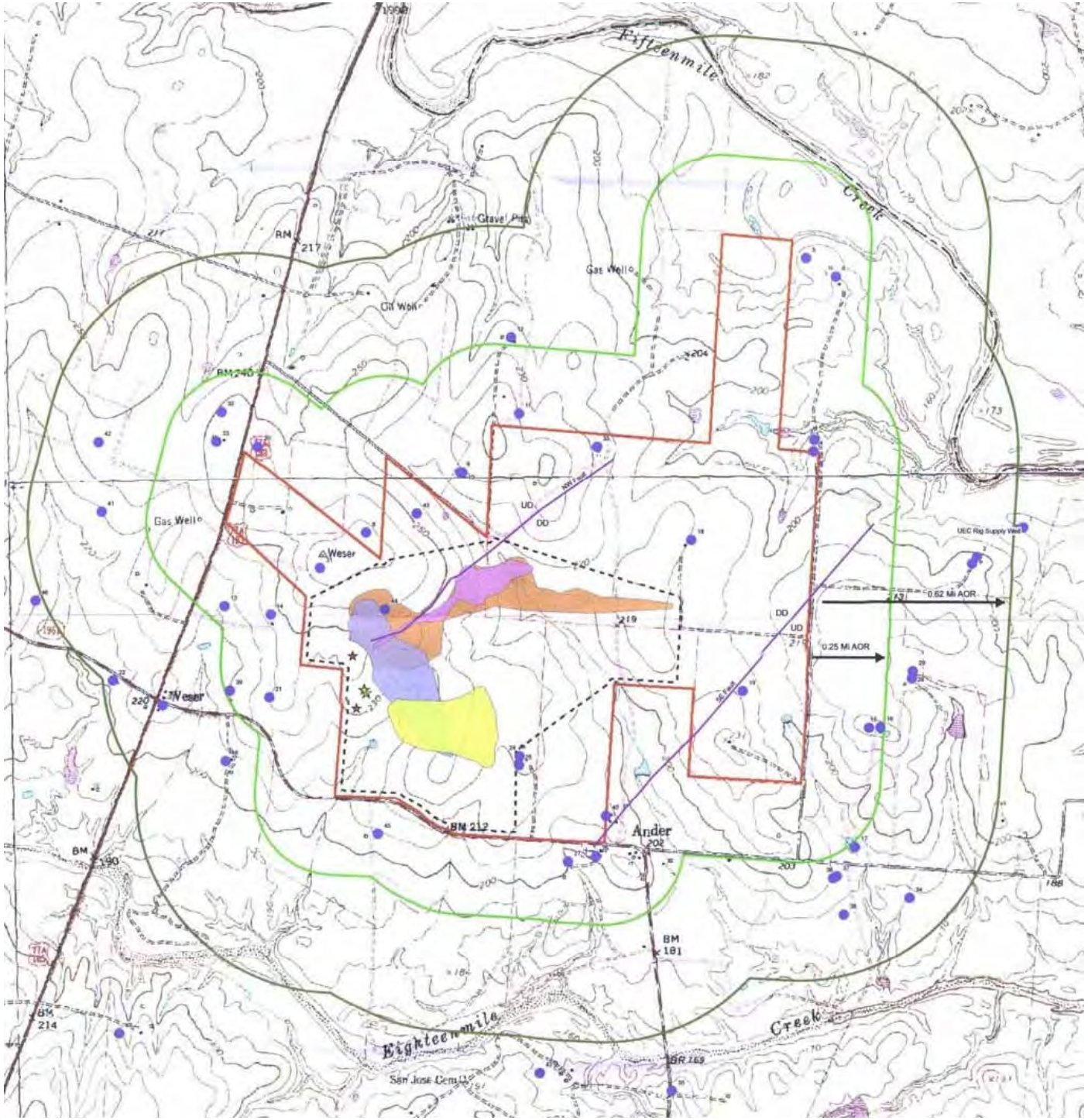

(32201-N1)
GL=391 ft.
TD=400 ft.
(32201-N5)
GL=388 ft.
TD=380 ft.
50
100
200
250
300
350
400

12/14/2000	1.303	0	0	1.174	0.331	1.296	0.356	0	0	1.445	0.741	0	1.445	0.547	0.519
12/15/2000	1.138	1.138	0	0.987	0.32	1.05	0.329	0	0	1.112	0.6	0	0.516	0.455	0.463
12/16/2000	0	1.092	0	0.957	0.532	1.027	0.256	0	0	1.062	0.547	0	1.053	0.532	0.545
12/17/2000	0	1.551	0	1.107	0.425	2	0.282	0	0	1.217	0.552	0	1.037	0.363	0.316
12/18/2000	0	0.988	0	1.001	0.632	1.091	0.502	0	0	1.185	0.46	0	0.866	0.51	0.524
12/19/2000	0	1.514	0	1.237	0.248	1.361	0.524	0	0	1.52	0.399	0	0.781	0.504	0.505
12/20/2000	0	1.389	0	1.165	0.658	1.267	0.18	0	0	1.274	0.348	0	0.652	0.371	0.344
12/21/2000	0	1.079	0	1.042	0.283	0.952	0.34	0	0	1.185	0.497	0	0.961	0.62	0.638
12/22/2000	0	1.436	0	1.192	0.216	1.291	0.519	0	0	1.365	0.45	0	0.86	0.473	0.46
12/23/2000	0	1.331	0	1.116	0.403	1.212	0.264	0	0	1.295	0.382	0	0.727	0.579	0.548
12/24/2000	0	1.556	0	1.275	0.34	1.382	0.346	0	0	1.442	0.398	0	0.758	0.458	0.433
12/25/2000	0	1.258	0	1.051	0.412	1.147	0.261	0	0	1.358	0.387	0	0.738	0.414	0.406
12/26/2000	0	1.407	0	1.163	0.17	1.259	0.517	0	0	1.29	0.385	0	0.732	0.363	0.356
12/27/2000	0	1.212	0	1.137	0.378	1.089	0.329	0	0	1.383	0.423	0	0.803	0.558	0.563
12/28/2000	0	1.264	0	1.045	0.452	1.132	0.283	0	0	1.149	0.491	0	0.934	0.418	0.391
12/29/2000	0	1.35	0	1.107	0.393	1.164	0.265	0	0	1.154	0.425	0	0.783	0.387	0.381
12/30/2000	0	1.167	0	0.955	0.322	1.033	0.558	0	0	1.101	0.469	0	0.912	0.375	0.373
12/31/2000	0	1.322	0	1.087	0.434	1.174	0.248	0	0	1.277	0.439	0	0.83	0.444	0.437
Total MG	268.839	377.454	437.915	93.021	216.369	202.960	209.220	108.638	411.827	458.903	117.200	202.580	226.530	252.982	253.897

Yr 2000

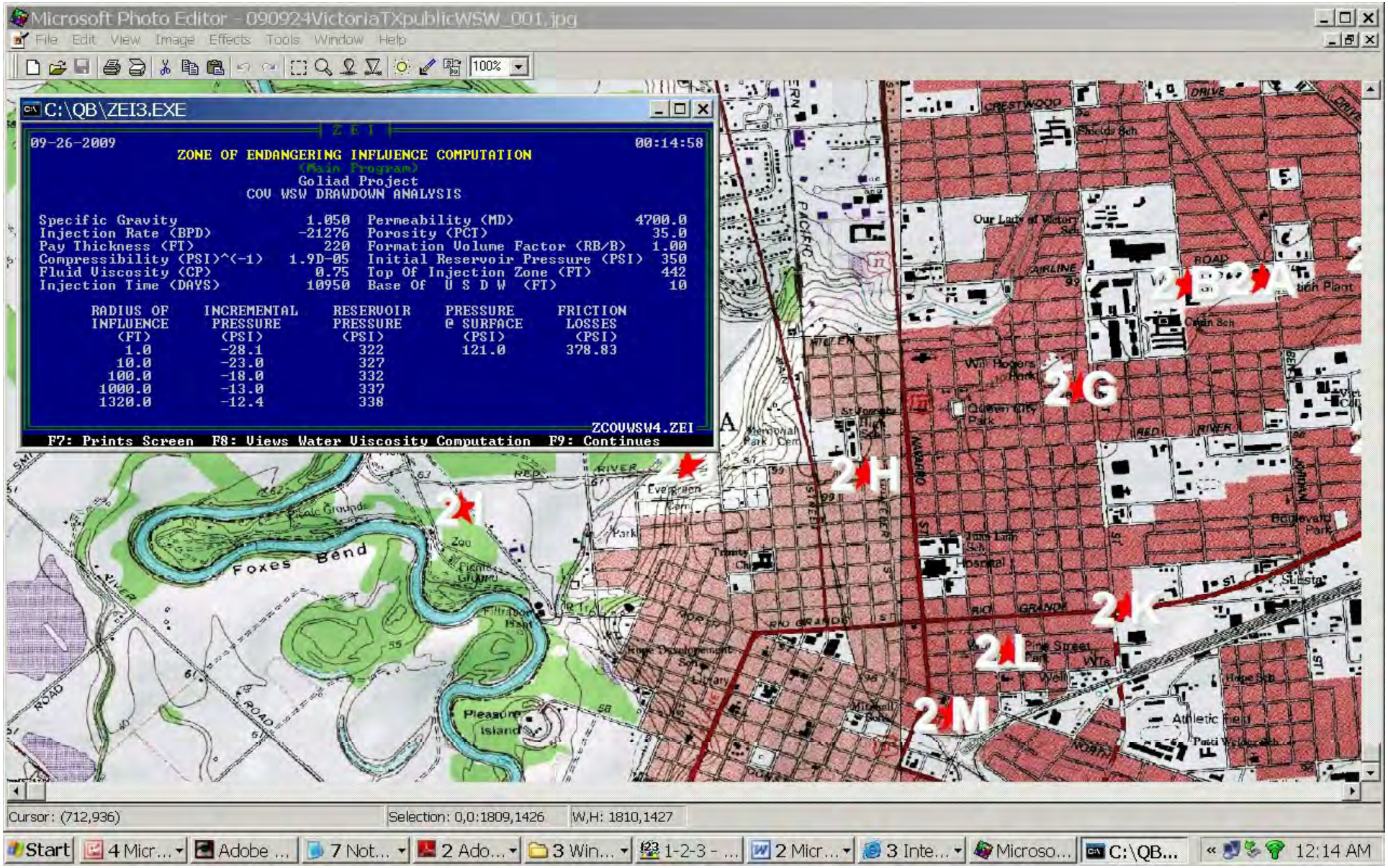
Well #	14	15	16	17	19	20	21	23	25	26	12	18	22	24	27
Max MGD	2.123	3.136	3.124	1.466	2.709	2.513	2.74	2.057	3.272	2.841	2	1.7	1.494	1.847	1.796
Acre/Ft	825.04	1,158.36	1,343.91	285.47	664.01	622.86	639.00	333.40	1,263.85	1,408.32	359.67	621.69	695.20	776.37	779.18

Total Acre/Ft 11,776.34


Fifteenmile
Creek
Gravel Pits
BM 217
Gas Wells
Oil Wells
BM 240
Gas Wells
Weser
UD
DD
UEC Rig Supply Yard
0.62 Mi AOR
0.25 Mi AOR
DD
UD
Weser
BM 212
Ander
202
BM 190
BM 181
BM 214
Eighteenmile
Creek
San Jose Cemetery
BR 169

Well Name	Map ID	Ground Level (ft) Above SL	Total Depth (ft)	Total Depth (ft) Above SL	Fluid Level (ft) From Surface	Fluid Level (ft) Above SL
J. Jacob 1	1	203	80	123	53.87	149.13
J. Jacob - ORW*	7	170	?		220.00	-50.00
C. Duderstadt 1	9	238	?		49.93	188.07
O. Bluntzer 1	15	230	128	102	80.00	150.00
K. Gray 1	17	185	?		36.04	148.96
T. Anklam 1	20	243	300	-57	86.60	156.40
A. Bade 1	22	204	86	118	31.00	173.00
A. Bade 2	23	218	?		49.05	168.95
M. Braquet 1	24	231	?		67.74	163.26
C. Tolbert 1	28	210	?		58.31	151.69
P. Breeden 3	38	178	460	-282	43.32	134.68
L. Schrade 1	40	212	?		68.57	143.43
H. Becker 1	47	177	?		21.18	155.82

* Old Rig Well



COV Preliminary Drawdown Analysis For 10^3 (Ac-Ft)/Yr – 65,000 Pop.

Modeled PSI Drawdown For Radii Between 1 Ft & 1320 Ft After 30 Yrs of Operation

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ZONE OF ENDANGERING INFLUENCE COMPUTATION

Goliad Project

COU WSW DRAWDOWN ANALYSIS

Specific Gravity	1.050	Permeability (MD)	4700.0
Injection Rate (BPD)	-21276	Porosity (PCT)	35.0
Pay Thickness (FT)	220	Formation Volume Factor (RB/B)	1.00
Compressibility (PSI)^(-1)	1.9D-05	Initial Reservoir Pressure (PSI)	350
Fluid Viscosity (CP)	0.75	Top Of Injection Zone (FT)	442
Injection Time (DAYS)	18250	Base Of U S D W (FT)	10

RADIUS OF INFLUENCE (FT)	INCREMENTAL PRESSURE (PSI)	RESERVOIR PRESSURE (PSI)
1.0	-28.6	321
10.0	-23.6	326
100.0	-18.6	331
1000.0	-13.5	336
1320.0	-12.9	337

F7: Prints Screen F8: Views Water Viscosity

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	A	B	C	D	Formula Bar	F
1	**FLOW OF FLUIDS IN POROUS MEDIA**					
2						
3	Reservoir Pressure Effects Computations					
4						
5	Production Rate (STBbl/Day)		21276		**Compute Diffusivity Factor**	
6	Time of Operation (Days)		18250			
7	Initial Reservoir Pressure (psia)		350		Numerator	29.704
8	Injected Fluid Viscosity (cp)		0.75		Denominator	4.99E-06
9	Formation Volume Factor (ResBbl/STBbl)		1			
10	Formation Porosity (Percent)		35		**Diffusivity Factor =**	5.96E+08
11	Formation Permeability (md)		4700			
12	Formation Interval Thickness (Ft)		220			
13	Formation Compressibility (1/psi)		1.90E-05			
14					**Compute "x"**	
15	Specified Radius (Ft)		1320			
16	Computed Pressure Change @ Specified Radius (psia)		-12.91		Numerator	1742400
17	Resulting Reservoir Pressure @ Specified Radius (psia)		337.1		Denominator	4.35E+11
18						

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Summary of Preliminary Aquifer Drawdown Analysis for the City of Victoria Ground Water Supply Wells

Basic Input Data

City's Population:	65,000		Datum:	Sea Level	Porosity (%)	35.0			
Number of Water Wel	15		Initial Reservoir Press. PSI	350.0	Permeability (md)	4,700	Compressibility (1/PSI)	1.90E-005	
GW Production. Rate	1,000	Ac-Ft/Yr	Viscosity (cp)	0.75	Thickness (Ft)	220			
	21,276	Bbl/Day	Form. Vol. Fctr.	1.0					

Model Results - Estimated Pressure and Hydrostatic Head Changes

Years of Operation	Drwdown @ 1.0 Ft From No. 14 Well PSI	Hydr. Head (Ft) Change @ 1.0 Ft From No. 14 Well	Drwdown @ 10 Ft From No. 14 Well PSI	Hydr. Head (Ft) Change @ 10 Ft From No. 14 Well	Drwdown @ 100 Ft From No. 14 Well PSI	Hydr. Head (Ft) Change @ 100 Ft From No. 14 Well	Drwdown @ 1000 Ft From No. 14 Well PSI	Hydr. Head (Ft) Change @ 1000 Ft From No. 14 Well	Drwdown @ 1320 Ft From No. 14 Well PSI	Hydr. Head (Ft) Change @ 1320 Ft From No. 14 Well
1	-24.3	-53.4	-19.3	-42.5	-14.3	-31.5	-9.3	-20.5	-8.7	-19.1
10	-26.9	-59.2	-21.8	-47.9	-16.8	-37.0	-11.8	-26.0	-11.2	-24.6
20	-27.6	-60.7	-22.6	-49.7	-17.6	-38.7	-12.5	-27.5	-11.9	-26.2
30	-28.1	-61.8	-23.0	-50.6	-18.0	-39.6	-13.0	-28.6	-12.4	-27.3
50	-28.6	-62.9	-23.6	-51.9	-18.6	-40.9	-13.5	-29.7	-12.9	-28.4

Years of Operation	Drwdown @ 5000 Ft From No. 14 Well PSI	Hydr. Head (Ft) Change @ 5000 Ft From No. 14 Well	Drwdown @ 30000 Ft From No. 14 Well PSI	Hydr. Head (Ft) Change @ 30000 Ft From No. 14 Well	Drwdown @ 50000 Ft From No. 14 Well PSI	Hydr. Head (Ft) Change @ 50000 Ft From No. 14 Well	Drwdown @ 80000 Ft From No. 14 Well PSI	Hydr. Head (Ft) Change @ 80000 Ft From No. 14 Well	Drwdown @ 110000 Ft From No. 14 Well PSI	Hydr. Head (Ft) Change @ 110000 Ft From No. 14 Well
1	-5.8	-12.8	-1.8	-4.0	-0.7	-1.5	0.0	0.0	0.0	0.0
10	-8.3	-18.3	-4.4	-9.7	-3.2	-7.0	-2.2	-4.8	-1.5	-3.3
20	-9.0	-19.8	-5.1	-11.2	-4.0	-8.8	-3.0	-6.6	-2.3	-5.1
30	-9.5	-20.9	-5.6	-12.3	-4.4	-9.7	-3.4	-7.5	-2.7	-5.9
50	-10.0	-22.0	-6.1	-13.4	-5.0	-11.0	-4.0	-8.8	-3.3	-7.3

Estimated Fluid Level Elevations (Feet Above/(Below) Sea Level) After Water Production @ COV

Assume Aquifer Initial "Static" Fluid Level = 175 Feet Above Sea Level

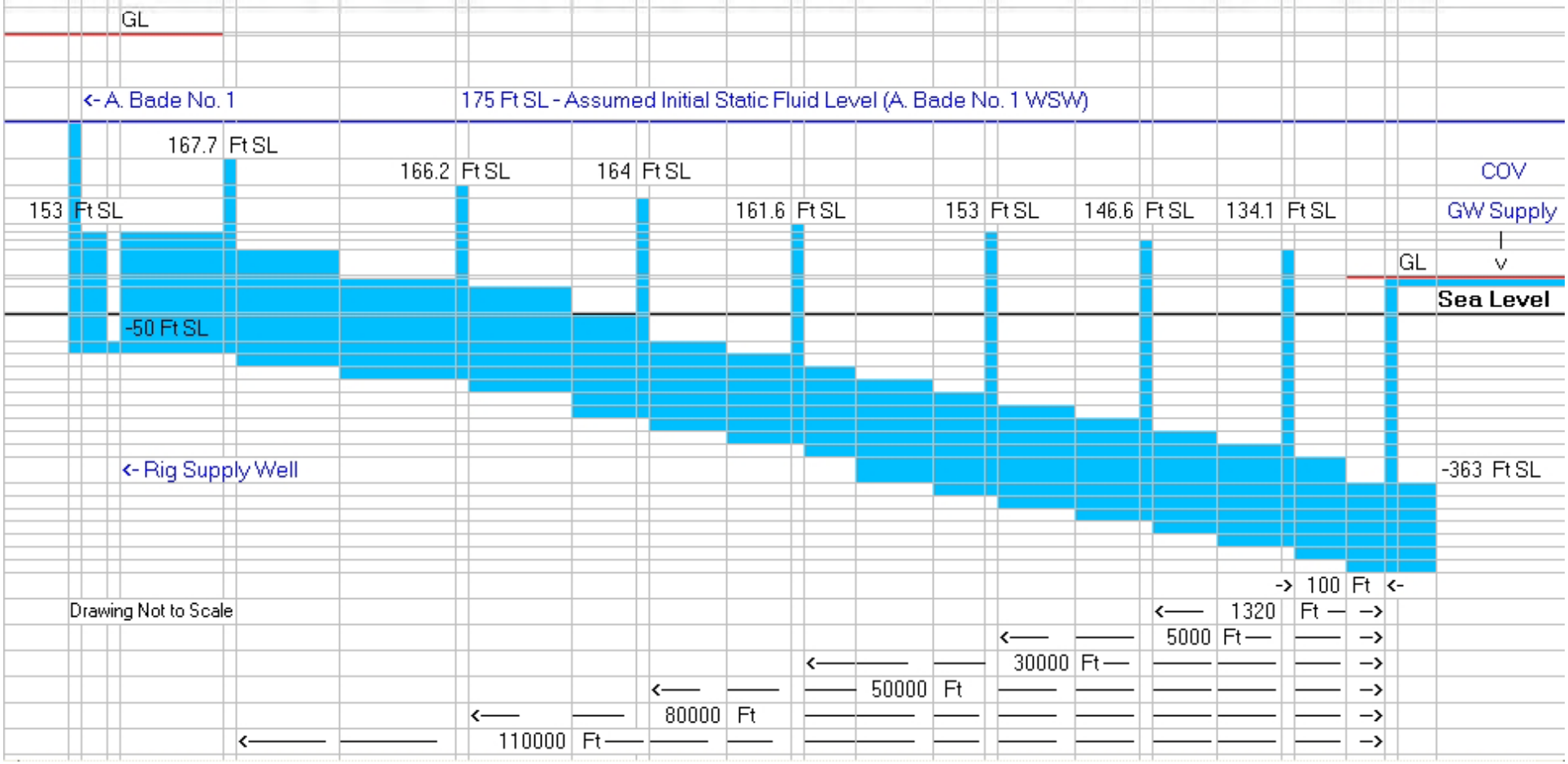
Source: Fluid Level at A. Bade No. 1 (Well No. 22 in UEC's Map). Fluid Level Assumed Static

Years of Operation	Hydr. Head Change (Ft) @ 1.0 Ft From No. 14 Well	Fluid Level (Feet SL) @ 1.0 Ft. From No. 14 Well	Hydr. Head Change (Ft) @ 10 Ft From No. 14 Well	Fluid Level (Feet SL) @ 10 Ft. From No. 14 Well	Hydr. Head Change (Ft) @ 100 Ft From No. 14 Well	Fluid Level (Feet SL) @ 100 Ft. From No. 14 Well	Hydr. Head Change (Ft) @ 1000 Ft From No. 14 Well	Fluid Level (Feet SL) @ 1000 Ft. From No. 14 Well	Hydr. Head Change (Ft) @ 1320 Ft From No. 14 Well	Fluid Level (Feet SL) @ 1320 Ft. From No. 14 Well
1	-53.4	121.6	-42.5	132.5	-31.5	143.5	-20.5	154.5	-19.1	155.9
10	-59.2	115.8	-47.9	127.1	-37.0	138.0	-26.0	149.0	-24.6	150.4
20	-60.7	114.3	-49.7	125.3	-38.7	136.3	-27.5	147.5	-26.2	148.8
30	-61.8	113.2	-50.6	124.4	-39.6	135.4	-28.6	146.4	-27.3	147.7
50	-62.9	112.1	-51.9	123.1	-40.9	134.1	-29.7	145.3	-28.4	146.6

Years of Operation	Hydr. Head Change (Ft) @ 5000 Ft From No. 14 Well	Fluid Level (Feet SL) @ 5000 Ft. From No. 14 Well	Hydr. Head Change (Ft) @ 30000 Ft From No. 14 Well	Fluid Level (Feet SL) @ 30000 Ft. From No. 14 Well	Hydr. Head Change (Ft) @ 50000 Ft From No. 14 Well	Fluid Level (Feet SL) @ 50000 Ft. From No. 14 Well	Hydr. Head Change (Ft) @ 80000 Ft From No. 14 Well	Fluid Level (Feet SL) @ 80000 Ft. From No. 14 Well	Hydr. Head Change (Ft) @ 110000 Ft From No. 14 Well	Fluid Level (Feet SL) @ 110000 Ft. From No. 14 Well
1	-12.8	162.2	-4.0	171.0	-1.5	173.5	0.0	175.0	0.0	175.0
10	-18.3	156.7	-9.7	165.3	-7.0	168.0	-4.8	170.2	-3.3	171.7
20	-19.8	155.2	-11.2	163.8	-8.8	166.2	-6.6	168.4	-5.1	169.9
30	-20.9	154.1	-12.3	162.7	-9.7	165.3	-7.5	167.5	-5.9	169.1
50	-22.0	153.0	-13.4	161.6	-11.0	164.0	-8.8	166.2	-7.3	167.7

Preliminary Aquifer Drawdown Analysis for City of Victoria (COV) Ground Water Supply System

Model Results For 50 Years of Operation at 1000 Ac-Ft/Yr Water Production Rate



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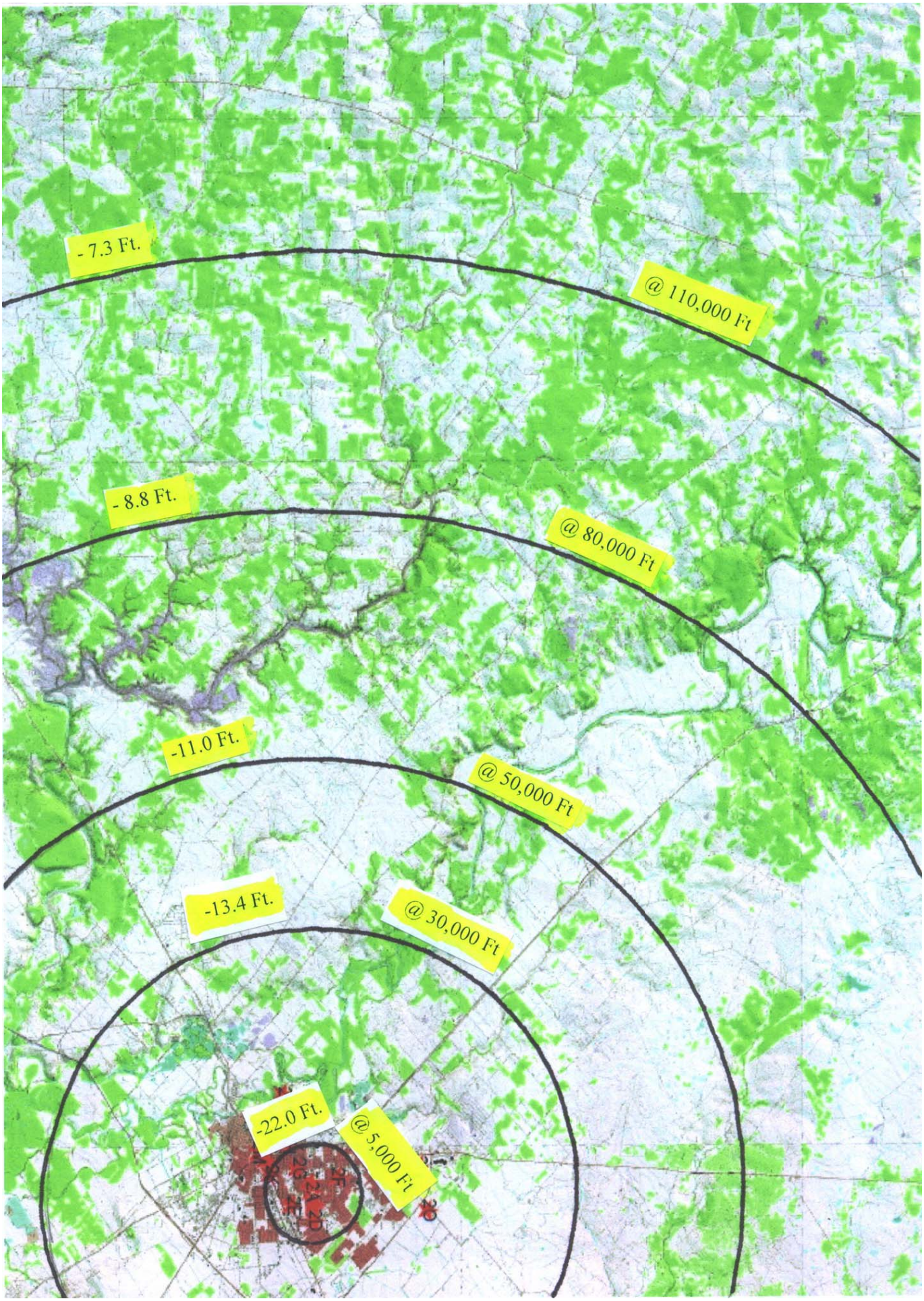
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A computer simulation and evaluation of groundwater resources in the Evangeline aquifer in the area of Kleberg County, Texas.

Publication: The Texas Journal of Science
Publication Date: 01-MAY-05
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Article Excerpt

Abstract. -- A computer simulation of groundwater flow in the Evangeline Aquifer was conducted to determine future groundwater availability within a 5776 square mile (14,960 [km.sup.2]) area southwest of Corpus Christi, Texas. This aquifer is a major source of fresh water for the region, in A...

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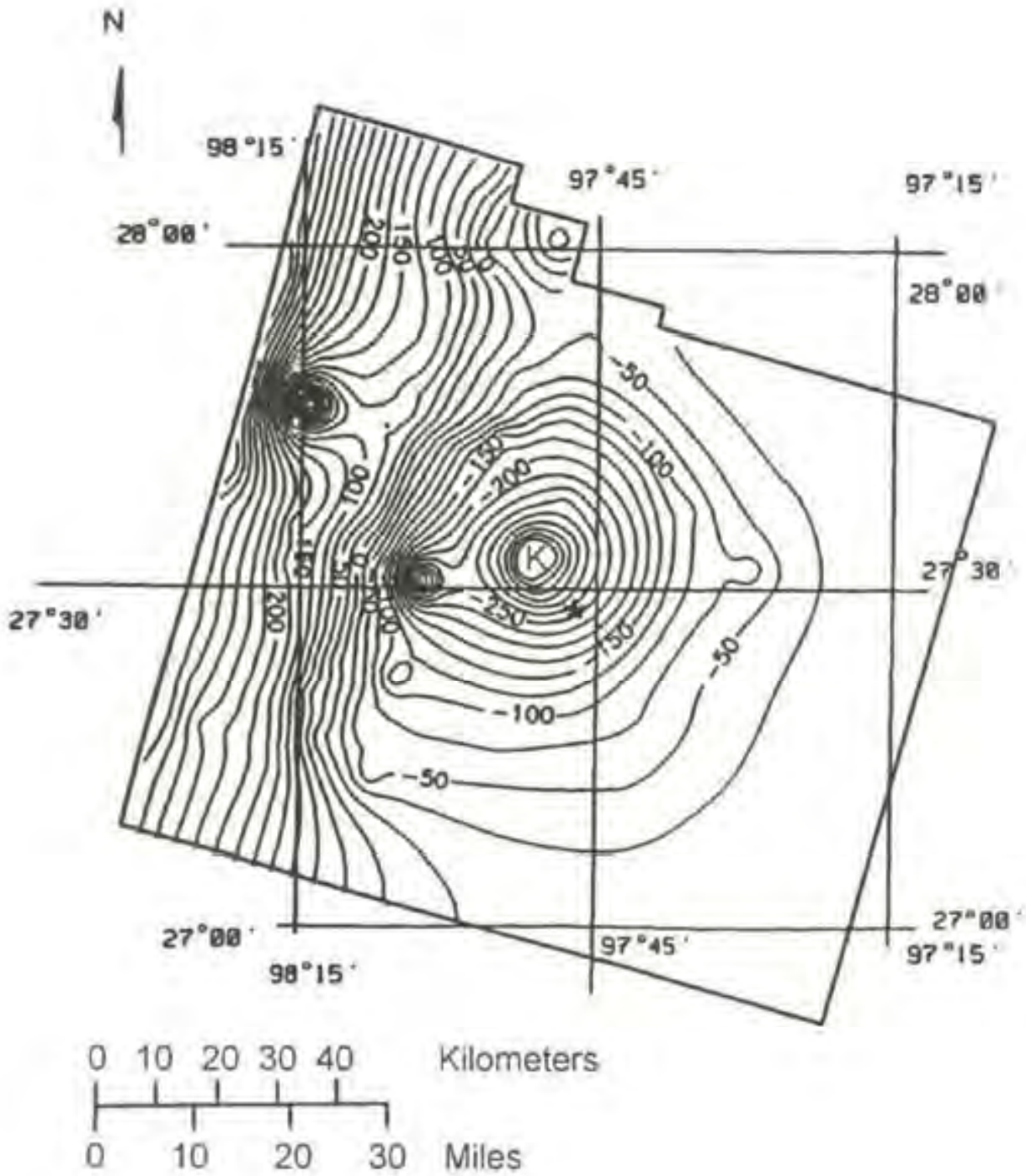
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