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AN ASSESSMENT OF SUBSURFACE SALT WATER
DISPOSAL EXPERIENCE ON THE TEXAS AND LOUISIANA
GULF COAST FOR APPLICATION TO DISPOSAL OF SALT
WATER FROM GEOPRESSURED GEOTHERMAL WELLS

Topical Report

By
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August 4, 1978

Work Performed Under Contract No. EY-77-C-08-1531

C. K. GeoEnergy Corporation
Las Vegas, Nevada

U. S. DEPARTMENT OF ENERGY
Geothermal Energy

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TOPICAL REPORT

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Prepared for the

Nevada Operations Office
U. S. Department of Energy
Division of Geothermal Energy
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1. INTRODUCTION

This investigation was conducted for the Division of Geothermal Energy, DOE, under contract No. EY 77-C-08-1531. The data and assessments upon which it is based were obtained primarily from participants in DOE/EPA sponsored Geopressured Geothermal Industrial Forum.

a. Objectives: The primary objective of this investigation was to provide a prognosis for subsurface disposal of salt water from geopressured geothermal fields in areas of interest in Louisiana and Texas. A geopressured geothermal field is currently envisioned to contain 20 producing wells with a salt water output of 40,000 bbls/day per well for a total field rate of 800,000 bbls/day. The areal extent of a field would be about 50 square miles, assuming a net pay thickness of about 300 ft. Under these conditions the expected disposal rate would be about 16,000 bbls/day per square mile of field.

In order to develop this prognosis, a number of secondary objectives were pursued. These included:

- 1) Determine from the literature and from current related investigations what the primary problems are with respect to salt water disposal in the Gulf Coast area in general.
- 2) Collect and analyze high rate salt water disposal well data for the specific counties and parishes of interest from the Texas Railroad Commission and the Louisiana Department of Conservation.
- 3) Solicit salt water disposal data and operating experience from at least three major oil and gas operating companies in the counties and parishes of interest and from Subsurface, Incorporated, a Houston based industrial waste engineering firm.

b. Scope

This investigation encompasses the subsurface disposal of salt water at rates equal to or greater than approximately 3,000 bbls/day or 1,000,000 bbls/yr per well. The counties and parishes of chief interest include those in which University of Texas at Austin and Louisiana State University

investigators have identified potential geopressured geothermal prospects in the Frio formation (see Figures 1 & 2). These include the following:

LOUISIANA PARISHES

Acadia
Assumption
Calcasieu
Cameron
Iberia
Jefferson Davis
LaFourche
St. Mary
Terrebonne
Vermilion

TEXAS COUNTIES

Brazoria
Galveston
Matagorda
Kenedy
Hidalgo
Willacy
Cameron
Aransas

c. Data Sources and Acknowledgements

A listing of Gulf Coast salt water disposal literature is included in the reference section of this report. Well permit data from the Texas Railroad Commission files were provided by Messrs. Robert Harris, James Morrow and George Singletary. Louisiana disposal well injection volumes and pressures were obtained from the Department of Conservation's files through the courtesy of Messrs. Arnold Chauviere and Charles King. Discussions regarding the potential for disposing of geopressured geothermal well salt water with all these individuals were particularly helpful in this investigation.

A number of companies, including Amoco Production Company and Marathon Oil Company provided data from their disposal operations. Mr. William Hahn of the U. S. Department of Energy's Strategic Petroleum Reserve Program provided brine disposal data related to their salt dome storage cavern development program in Texas and Louisiana. Valuable insight was provided by a Houston-based design and engineering firm.

2. SUMMARY OF LITERATURE

a. Introduction

The disposal of geothermal brine has been discussed in the literature resulting from a number of symposia and workshops. (1-12) In addition, a number of State and Federal agencies such as the Louisiana Department of Conservation, the Texas Railroad Commission, the Texas Water Development Board, the Bureau of Mines (now DOE), and the USGS, as well as industrial related and academic research groups such as the Interstate Oil Compact Commission, EPRI, and Battelle have issued pertinent publications and reports. Other papers of interest, relating to brine disposal, are to be found in the technical literature.

A representative cross section of this literature was perused and some of the general information and concepts resulting from this survey is summarized in the following sections of this report. The literature cited is listed in the appended list of references. Additional literature is listed in the bibliography.

b. Gulf Coast Geology

Tens of thousands of oil and gas exploration and development wells have been drilled in the Texas and Louisiana Gulf Coast Region. Thus, the general geology is well known.

The base of the "fresh"* water zone has been defined for the geopressured geothermal trend in on-shore Texas and Louisiana. (13-15) Currently from the surface to the base of the 3000 mg/l zone is considered the fresh water or protected interval. The more conservative-base of the 10,000 mg/l - might be used for the geopressured brine disposal operations since (1) this interval has been defined for the area of interest, (2) there seems to be an adequate interval of shallow sand aquifers below this zone, (3) this would be consistent

* AWWA Classification

<	500 mg/l	Drinking water
≤	1,000 mg/l	Fresh water
	1,000- 3,000 mg/l	Slightly brackish water
	3,000-10,000 mg/l	Moderately brackish water
	10,000-33,000 mg/l	Highly brackish water
	33,000-36,000 mg/l	Sea water
>	36,000 mg/l	Brine

with the postulated future use of this value (10,000 mg/l) to define the protected interval and (4) it would minimize any problems caused by a redefinition of terms and changes in permissible injection intervals.

The 10,000 mg/l zone occurs at a depth of about 500 ft (152m) at La Fourche Crossing, 1000 ft (305m) at the Magma Gulf sites in Louisiana⁽¹³⁾ and about 3000 ft (914m) at the Brazoria site in Texas.⁽¹⁵⁾

The general structure and stratigraphy of the Gulf Coast is a series of clastic formations striking parallel to the coast and dipping gulfward. The outcropping surface rocks are younger toward the coast and a series of down to the coast faults that parallel the strike has resulted in enhancing the gulfward thickening of the units.

Figure 3 is a cross section transverse to the strike near the Brazoria County site. The site is near Well No. 10. The lower limit of the 3000 mg/l zone is at about 1000 ft (305m) and the 10,000 mg/l about 2000 ft (610m) below sea level at the Well No. 10 location. There appears to be about 1000 ft (305m) of net sand containing saline water between 3000 ft (915m) and 6000 ft (1829m) at the Brazoria location.

The geology of a number of viable disposal projects in the general Brazoria area has been discussed in the literature.⁽¹⁶⁻¹⁸⁾ Although the rocks are complex piles of deltaic and marginal marine sandstones and shales,⁽¹⁹⁾ the continuities were great enough so that no instances of "filling up the aquifers" were reported.

The disposal aquifers have reported permeabilities ranging from 200 to 1500 md, porosities from 28 to 35% and static pressure gradients from 0.43 to 0.47 psi/ft (0.9-0.99 KPa/m). A rule of thumb was presented of 100 md for a minimum permeability.⁽¹⁶⁻¹⁸⁾

Fracture gradients of from 0.8 - 0.85 psi/ft (1.68 - 1.78 KPa/m) were reported for these same aquifers.⁽¹⁶⁻¹⁸⁾ Thus, maximum allowable surface pressures are in the order of:

Depth ft, (m)	Calculated Min. Frac. Pressure, psi, (MPa)	Fluid Column Pressure, psi, (MPa)	Estimated Pressure Drop, psi, (MPa)	Maximum Surface Pressure, psi, (MPa)
3000 (914)	2430 (16.7)	1295 (9.6)	75 (.5)	960 (6.6)
4000 (1219)	3240 (22.3)	1860 (11.8)	100 (.69)	1280 (8.8)
6000 (1829)	4860 (33.5)	2790 (19.2)	150 (1.03)	1920 (13.2)

The suggested aquifer evaluation technique was to take a complete set of geophysical logs from at least one of the disposal wells, and compare calculated rock and fluid properties with core and fluid analysis results (from samples collected in the zone of interest in the comprehensively logged well). Additional wells would be logged with the minimum suite which would allow comparative calculated rock and fluid properties. The available logs from the surrounding wells should be evaluated and compared with the disposal well logs to provide estimates of sand continuity and indications of nearby structural anomalies, especially faults. (20)

Production/drawdown-buildup tests are very useful not only to check calculated aquifer transmissivities but also to check on boundaries. (20)

The majority of waste disposal projects are relatively carefully designed systems, however 4% of the wells are failures due to poor geology or well construction, and an additional 25% have been plugged and abandoned because of well problems or less than anticipated injection fluids volume (surface system failures). Of the remaining viable disposal wells located on the Gulf Coast 93% are completed in the shallow sand aquifers previously discussed, 5% of these have reported injection rates above 14,000 B/D (2226 M³/D), and 40% above 3,500 B/D (556 M³/D). (21)

c. Mechanical and Chemical Problems

Some of the general brine injection problem areas discussed in the literature are:

- groundwater pollution
- surfacewater pollution
- surface subsidence
- earthquakes
- interference with other resource development(22)

The groundwater pollution could occur if (1) an injection well or wells leaked into a potable water zone, (2) the injection aquifer was overpressured and fractured into a groundwater aquifer, or (3) water leaked around or up through a poorly plugged and abandoned well up into a groundwater zone. Similar problems plus surface leaks could result in the pollution of surface water. Surface subsidence could occur if the injection water caused a rock-water reaction that resulted in the shrinkage of clays or other components. Earthquakes have been triggered by fluid injection in tectonically active areas, and a highly pressured aquifer could inhibit adjacent sulfur recovery projects or other resource developments. No examples of significant pollution, earthquakes, subsidence or interference with other resource development in the Gulf Coast areas were found in the literature.

Some of the specific brine disposal problems cited in the literature are:

- Organic growth
- Precipitation
- Scale deposition
- Corrosion
- Formation plugging
 - brine-connate water reaction
 - brine-rock reactions
 - clay swelling
 - mobilization of fines
 - phase separation
 - particle plugging(16-18,21,23-30)
- Formation disaggregation

The organic growth, precipitation, and scale deposition can usually be handled by additives in a closed system or by aeration, flocculation settling, and filtration in an open system. Combating corrosion requires proper material and equipment; and combating formation plugging require proper brine treatment, well design, and disposal aquifer selection.

In general it has seldom been possible to inject untreated brine over an extended period, (20,21) thus treating should be considered a "fact of life" in any disposal project. Adequate treatment depends upon applying good design procedures to a system where injection brine, formation fluid and formation rock properties are well characterized.

Some common features of good injection well designs, are displayed in Figures 4 and 5. The fresh water aquifers are cased with a string cemented to the surface, A. The major casing string, is cemented from TD to at least up inside the fresh water protection string, B. The injection string is packed off, and is fabricated from brine corrosion resistant material, C. all material exposed to the brine from the packer is fabricated from brine corrosion material, D. An attempt is made to stabilize the formation or provide some control so that sand will not be produced in quantity during the required backflow operations, E. An inert packer fluid is placed between the injection string and the long casing string, and the pressure is monitored to detect any leak in the packer or either string, F.

The well life is usually a function of the operator's ability to backwash, acid treat or otherwise renew the wells' injectivity which is impaired by sand face plugging. The formation generally disaggregation to a certain extent during each backwash operation, and that results in a subsequent collapse - generally terminating injection into the repeatedly backwashed interval.

d. Economic Aspects

The economics of brine injection are closely related to injection aquifer depths, volumes of brine handled, dispersion of gathering and injection facilities, complexity of treating plant and surface facilities, and monitoring requirements. Injection costs are discussed in the literature for several projects. (17,29)

<u>Project</u>	<u>Depth</u>	<u>Daily Volume</u>	<u>Costs</u>
East Texas	3600 ft.(1095m)	500,000B (72,600m ³)	2-3¢/B (14-21¢/m ³)
Hastings	2500-4300 ft. (760-1370m)	50,000B (7,300m)	4-5¢/B (28-35¢m ³)
Block 73*	4300 ft.(1311m)	50,000B (7,300m)	3-4¢/B (21-28¢/m ³) **

Capital costs are currently higher than the literature cases and a multiplier of at least 2 should be used. If some of the currently contemplated environmental programs are instituted a multiplier of 4 might be in order.

e. Environmental Aspects

Seven criteria have been suggested for environmental evaluation of subsurface brine disposal (31).

1. Alternatives have been explored and found to be more risky to environment.
2. Preinjection tests have been made sufficient to allow prediction of what will happen to brine.
3. Adequate evidence shows no harm will result.
4. The wastes are pretreated in the best practical manner.
5. The system is well designed and built.
6. Operators and effects are monitored adequately and continuously.
7. When the operation is terminated, the system is "safe" from the standpoint of future significant adverse environmental effects.

Each disposal operation should be evaluated against these criteria.

f. Legal and Institutional Aspects

The underground space has value and belongs to the landowner(32). There is legal precedence that the organization injecting fluids into the subsurface is liable for harm(33).

* Production, but handling similar to injection.

** Handling costs only.

The general Federal legal philosophy is that injection is permissible if (1) no contamination of surface or subsurface waters will occur, (2) no other damage to the environment is likely, and (3) no interference with present or potential use of subsurface waters is probable (34).

The state of Texas recently passed a Geothermal Resources Act (1975) in anticipation of geothermal development. Some of the measures effecting brine disposal are: (35)

- The operation of each geothermal resource well or well drilled for exploratory purposes shall be carried on so that no pollution of any stream or water course of this state, or any subsurface waters, will occur as the result of the escape or release or injection of geothermal resource or other mineralized waters from any well.

- All operators conducting geothermal resources development and production are prohibited from using saltwater disposal pits for storage and evaporation of geothermal resource waters. Impervious collecting pits may be approved for use in conjunction with approved saltwater disposal operations. Discharge of geothermal resource waters into a surface drainage water course, whether it be dry creek, a flowing creek, or a river, except when permitted by the Commission is not an acceptable disposal operation and is prohibited.

- The operator shall not pollute the waters of the Texas offshore and adjacent estuarine zones or damage the aquatic life therein. Geothermal resource well drilling and producing operations shall be conducted in such a manner to preclude the pollution of the waters of the Texas offshore and adjacent estuarine zones. The disposal of liquid waste material into the Texas offshore and adjacent estuarine zones shall be limited to saltwater and other materials which have been treated, when necessary, for the removal of constituents which may be harmful to aquatic life or injurious to life or property.

- Salt water unfit for domestic, stock, irrigation, or other general use may be disposed of by injection into the following formations: All nonproducing zones of oil, gas, or geothermal resources bearing formations that contain water mineralized by processes of nature to such a degree that the water is unfit for domestic, stock, irrigation or other general uses.

Another law, the Well Disposal Act, describes permitting procedures for injecting the two types of wastes. In Subchapter B, it states, "No person may begin drilling a disposal well or converting an existing well into a disposal well to dispose of industrial and municipal waste without first obtaining a permit from the Texas Water Quality Board." In Subchapter C, it states "No person may begin drilling a disposal well or converting an existing well into a disposal well to dispose of oil and gas waste without first obtaining a permit from the Railroad Commission of Texas." Clearly, the Well Disposal Act is in direct conflict with the Texas Geothermal Resources Act, assigning geothermal responsibilities to the Water Quality Board rather than the Texas Railroad Commission. This issue has not yet been decided in court. Cooperation does exist between the agencies however, as exemplified by the Disposal Act. Anyone requesting a waste injection permit from the Water Quality Board must obtain a letter from the Railroad Commission which states that the proposed well will not endanger oil and gas operations, and vice versa.

The state of Louisiana is currently preparing regulations for geothermal development. A number of the concepts under consideration will effect brine injection. The lead agency for geothermal regulation will be the Department of Conservation, which will administer the exploration and development of geopressured resources. The Stream Control Commission is responsible for the quality of surface waters. Other agencies with possible peripheral involvement are the Department of Public Works (freshwater wells) and the Department of Health (drinking water).

Injection of geothermal effluents into saline aquifers with greater than 10,000 mg/2 of total dissolved solids is currently considered to be the most desirable technique for waste disposal. The importance of water supplies and district water pollution regulations will largely eliminate surface water disposal.

3. DISPOSAL STATISTICS - TEXAS RAILROAD COMMISSION

Salt water disposal well permit data were obtained from George Singletary of the Railroad Commission for 1950 to 1978. Data were extracted for Brazoria, Galveston, Matagorda, Kenedy, Hidalgo, Willacy, Cameron, and Aransas counties and include 1) names of major oil company operators, 2) depths of proposed disposal intervals, 3) maximum and minimum expected disposal rates and 4) field names for some high rate wells only. Available expected wellhead pressures were also extracted. Only those Commission data which were readily available in log books and on computer printouts were used. More complete data are available in the permit application files, both at the Railroad Commission and the Department of Water Resources. Reports of actual volumes of salt water injected are not required by Texas law.

The number of permitted disposal wells, the number of permitted disposal wells for which the anticipated injection rates were obtained, and the number of these permitted disposal wells with anticipated maximum injection rates of 5,000 bbls/day or more are shown below for the counties of interest for the period January, 1950 through May, 1978.

COUNTY	Total No. of permitted disposal wells	Total No. of permitted wells for which expect- ed rates were obtained	Total No. of permitted wells for which rates were obtained with max. expected injection rates of ≥ 5000 bbl/day
ARANSAS	7	6	0
BRAZORIA	314	150	59
CAMERON	0	0	0
GALVESTON	48	13	1
HIDALGO	51	30	0
KENEDY	5	3	0
MATAGORDA	158	68	22
WILLACY	<u>27</u>	<u>13</u>	<u>0</u>
	610	283	82

As indicated in this tabulation, more than 50% of the disposal wells were permitted in Brazoria County and more than 25% in Matagorda County. Also, except for one well in Galveston County, all the high rate (maximum expected injection rate of 25,000 barrels/day) permitted wells identified in this investigation are located in these two counties. Roughly 35% of the wells for which rate data were obtained in

Matagorda and Brazoria Counties were high rate wells. (Rate data are available in the log books for most of the 1964 - 1975 period.) The high rate well data obtained are presented in Appendices A,B,and C.

a. High Rate Disposal Well Operators And Fields

Over ninety percent of the 82 identified high rate disposal wells permitted were drilled by major oil companies. These companies are given in Table 1, along with the numbers of permitted high rate wells identified for each. The fields in which these wells were drilled by these operators are presented as follows:

<u>Operator</u>	<u>Field</u>	<u>County</u>
AMOCO	Hastings, West Hastings, East	Matagorda, Brazoria Brazoria
EXXON	Hastings, West Hastings, East Sugar Valley	Brazoria Brazoria Matagorda
MARATHON	Markham, N. Bay City, N.	Matagorda Matagorda
MOBIL	Wadsworth SW Pheasant	Matagorda Matagorda
TEXACO	Manvel West Columbia	Brazoria Brazoria
INDEPENDENTS	Bay City Arch Hastings, West North Ranch Stratton Ridge	Matagorda Matagorda Brazoria Matagorda Brazoria

b. Depths of Disposal Intervals - High Rate Wells

The approximate depths to the base of disposal intervals are presented in Table 2 for the identified high rate wells. As indicated in this table, more than 90% of the intervals were no deeper than 6000 feet. In Brazoria County the preponderant depth of the interval base is between 4,000 and 6,000 feet and in Matagorda County, it is between 2,000 and 3,000 feet.

c. Disposal Interval Thicknesses-High Rate Wells

Table 3 depicts the approximate thicknesses of the identified permitted wells' disposal intervals. Considerable disparity in interval thicknesses is evident between Brazoria and Matagorda Counties. In Brazoria County 66% of the intervals

exceed 2000 feet in thickness and in Matagorda County, about 68% are less than 500 feet.

d. Distribution of Maximum Expected Disposal Rates for Identified High Rate Wells Permitted

The highest maximum expected disposal rate identified was 34,000 bbls per day. This rate was expected for a well permitted for Fenix and Scisson in the Stratton Ridge Field in Brazoria County. The median maximum expected disposal rate is 8,000 bbls/day. The distribution of rates for identified high rate wells is shown in Figure 6.

e. Expected Wellhead Pressures for Identified High Rate Disposal Wells.

Expected wellhead pressures were obtained for 30 of the 82 high rate disposal wells identified. These pressures range between 200 and 1600 psi with a median value of 250 psi. The distribution of pressures is shown in Figure 7.

The maximum expected pressure was 1600 psi. This well had a maximum expected rate of 8,000 bbls/day and an interval of 1600 feet at a depth of 2000-3600 feet. On the other hand, for the wells with expected pressure data, the expected pressure for the well with the maximum expected rate (25,000 bbls/day) was 950 psi. Interval thickness in this case was 1000 feet at a depth of 4,000 to 5,000 feet.

4. DISPOSAL STATISTICS - LOUISIANA OFFICE OF CONSERVATION

Salt water disposal well data were obtained from Charles King of the Office of Conservation, Baton Rouge for the following parishes: Acadia, Assumption, Calcasieu, Cameron, Iberia, Jefferson Davis, La Fourche, St. Mary, Terrebonne, and Vermilion. Data are available for all wells permitted by the Office of Conservation, most of which were completed since the early 40's. Annual disposal volumes for each well are on file for the years 1967 to present.

The total number of salt water disposal wells permitted and the number of "high rate" wells (wells through which at least one million barrels of salt water were injected in one year during the period 1967-1977) are listed as follows for all 10 parishes of interest.

As indicated in this tabulation, there are 184 "high rate" wells in these 10 parishes, which account for about 14% of the total number of disposal wells permitted.

<u>PARISH</u>	<u>Number of Wells Permitted</u>	<u>Number of Wells through which at least 1 million barrels of salt water were inject- ed in a single year (1967-1977 period)</u>
Acadia	238	28
Assumption	57	1
Calcasieu	165	24
Cameron	102	19
Iberia	75	15
Jefferson Davis	141	17
La Fourche	132	13
St. Mary	102	21
Terrebonne	103	19
Vermilion	<u>179</u>	<u>27</u>
Totals	1294	184

All available annual disposal volumes were extracted from the files of the Conservation Commission for all the "high rate" wells. These data, along with all available maximum observed surface injection pressures, operator names, field names, depths of latest completed injection zones, and injection start dates are presented in Appendices D - M.

In analyzing these data in terms of total volumes of salt water injected per well, it was found that there were 66 wells which had disposed of at least 10,000,000 barrels at

some time during 1967-1977 and 13 wells which had disposed of at least 20,000,000 bbls during this same period. One well in Acadia Parish has disposed of over 70,000,000 barrels of salt water, and during 1977 its average daily rate was still high (on the order of 26,000 bbls/day). The total numbers of wells which have disposed of salt water volumes in arbitrarily established ranges up to 75,000,000 bbls are presented in Table 4. As this table indicates, 36% of the "high rate" wells have already disposed of at least 10,000,000 barrels of salt water apiece. The total approximate volumes of salt water which were injected sometime during 1967-1977 via the 10,000,000 + bbl wells were calculated by assigning the midrange volume value from this table to each well. These approximate volumes are presented as follows for each parish of interest.

PARISH	Approximate volume (million barrels) of salt water injected via wells with a 10,000,000 BBL-minimum cumulative disposal volume during the period 1967-1977.	NO. OF WELLS
Acadia	208	9
Assumption	-	0
Calcasieu	170	10
Cameron	178	9
Iberia	58	3
Jefferson Davis	25	2
LaFourche	88	5
St. Mary	100	6
Terrebonne	148	9
Vermilion	233	13
Totals	1208	66

Maximum average daily injection rates for the high rate wells are presented for each parish in Table 5. The maximum observed average daily rate which was sustained for one year. as indicated in this table, is 30,000 bbls/day for a single well in Acadia Parish. This well was disposing of salt water in 1976 and in 1977 at rates (30,000 and 26,000 bbls/day respectively) in excess of the 10 year average of 20,000 bbls/day.

Individual disposal aquifer thicknesses range up to about 100 ft. according to Conservation Commission officials. The practice of the operators is to complete the lowermost disposal aquifer in each well and move up hole to another zone when the lowermost zone becomes ineffective for disposal. Indications that zones had been abandoned and others completed are abundant in the records examined. Actual zone thicknesses and dates of

recompletions are available in the individual well files in the Commission archives. Aquifer porosity, water salinity, and permeability data are not required for permitting and hence are not available.

The distribution of depths of the latest perforation tops for all the zones listed in Appendixes A-J are presented in the histogram in Figure 8. As indicated in this histogram the rounded depths of disposal zone tops range between 600 and 8800 ft. The median is 1900 ft. and 64% of the depths are in the range of 1300 to 2700 ft. Depth to the top of the latest perforations for the well with the highest rate (30,000 bbls/day - Acadia Parish) is 3,580 ft.

The distribution of maximum surface pressures is presented for the latest year reported in Figure 9. These pressures range from negative values to 2,800 psi. Median value is 280 psi. As indicated in the figure, 98% of the pressures range from a vacuum to 800 psi.

While a substantial number of recompletions were made, it is interesting to note that when comparing the earliest reported with the latest reported maximum surface pressures, 56% of the latest were either the same as or less than the earliest. Such is the case with the 30,000 bbls/day Acadia Parish Well-its maximum surface pressure was 350 psi for at least 11 years.

5. POLICIES FOR ADMINISTERING SALT WATER DISPOSAL OPERATIONS

The effectiveness of Louisiana and Texas state policies for administering subsurface salt water disposal operations coupled with the effectiveness of the operators' precautions has resulted in no reported cases of ground water pollution of any consequence in either state resulting from subsurface salt water disposal activities. The leaks around casing which have occurred have been stopped by plugging in the case of old abandoned wells, and by cement squeezing in the case of active wells. No leaks along geologic planes of weakness have been reported in either state.

a. Louisiana Policies

Applications for salt water disposal wells must be filed with the Department of Conservation's District Office. An application must include the following:

- "1. An electrical log of the well with proposed zone marked (in the case of wells already drilled), or the proposed zone to be used for disposal, and the approximate depth of said zone (in the case of undrilled wells).
2. A plat showing the location, or proposed location, of the well.
3. The casing and cementing program, including packers, etc.
4. Depth of tubing set or to be set.
5. Daily volume of salt water to be injected
6. Other instances in which proposed disposal zone has been used for previous salt water disposal."

The application is checked from both an engineering and geological standpoint and the operator is notified of approval or disapproval. A drawing of a typical disposal well installation which was provided by the Department of Conservation is presented in Figure 10. The Department's description of the installation is presented as follows:

"This well is operated by the Sun Oil Company in the Shuteston Gas Field. It is used for disposal of salt water produced by natural gas wells. The well is presently completed for injection of salt water in the sand occurring in the interval from 1,095-1,185 feet. This sand contains salt water and the top is 295' below the base of fresh water. It is separated from the fresh water by 175 feet of shale, 45 feet of sand which contains brackish water, and 75 ft. of salt water sand.

The well is completed as follows:

10 3/4 inch casing set at 95 feet, 45 sacks cement.

Circulated to surface.

7 inch casing set at 1,829 feet. Perforated from 1,165-1,175'. 465 sacks of cement. Circulated to surface.

2 7/8 inch tubing set on packer at 1,105 feet.

3,000 bbls. of salt water is injected per day.

Pressure 0-150 lbs.

Cast iron bridge plug set at 1,200 feet.

This well was originally completed for disposal in 1945 and two sands, 1,740-1,795' and 1,580-1,610', have previously been used for disposal of salt water. These zones became inadequate to handle the volume of salt water and the well was reworked and the present completion made in January 1963."

Operators are required to report maximum and minimum surface pressures and volumes of salt water injected for each well annually. District Office personnel carry out inspections periodically and should a problem develop, personnel from the Inspection and Enforcement section carry out an investigation.

b. Texas Policies

Applications for salt water disposal well permits are filed with the Austin Office of the Railroad Commission. The Texas Water Quality Board reviews the applications and makes recommendations to the Railroad Commission which approves or disapproves. Information required by the Commission includes:

1. Electrical log of the well or a log of a nearby well.
2. Area plat showing location of all wells within a half mile with surveys marked.
3. Well location, TD, ground surface elevation, date drilled.
4. Casing and tubing data.
5. Depth of injection zone's top and bottom.
6. Type of completion: perforation or open hole.
7. Cement squeeze operations documentation.
8. Depth of deepest fresh water zone and depth of shallowest productive oil or gas zone in the field.

9. Anticipated maximum and minimum injection volume and approximate pressure.
10. Whether it is an open or closed system.
11. Whether injection is by gravity or pressure.
12. Whether or not the water must be filtered or chemically treated.
13. Whether or not the well is so cased and completed that water can enter no other zone than that applied for.
14. Source of fluid to be injected.
15. Whether or not other salt water disposal wells are using the same zone in the same field.
16. Names and addresses of all offset operators and whether or not they have received notification of the application.

Tests of the integrity of salt water disposal well casing may be required, depending on the area, condition of the casing, age of the well, rate of injections and/or surface pressure. Such tests could be required either annually or semiannually.

c. Proposed Federal Regulations

The EPA has proposed regulations for underground injection control (40.CFR Part 146) in conformance with the mandates of the Safe Drinking Water Act, PL93-523, as amended by the Safe Drinking Water Amendments of 1977, PL 95-190. These proposed regulations will substantially increase the cost of salt water disposal if promulgated. They have generated considerable controversy in both Texas and Louisiana.

These repropoed regulations, dated April 28, 1978, as they apply to Louisiana and Texas specify the following for example:

1. Existing disposal wells must be re-permitted within 5 years after approval of State program.
2. Operator shall always retain burden of establishing that injection practice is in compliance.
3. An injection well can't be operated as to endanger or contaminate drinking water sources whether a permit is issued or not.
4. Prior to issuance of a permit and at a minimum of once every five years thereafter for the life of the permit, the operator shall conduct a surface monitored, down hole test and other tests as required to demonstrate well integrity.

5. Surface injection pressure and annulus pressure will be read weekly. (If an annulus is not available for monitoring, the requirement to monitor may be excluded.)
6. Quarterly reports will be made of all monitoring. This will include all periodic injection well tests, water analyses, and volume of fluid injection in the quarter.
7. Immediate reporting of any malfunction of the injection system which may endanger underground drinking water sources is required.
8. The following information must be filed for new injection wells:
 - a) ownership and location data
 - b) engineering data
 - c) a map showing well number, or name, and location of all producing wells, injection wells within the area of review. (Only wells of public record are required to be included.)
 - d) a tabulation of all wells within the area of review penetrating the injection zone, including data on plugging and/or completion and other information as required
 - e) type, source and characteristics of injection fluid, anticipated average and maximum daily injection volumes, and anticipated average and maximum injection pressure
 - f) appropriate geological data on injection zone and confining strata, including such data as lithologic or geological name, thickness, depth, and area of extent of zone
 - g) geologic name, lateral extent and depth to top and bottom of all underground drinking water sources which may be affected by the injection.
 - h) logging and testing program data
 - i) for wells not properly completed or plugged, the action proposed to be taken to prevent endangerment of underground water sources

6. SALT WATER DISPOSAL EXPERIENCE OF GULF COAST OPERATORS

Information on salt water disposal operations were provided for fields in the areas of interest in Texas and Louisiana. In all cases, backwashing of the injected zone is necessary and some cleanup of the salt water (oil and solids) is accomplished. A rough estimate of the typical completion life is on the order of 5+ years. Generally speaking, there are aquifers with the capacity to accept large quantities of salt water. The key problem is maintaining the effective permeability of the zone around the wellbore. All operators contacted perceive of disposing of 800,000 bbls/day of salt water as a major problem. Most, but not all, feel it can be done in their areas, however, providing that plugging problems can be minimized.

Representatives of a Gulf Coast subsurface fluid disposal design and engineering firm indicated that they believe that an 800,000 bbls/day disposal rate for a geopressured geothermal field is possible and that 30,000 to 40,000 bbl/day wells can be successfully operated. They have designed disposal wells which have successfully operated at the following rates:

Brine	- 60,000 bbls/day
Sour spent caustic	- 50,000 bbls/day
Brine with ammonium sulphate	- 35,000 bbls/day

They have found that screens are best in certain areas, simple perforations in others and open hole completions in still others.

Injected salt water has been known to leak up around the pipe in old wells. Such leakages have always been amenable to plugging in such cases and, of course, were plugged. Chances for "geologic" leaks are very remote.

Direction of movement of injected salt water can be controlled by bringing disposal wells on stream in a pre-determined timed sequence. Computer models of the disposal reservoir(s) system are used to predict fluid pressures as a function of distance from the injected well.

Pertinent data and assessments received from the oil company representatives are presented in the following section.

a. Field A

120,000 bbls of salt water per day are being injected at Field A via 7 disposal wells. (An additional pit well is utilized for backwash returns.) Maximum single well injection rate is about 30,000 bbls/day. High rate injection was initiated in this field in 1968 at an average rate of about 60,000 bbls/day and has continually increased since then to the current rate. Surface injection pressures range up to about 350 psi.

Salt water is injected into a sandstone aquifer at a depth of about 2,100 ft. This aquifer is on the order of 100 ft. thick with a porosity of about 40% and darcy permeability. Its continuity is very good. The aquifer is initially completed at the base. When this basal zone is rendered ineffective, the upper portion is completed for injection.

Both old oil wells and new disposal wells are used for injection. The new wells are cased with 7" casing and are equipped with 1½" to 2" tubing to facilitate backwashing. The well is completed using perforations. Two good completions are obtainable in each well.

Salt water cleanup is carried out in three 5,000-bbl. tanks. Oil is skimmed off and solids separated out. Hydroclones are used for further removal of solids. A gas blanket is maintained above the salt water in the tanks. Oil content of the injected salt water averages 100 ppm. and solids content, on the order of 5-10 ppm.

Some scaling and corrosion problems have been encountered. The inside of surface flow lines are plastic coated to counter these effects.

Backwashing is necessary during the early years of the well life, about twice per year and more often later on. Total injection capacity of a well is estimated to be about 18,000,000 bbls.

b. Field B

Subsurface salt water injection is being conducted in Field B at a current rate of about 25,000 bbls/day via 4-5 disposal wells. The rate has declined from about 40,000 bbls/day in 1968. Maximum single well rate is about 15,000 bbls/day. Injection pressures are on the order of 350 psi. They are normally not allowed to exceed this value.

Two good disposal zones are utilized in the 3100-3500' depth range. These zones range in thickness between about 60 and 80 ft.

Both old oil wells and new "disposal-only" wells are utilized. New wells are cased with 7" casing and are equipped with 1½" - 2" tubing to accomodate backwashing. Salt water is injected via the 7" casing.

Oil and solids are removed in two 5000-bbl tanks prior to injection. Oil content of the injected water averages about 30 ppm. Because of plugging, the wells must be backwashed on the order of 2 to 3 times per year early in the life of the well and more frequently prior to zone abandonment. A completed zone will accomodate about 7,000,000 bbls before it is rendered ineffective for disposal.

c. Field C

Salt water disposal rate at Field C is currently 40,000 bbls/day via 8-9 disposal wells. Maximum single well rate is about 10,000 bbls/day. Surface injection pressures average 0 to 15 psi and do not exceed 30 psi. Disposal operations have been carried out under these conditions for at least 10 years in this field.

Disposal horizons utilized occur in the 1000-2000 ft. depth range. Individual zone thicknesses are on the order of 30 ft. Two or three zones have been demonstrated to be capable of accomodating the rates required.

Both old oil wells and new wells drilled specifically for disposal are utilized. The new wells are cased with 7" casing and are equipped with 1½" to 2" diameter tubing to accomodate backwashing. Salt water is injected into the disposal horizons through the 7" casing.

Four horizontal 10' x 30' precipitator tanks are utilized to remove solids and skim the residual oil from the salt water prior to injection. A biocide is also utilized.

Backwashing is necessary 2 to 3 times per year during the early years of injection. Later this frequency is increased. Disposal completions last at least 5 years.

At this field, it has been found that wells which are used intermittently lose capacity much more rapidly than do those wells which are used continuously.

d. Field D

Currently, salt water is being disposed of in Field D (areal extent of 7,087 ac) at a rate of approximately 60,000 bbls/day via 15 disposal wells. The injection rate has been increased from 30,000 bbls/day in 1974 to this current rate. Individual well injection rates currently range from below 500 to 8,650 bbls/day. Most of the 15 wells have accomodated rates of 8,000 bbls/day at one time or another. Surface injection pressures range between 40 and 240 psi. A limit of 300 psi is employed.

Salt water is injected into Miocene sands at depths ranging between about 2,000 and 3,000 ft. Disposal aquifer thicknesses range between 20 and 50 ft. Their fluid pressures are normal.

Most of the disposal wells are old oil wells. Several new disposal wells have been drilled specifically for this purpose. Performances of both new and old wells are comparable. Most of the old wells are cased with 7" casing; some have larger casing. They are generally equipped with 2 7/8" plastic coated tubing set with a packer. Gas lift capability is incorporated in the wells for backflushing.

Single aquifers are used in each well. When an aquifer become incapable of sustaining the required flow, it is abandoned and a shallower one is completed. Effective completion life has been on the order of 5-6 years. Back-flushing is necessary and is carried out roughly once a month. Gas lift greatly improves the effectiveness of the back-washing. Pressure gauges on the annuli are used to detect tubing leaks. The effective life of the plastic coating on the tubing is on the order of 5 years. (A 1/2" cement lined tubing is available which is quite resistant to corrosion.)

Two ~ 5,000 bbl settling tanks are used to eliminate solids and to remove oil by skimming prior to injection. A gas blanket is maintained in the tanks to protect the water from oxygen. The oil content of the salt water is generally kept below 25 ppm.

Three problems which must be dealt with are corrosion, plugging of the aquifer pores, and scaling (primarily carbonate). The small amount of oil contained in the water probably contributes significantly to the plugging problem. Continued baskwashing to unplug the pores brings sand into the wellbores and eventually chunks of cement. The resultant slumping degrades the casing integrity and eventually the zone must be abandoned.

(Field D continued)

Multiple-aquifer completions have been tried and it has been found that the lower aquifer(s) get plugged with sand from the upper aquifer(s). Consequently, single-aquifer completions are utilized exclusively.

Some sands have been completed which have apparently had very little continuity since they were incapable of sustaining flow under the imposed pressure conditions.

e. Field E

Salt water has been disposed of at the rate of ~ 70,000 - 85,000 bpd for more than 5 years in Field E. Areal extent of the field is about 3 x 5 miles. Current injection rate is 83,000 bpd with 20+ disposal wells in operation. A wellhead pressure limit of 500 psi is employed and although a few wells approach 450 psi, injection pressures generally are less than 200 psi. Single well maximum injection rates were on the order of 3,500 bpd prior to April 1977. At this time, the rate for one well was increased to 10,000 bpd. Early in 1978, 5 wells were approaching this rate.

Salt water injection is carried out in non-productive Miocene salt water aquifers in the interval 2,000 to 5,300 ft. The salt water from the produced interval is compatible with that in the disposal aquifers. Average disposal aquifer thickness is 30' - 50'. Aquifer fluid pressure is normal.

The disposal wells are all old oil wells, most of which were drilled in the 30's and 40's. Most have 7" casing, although some have 5". The 7" wells are completed with a 5" liner and a packer (the 5½" wells have a 3½" liner with a packer). Pressure tests are conducted on the annuli of these wells annually.

The operator has obtained permission from the regulatory authorities to inject in all non-productive salt water aquifers in the interval above the productive horizon and below a point located at least 250' below a rather thick shale "caprock" which lies below the fresh water zone for most of the disposal wells. The practice is to perforate the lower-most sand and inject into it until the pressure limit of 500 psi is approached. Subsequently, the next overlying sand is perforated and injection is resumed.

Backwashing is periodically carried out when the well-head pressure increases to a specified point. With backwashing, individual sands are generally capable of accepting salt water for 2 to 5 years, some for as many as 10-15 years, at pressures less than 500 psi. Sand continuity is generally sufficient to accomodate injection under these conditions, although there have been sands completed which were not sufficiently continuous.

The salt water to be injected is cleaned up after it leaves the separator in a series of three tanks. Oil is skimmed from the top and sand is eliminated at the bottom of

(Field E continued)

each tank. After this cleanup operation, the oil content of the water is generally less than 50 ppm. A gas blanket is maintained on the water to protect it from oxygen. O_2 content is held below 1 ppm.

Should the operator need to drill new disposal wells, he would probably try an open-hole gravel pack with screen completion. It is believed that with higher operating pressures, the 10,000 bpd wells would be capable of 30,000 bpd.

7. FEDERAL STRATEGIC PETROLEUM RESERVE PROGRAM'S BRINE
DISPOSAL OPERATIONS

Mr. William Hahn of the Department of Energy's Strategic Oil Storage Program has provided the following information regarding their subsurface brine disposal operations:

<u>Salt & Dome Site</u>	<u>No. & Capacity of Disposal Wells</u>
Bryan Mound Brazoria County, Texas	1 Shallow operating well, 6,000-8,000 bpd.- 2 wells to be completed.
West Hackberry Cameron Parish, Louisiana	2 operating wells, 30,000 bpd/ea
Sulfur Mines, Calcasieu Parish, Louisiana	1 test well, 25,000 bpd possibly
Bayou Choctaw Iberville Parish, Louisiana	1 operating well, 12,000-16,000 bpd.

This group will probably be setting new records in the area of high rate, high volume brine disposal in that their solution mining cavern development operations will result in the production of about 7 bbls. of brine per bbl. of storage capacity mined. According to Mr. Hahn, storage capacity of 1 billion bbls. must be available by 1985. Approximately 300 million bbls. of capacity have already been acquired. The remainder will be acquired by 1) purchasing existing storage capacity, 2) expanding existing capacity, 3) leaching new caverns, and 4) possibly using a Canadian site. Mr. Hahn has indicated that their disposal operating data will be provided to the geopressured geothermal resource development program as it becomes available.

8. PROGNOSIS

a. Introduction

This prognosis will be in the form of a scenario for the development of a disposal facility located on the Gulf Coast of either Eastern Texas or Western Central Louisiana. The hypothetical project will be an integrated electric power generating and methane recovery complex with associated industries that will utilize the low level heat that is ejected from the power generation.

b. Site Evaluation

A suggested procedure for site evaluation includes a number of elements.

Surface information should be acquired for the general site area. This background information might include surface geological maps, topography maps, well location plots, ownership maps, and facilities/utilities maps. These illustrations will assist in the selection of specific well locations as well as providing a background for the subsidence data acquisition effort.

The subsurface background data that should be developed is an extensive laundry list. Generalized cross sections through and near the project area are available in the technical literature and in the voluminous publications of the several Gulf Coast geological societies. These sections provide a generalized picture of the sites stratigraphy. Generalized structural maps of the area, contoured on one or more of the aquifers in the target zone (3000-6000 ft, 914-1829m), should be one of the next acquisitions. Geophysical coverage of the area, if available, will usually enhance the subsurface picture obtained from the structural maps.

The logs and records of the wells in the general area should be the next type of information obtained. A study of the well logs should provide a more detailed picture of the structure and stratigraphy of the area and provide some insight into aquifer continuity if an area providing dense well spacing is present in the vicinity of the site.

The data package just discussed should provide the information necessary for the construction of generalized aquifer/aquitard (/aquiclude) model. The next step is to develop the rock and fluid properties and the production/injection history for the site area. BETC is setting up a

"U. S. Oil Field Water Data Bank" at O.U.* and the USGS has a water resource data program "WATSTORE"(36) which also contains ground water information. The SPWLA, State Agencies, other operators and technical publications also provide sources of water information. Rock property information may be present in the literature from state agencies or from other operators in the area, and some insight into porosity (and water salinity) can be obtained from an analysis of well logs.

Some preliminary rough calculations on injection water-concrete water instability problems (22) and injection water-aquifer rock problems can be made (25,26,37) using reaction simulation models discussed in the literature.

At this point a preliminary estimate of site suitability can be made, since estimates of aquifer characteristics, water-water and rock-water reactions, injectivities, interference, volumes, etc should be available. Based upon the preliminary estimate a preliminary design can be developed and the first well can be drilled, samples and logs evaluated, and tested.

c. Well Design and Construction

The purpose of the first well should be to obtain information and ultimately to serve as a viable injection well if the preliminary estimate of favorability is born out.

A conservative well design would locate the well in a convenient position with respect to both the power generation complex and associated facilities and to a position where a representative subsurface section and sampling program would be expected.

The physical characteristics of the surface location should be stable and not subject to adverse external influences such as floods, probability of transportation accident, etc. A convenient diameter surface casing should be cemented to the surface and tested. A fresh water protection string should be run at least 250 ft (76m) below the base of the "fresh" water (probably $\sim 10,000$ mg/l) or 3000 ft (914m) whichever is the shallower and cemented to the surface. A coring program should be included that provides samples of

* Personal communication, Gene Collins BETC, Bartlesville, Oklahoma

the overlying aquitard/aquiclude and the aquifer. The drilling fluids design should produce a gauge hole and the minimum particle invasion and formation damage. A comprehensive logging program should be carried out in both the upper 3000 ft (914m) and in the section below the protection string. The logs should include DIL, sonic, γ -n, density and caliper. The final casing string design should include material resistant to anticipated brine corrosion from the packer seat to T.D., and the cement used for this interval should also be resistant to brine attack. The final casing string should be cemented either up into the protection string or to the surface. The completion technique should be either gravel pack, screen, or perforations as determined by the aquifer conditions.

The well should be production tested and pressure breakdown and buildup and rate data obtained during the tests. These tests should be evaluated for evidence of boundaries. The produced aquifer fluids should be evaluated, and the compatibility of the connate water and injection water tested.

If instabilities occur, then a buffer fluid or some other stabilization technique should be factored into the injection plans.

The compatibility of the injection fluid and the aquiclude and aquitard/aquiclude material should also be evaluated. If adverse reactions are postulated as the result of these tests, then mitigation measures should be taken to insure formation stability at least near the well.

If the existing well locations or the injected well pattern allow, within-the-aquifer and between aquifer pulse testing should be carried out, to evaluate the storage coefficient and aquifer and aquitard/aquiclude permeabilities.

If well tests indicate a viable location, the subsequent steps in the subsurface brine disposal system construction can be carried out.

The actual injection should be carried out through a brine corrosion resistant tubing string, landed in a corrosion resistant packer and an inert packer fluid under pressure should be placed in the annulus between the casing and the tubing. This fluid pressure can be monitored to detect leaks in the casing/packer/tubing.

Old wells in the injection effected areas should be carefully evaluated and replugged or recemented if there is evidence that they might provide a path which would allow the injected to contaminate the fresh water.

Injection pressures should be kept low enough so that no formation fracturing will occur.

d. Surface Facilities

The surface facilities should be designed so that a non-plugging "clean" fluid is injected into the aquifer formation. This will probably incorporate a closed system to prevent oxidation of the brine, gas separation to prevent two phase segregation in the aquifer, chemical treatment, settling filtration, and final water polishing with well head filters. Surface construction should be of corrosion resistant material. The piping, valves, and vessels should be of adequate strength so that failure from inadvertent over pressure is unlikely.

There should be enough replication of equipment so that the injection can continue even if wells, filters, or portions of the system must be shut down for service or repair.

e. Operations and Monitoring

The chemistry of the injection water, the corrosion/erosion of equipment, the pressures, temperatures and injection volumes should be monitored as part of the disposal facility operations. In addition, water quality should be evaluated for all injection well location with Cerini type filter tests.

The down hole well conditions should be monitored periodically, as well as the aquifer and adjacent aquifer pressures and fluid composition if this can be accomplished at a reasonable information retrieval cost (or cost effective manner).

The principal down hole (expensive) operational problems will probably be associated with well bore plugging. This can usually be remedied by backwashing and/or chemical treatment. The capability for easy backwash should be built into the surface and downhole design. It is prudent to have the capability of evaluating and sampling the solids entrained in the backwashed fluids. This allows optimum selection of chemical treatment as well as providing a good insight into the condition of the completion interval in each well.

A critical factor in a minimum cost continuing injection program is the continued adequate monitoring and competent supervision of the day to day injection operation.

Based upon the literature survey, it would appear that subsurface brine disposal should be possible in the general area of the Brazoria County site and in the areas of the proposed Louisiana sites. The required rates should be obtainable if an adequate evaluation is carried out, and if a well designed and constructed surface and subsurface facility is utilized.

Table 1. Number of Identified High Rate* Disposal Wells Permitted 1964-1978 As a Function of Field Operator.

County	Amoco	Exxon	Marathon	Mobil	Texaco	Independents	Total
Brazoria	26	14			16	3	59
Galveston	1						1
Matagorda	<u>1</u>	<u>1</u>	<u>12</u>	<u>3</u>	<u>—</u>	<u>5</u>	<u>22</u>
TOTALS	28	15	12	3	16	8	82

Table 2. Number of Identified High Rate* Disposal Wells Permitted 1964-1978 As a Function of Disposal Interval Base Depth.

County	Disposal Interval Base Depth, 1,000's ft							Total
	<u>0<1</u>	<u>1<2</u>	<u>2<3</u>	<u>3<4</u>	<u>4<5</u>	<u>5<6</u>	<u>≥ 6</u>	
Brazoria	1		4	7	14	30	3	59
Galveston						1		1
Matagorda	<u>—</u>	<u>2</u>	<u>17</u>	<u>—</u>	<u>—</u>	<u>1</u>	<u>2</u>	<u>22</u>
TOTALS	1	2	21	7	14	32	5	82

Table 3. Number of Identified High Rate* Disposal Wells Permitted 1964-1978 As a Function of Disposal Interval Thickness.

County	Disposal Interval Thickness, 100's ft					Total
	<u>< 5</u>	<u>5<10</u>	<u>10<20</u>	<u>20<30</u>	<u>≥ 30</u>	
Brazoria	7	6	7	20	19	59
Galveston					1	1
Matagorda	<u>15</u>	<u>5</u>	<u>—</u>	<u>—</u>	<u>2</u>	<u>22</u>
TOTALS	22	11	7	20	22	82

*Maximum expected injection rate of 5,000 bbls/day or more.

		Number of High Rate* Disposal Wells Operative For At Least One Year-During 1967-1977 With Cumulative Disposal Volumes (Million bbls) During This Period Of:											
PARISH	NUMBER FIELDS	< 10	10-15	15-20	20-25	25-30	30-35	35-40	40-50	50-55	55-70	70-75	10-75
ACADIA	15	19	4	3			1					1	28
ASSUMPTION	1	1											1
CALCASIEU	10	14	6	2	1			1					24
CAMERON	9	10	3	5						1			19
IBERIA	5	12	1	1		1							15
JEFFERSON DAVIS	6	15	2										17
LAFOURCHE	5	8	3		1	1							13
ST. MARY	5	15	1	5									21
TERREBONNE	7	10	4	3	2								19
VERMILLION	10	14	4	6	1	2							27
TOTALS	73	118	28	25	5	4	1	1		1		1	184

* Arbitrarily defined as a least 1 million barrels/yr for 1 full year.

TABLE 4 Number of High Rate saltwater disposal wells and cumulative disposal volumes, 1967-1977, in 10 Louisiana Parishes.

MAXIMUM AVERAGE DAILY INJECTION RATES (10 ³ BBLS/D) FOR A SINGLE HIGH RATE WELL DURING 1967-1977 FOR TIME PERIODS (YEARS) OF:												
PARISH	1	2	3	4	5	6	7	8	9	10	1967 RATE	1977 RATE
ACADIA	30	29	28	26	24	24	23	23	21	20	30	26
ASSUMPTION	5	5	5	5	4	4					4	*
CALCASIEU	18	13	14	13	12	12	11	12	12		12	*
CAMERON	29	28	27	25	22	29	19				29	18
IBERIA	12	12	9	8	8	8	8	8	7	7	6	4
JEFFERSON DAVIS	6	5	5	5	5	5	4				**	
LA FOURCHE	9	8	8	8	8	8	8	8	8	8	7	*
ST. MARY	11	10	10	9	8	8	7	6	6		3	1
TERREBONNE	17	15	13	10	8	7	7	6	6	6	5	*
VERMILLION	15	12	10	10	9	9	8	8	7	7	3	3

* Not available

** Stopped injection 1974

TABLE 5 Maximum Average Daily Injection Rates for Single Wells in 10 Louisiana Parishes During the period 1967-1977

FIGURE 1. Geopressured Geothermal Prospects in Southern Louisiana (Louisiana State University Map presented at the 5th Meeting of the Environmental/Laboratory Research Working Subgroup-DOE/Industry Geopressured Geothermal Resource Development Forum - Houston, Texas July 18, 1978)

FIGURE 2. Geopressed Geothermal Fairways, Texas Gulf Coast (after Bebout, D. G., R. G. Loucks, A. R. Gregory, "Study Looks at Gulf Coast Geothermal Potential", Oil and Gas Journal, Sept. 26 and Oct. 3, 1977)

FIGURE 3. Cross Section Perpendicular to Texas Gulf Coast Located near Brazoria County Site.

FIGURE 4. Gravel Pack completion.

- (A) Freshwater protection string
- (B) Long string cemented
- (C) Injection String
- (D) Corrosion resistant down hole assembly
- (E) Sand control technique
- (F) Noncorrosive fluid under pressure between packer and long string.

FIGURE 5. Screen completion

- (A) Freshwater protection string
- (B) Long string cemented inside pipe
- (C) Injection String
- (D) Corrosion resistant down hole assembly
- (E) Sand control technique
- (F) Noncorrosive fluid under pressure between packer and long string.

Figure 6. Distribution of Maximum Expected Disposal Rates for 82 High Rate Wells Permitted in Brazoria, Galveston and Matagorda Counties, Texas

Figure 7. Distribution of Expected Wellhead Disposal Pressures for 30 High Rate Disposal Wells Permitted in Brazoria and Matagorda Counties, Texas

FIGURE 8. Depth to Top of Latest Perforations of Disposal Zones in Wells which have Disposed of at least 1 million bbls of Salt Water in a Single Year in 10 Louisiana Parishes, ft. (rounded to nearest 100 ft.)

FIGURE 9. Latest Reported Maximum Surface Pressures for Wells which have Disposed of at least 1 million bbls of Salt Water in a Single Year in 10 Louisiana Parishes, psi (rounded to nearest 20 psi)

SALT WATER DISPOSAL WELL NO. 1
BURLEIGH - MILLER POOL
SHUTESTON FIELD
ST LANDRY PARISH
SEC. 37, T. 7 S., R. 4 E.

FIGURE 10. Typical Louisiana Disposal Well Installation

APPENDIX A

LIST OF IDENTIFIED HIGH RATE (5,000+ bbls/d expected maximum
disposal rate) DISPOSAL WELLS PERMITTED 1964-1978
BRAZORIA, COUNTY, TEXAS

<u>Operator</u>	<u>Field</u>	<u>Disposal Interval Depth, Nearest 100 ft.</u>	<u>Expected Disposal Rate, 1000 bbls/d</u>	<u>Expected Wellhead Pressure, psi</u>
Exxon	Hastings	21-51	8.0	
Amoco	Hastings	35-72	5.0	
Amoco	Hastings	42-49	5.0	
Exxon	Hastings,W	21-52	5.0	
Amoco	Hastings	23-52	5.0	
Texaco	Manvel	44-51	.5-7.2	
Amoco	Hastings,W	48-52	3.0-10.0	
Exxon		17-53	5.0	
Pet. Co. Tx.	Hastings,W	32-32	2.0-6.0	
Exxon	Hastings,E	21-50	7.0	
Amoco	Hastings,E	27-47	3.0-10.0	
Amoco	Hastings,E	20-52	3.0-10	
Exxon	Hastings,E	19-53	3.0- 5	
Amoco	Hastings,E	20-53	3.0-10	
Exxon	Hastings	20-32	5.0-10	
Amoco	Hastings,W	20-49	1.5-7.5	
Amoco	Hastings	23-50	1.5-7.5	
Amoco		22-42	2.0-7.5	
Texaco	Manvel	41-51	0-10	
Texaco	Manvel	26-37	6.0-8	
Texaco	Manvel	42-45	0-6.5	
Texaco	Manvel	42-45	0-7.0	
Texaco	W. Columbia	6-9	10.0-15	
Texaco	Manvel	22-30	.5-8.0	
F & S	Stratton Ridge	31-50	28.0-34.0	
Texaco	Manvel	26-31	2.0-7.0	
Amoco	Hastings	23-56	3.0-10	
Texaco	Manvel	26-32	1.0-7.0	
Texaco		44-48	10.0-16.0	
Exxon		21-54	7.0	
Amoco		23-53	3.0-10.0	250
Amoco		21-51	1.0-5.0	250
Amoco		23-53	3.0-10	250
Amoco		24-52	3.0-10	250
Amoco		23-52	3.0-10	250
F & S		40-50	15.0-25.0	950
Amoco		23-52	3.0-10.0	250

APPENDIX A

List of Identified High Rate (5,000+ bbls/d expected maximum disposal rate) Disposal Wells Permitted 1964-1978
Brazoria, County, Texas

<u>Operator</u>	<u>Field</u>	<u>Disposal Interval Depth, Nearest 100 ft.</u>	<u>Expected Disposal Rate, 1000 bbls/d</u>	<u>Expected Wellhead Pressure, psi</u>
Exxon		17-39	.2-5	600
Texaco		20-67	0-8	500
Texaco		20-36	.5-8	1600
Texaco		21-23	.5-8	600
Amoco		21-52	2.0-6	100
Amoco		21-52	3.0-8	250
Amoco		21-50	2.0-8	200
Amoco		21-53	3.0-8	200
Amoco		21-49	3.0-8	250
Amoco		21-53	2.0-8	500
Amoco		21-51	3.0-8	250
Texaco		46-61	10.0-15	1000
Texaco		21-45	0-5.0	800
Texaco	Manvel	21-28	0-5.0	1000
Amoco		22-51	3.0-10	250
Exxon		22-43	0-7.0	200
Exxon		21-43	0-7.0	200
Exxon	Hastings, W.	23-24	0-7.0	200
Amoco	Hastings, W.	29-53	7.5	500
Exxon		23-52	1.0-5	600
Exxon	Hastings, W.	25-49	3.0-7	600
Exxon		27-52	3.0-7	600

APPENDIX B

LIST OF IDENTIFIED HIGH RATE (5,000+ bbls/d expected maximum disposal rate) DISPOSAL WELLS PERMITTED 1964-1978
MATAGORDA, COUNTY, TEXAS

<u>Operator</u>	<u>Field</u>	<u>Disposal Interval Depth, Nearest 100 ft.</u>	<u>Expected Disposal Rate, 1000 bbls/d</u>	<u>Expected Wellhead Pressure psi</u>
Skelly	Bay City	16-17	4.0-8.0	
Texas Pacific	Arch	23-24	1.0-5.0	
Marathon		20-21	5.0-10.0	
Amoco	Hastings,W.	18-53	3.0-10.0	
Marathon	Markham,N.			
	Bay City,N.	20-20	5.0-10.0	
Mobil	Wadsworth	20-29	1.5-5.0	
Marathon	Markham,N.			
	Bay City,N.	17-17	5.0-8.0	
Marathon	Markham,N.	25-25	5.0-8.0	
Mobil	SW Pleasant	17-21	3.0-5.0	
Skelly	Bay City	21-21	2.0-5.0	
Mobil	Wadsworth	16-22	1.5-5.0	
Marathon	Markham,N.	24-25	4.0-10	
	Bay City			
Marathon	Markham,N.	23-24	5.0-10	
	Bay City,N.			
Marathon	Markham,N.	19-21	2.0-8	
	Bay City,N.			
Marathon	Markham,N.	23-24	4.0-10	
	Bay City,N.			
Skelly	Bay City	17-23	4.5-7.0	
Exxon	Sugar Valley	14-60	5.0-10	
Marathon	Markham,N.	23-26	5.0-8	
	Bay City,N.			
	N. Ranch	24-25	4.0-6	
Marathon	Markham,N.	80-81	4.0-8	
	Bay City,N.			
Marathon		80-81	3.0-5	
Marathon		20-28	8.0	400

APPENDIX C

LIST OF IDENTIFIED HIGH RATE (5,000+ bbls/d expected maximum
disposal rate) DISPOSAL WELLS PERMITTED 1964-1978
GALVESTON COUNTY, TEXAS

<u>Operator</u>	<u>Field</u>	<u>Disposal Interval Depth, Nearest 100 ft.</u>	<u>Expected Disposal Rate, 1000 bbls/d</u>	<u>Expected Wellhead Pressure, psi</u>
Amoco	Hastings	20-52	10.0	

SALT WATER DISPOSAL STATISTICS FOR WELLS IN ACADIA PARISH, LOUISIANA
INTO WHICH AT LEAST 1,000,000 BARRELS HAVE BEEN INJECTED IN A SINGLE YEAR

APPENDIX D

Field/Operator	Start Date	Latest Perf. Depth, ft.	Annual Volume Injected, 10 ⁶ bbls Maximum Pressure, psi										
			1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Bayou Mallet/ Union		2468- 88	<u>1.1</u> <u>115</u>	<u>1.1</u> <u>115</u>	<u>.9</u> <u>115</u>	<u>.8</u> <u>115</u>	<u>.6</u> <u>150</u>	<u>.5</u> <u>135</u>					
Bayou Mallet/ K&H Op.			<u>1.5</u>	<u>1.0</u> <u>400</u>									
Bayou Mallet/ Superior		2144-2201	<u>.9</u> <u>190</u>	<u>.8</u> <u>190</u>	<u>.9</u> <u>175</u>	<u>1.0</u> <u>175</u>	<u>1.3</u> <u>150</u>	<u>1.2</u> <u>175</u>	<u>.9</u> <u>150</u>	<u>.8</u> <u>180</u>	<u>.7</u> <u>175</u>	<u>.8</u> <u>180</u>	<u>.8</u> <u>180</u>
Bosco/ Superior		3280-3330	<u>3.0</u> <u>200</u>	<u>2.8</u> <u>200</u>	<u>2.7</u> <u>420</u>	<u>3.2</u> <u>260</u>	<u>3.5</u> <u>360</u>	<u>3.2</u> <u>440</u>	<u>3.2</u> <u>470</u>	<u>2.8</u> <u>440</u>	<u>2.9</u> <u>475</u>	<u>3.2</u> <u>700</u>	<u>3.7</u> <u>700</u>
Church Pt./ Getty	62	1920-1835	<u>.6</u> <u>600</u>	<u>1.0</u> <u>600</u>	<u>.8</u> <u>600</u>		<u>.4</u> <u>600</u>	<u>1.5</u> <u>600</u>	<u>1.1</u> <u>600</u>	<u>1.1</u> <u>600</u>	<u>.9</u> <u>600</u>	<u>.7</u> <u>600</u>	<u>.5</u> <u>600</u>
Egan/Sun	2/65	1450- 70	<u>.9</u> <u>290</u>	<u>.8</u> <u>290</u>	<u>1.0</u> <u>290</u>	<u>1.6</u> <u>290</u>	<u>1.9</u> <u>290</u>	<u>1.4</u> <u>290</u>	<u>1.8</u> <u>290</u>	<u>1.4</u> <u>290</u>	<u>1.5</u> <u>290</u>	<u>1.7</u> <u>290</u>	<u>1.8</u> <u>290</u>
Egan/Sun	12/63	1340- 60	<u>1.2</u> <u>280</u>	<u>1.5</u> <u>280</u>	<u>1.2</u> <u>280</u>	<u>1.1</u> <u>280</u>	<u>1.2</u> <u>280</u>	<u>1.2</u> <u>280</u>	<u>.9</u> <u>280</u>	<u>.8</u> <u>280</u>	<u>.8</u> <u>280</u>	<u>1.3</u> <u>280</u>	<u>1.8</u> <u>280</u>
Egan/Sun	12/63	1390-1440	<u>.6</u> <u>290</u>	<u>.4</u> <u>290</u>	<u>.7</u> <u>290</u>	<u>1.0</u> <u>290</u>	<u>1.0</u> <u>290</u>	<u>.8</u> <u>290</u>	<u>.3</u> <u>290</u>	<u>1.1</u> <u>290</u>	<u>.9</u> <u>290</u>	<u>1.1</u> <u>290</u>	<u>1.3</u> <u>290</u>
Egan/Sun	12/63	2070- 80	<u>1.4</u> <u>290</u>	<u>1.2</u> <u>290</u>	<u>1.2</u> <u>290</u>	<u>1.4</u> <u>290</u>	<u>1.3</u> <u>290</u>	<u>.5</u> <u>290</u>	<u>.3</u> <u>290</u>	<u>.3</u> <u>290</u>	<u>.6</u> <u>290</u>	<u>.3</u> <u>290</u>	<u>.6</u> <u>290</u>
Egan/Sun	11/66	2210- 20	<u>1.1</u> <u>800</u>	<u>.2</u> <u>800</u>	<u>.3</u> <u>800</u>	<u>.1</u> <u>800</u>							
Egan/Sun	11/71	1360- 74 1950- 58						<u>1.4</u>	<u>1.3</u>	<u>1.2</u>	<u>1.5</u>	<u>1.2</u>	<u>.9</u>

SALT WATER DISPOSAL STATISTICS FOR WELLS IN ACADIA PARISH, LOUISIANA
INTO WHICH AT LEAST 1,000,000 BARRELS HAVE BEEN INJECTED IN A SINGLE YEAR

APPENDIX D

Field/Operator	Start Date	Latest Perf. Depth, ft.	Annual Volume Injected, 10 ⁶ bbls										
			Maximum Pressure, psi										
			1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Egan/Sun	11/66	2060- 90	<u>.8</u> 300	<u>.9</u> 300	<u>.4</u> 300	<u>.6</u> 300	<u>1.1</u> 300	<u>.7</u> 300	<u>.4</u> 300	<u>.5</u> 300	<u>.3</u> 300	<u>.2</u> 300	
Ellis/Sun	12/63	1860- 80	<u>1.1</u> 385	<u>1.0</u> 385	<u>.8</u> 385	<u>.9</u> 385	<u>.9</u> 385	<u>.1</u> 385		<u>.1</u> 385	<u>.2</u> 385	<u>.3</u> 385	<u>.3</u> 385
Lawson/Humble	1/67	5050- 70	<u>.2</u>	<u>1.2</u> 575	<u>.6</u> 100	<u>.3</u> 700	<u>.1</u> 700						
Midland/Arco	8/67	5790-5800			<u>.7</u> 550	<u>.8</u> 550	<u>.7</u> 550	<u>1.5</u> 550	<u>1.2</u> 550	<u>1.4</u> 550	<u>1.0</u> 150	<u>1.5</u> 150	<u>1.3</u> 150
Midland/Arco		1557- 67			<u>.4</u> 400	<u>.5</u> 400	<u>.5</u> 400	<u>1.6</u> 400	<u>.9</u> 400	<u>1.1</u> 400	<u>1.3</u> 400	<u>1.5</u> 400	<u>1.8</u> 400
N. Crowley/Humble		3674- 98	<u>1.9</u>	<u>2.2</u> 350	<u>2.5</u> 350	<u>1.3</u> 400	<u>.4</u> 500	<u>.4</u> 500	<u>1.5</u> 500	<u>2.8</u> 500	<u>.5</u> 500	<u>.6</u> 500	<u>.5</u> 500
N. Crowley/Humble		3580-3600	<u>1.9</u> 350	<u>2.2</u> 350	<u>2.5</u> 350	<u>6.8</u> 350	<u>7.8</u> 350	<u>7.8</u> 350	<u>6.8</u> 350	<u>6.6</u> 350	<u>10.4</u> 350	<u>10.9</u> 350	<u>9.6</u> 350
N. Crowley/Humble	8/67	5570-5610	<u>1.1</u>	<u>2.2</u> 350	<u>2.3</u> 350	<u>.4</u> 500	<u>.4</u> 500	<u>.4</u> 600	<u>1.5</u> 600				
N. Tepetate/Arco	3/67	4760- 70			<u>1.6</u> 200	<u>.7</u> 200	<u>.1</u> 200	<u>1.3</u> 200	<u>1.1</u> 200	<u>.9</u> 200	<u>.9</u> 200	<u>.8</u> 200	<u>1.0</u> 200
Rayne/Conoco		2178-2216	<u>1.1</u> 135	<u>1.2</u>	<u>.9</u> 135	<u>1.0</u> 200	<u>1.0</u> 40	<u>.1</u> 20	<u>.7</u> 120	<u>.9</u> 138	<u>1.0</u> 131	<u>1.0</u> 175	<u>1.1</u> 105
Rayne/Conoco	4/72	3560- 90						<u>.7</u> 110	<u>.7</u> 120	<u>1.4</u> 60			

SALT WATER DISPOSAL STATISTICS FOR WELLS IN ACADIA PARISH, LOUISIANA
INTO WHICH AT LEAST 1,000,000 BARRELS HAVE BEEN INJECTED IN A SINGLE YEAR

APPENDIX D

Field/Operator	Start Date	Latest Perf. Depth, ft.	Annual Volume Injected, 10 ⁶ bbls										
			Maximum Pressure, psi										
			1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Ritchie/ Nicklas O&G	2/75	2680-2710									1.1 200	1.1 200	1.1 200
Ritchie/ Nicklas O&G	7/75	2680-2710									.5 200	1.1 200	1.1 200
So. Bayou Mallet/ Union Texas		2720- 45	1.1 115	1.1 115									
Tepetate/Conoco		2870- 90 2909- 85	8.1 700	1.7 700	1.6 700	.5 750					.7 600		
Tepetate/Conoco		1656- 69 1698-1728								3.1 550	.7 600		
Tepetate/Conoco		3820- 70 4200-4260			1.6 700	.3 750	.5 700	.7 600	.7 600				

SALT WATER DISPOSAL STATISTICS FOR WELLS IN ASSUMPTION PARISH, LOUISIANA
 INTO WHICH AT LEAST 1,000,000 BARRELS HAVE BEEN INJECTED IN A SINGLE YEAR

APPENDIX E

Field/Operator	Start Date	Latest Perf. Depth, ft.	Annual Volume Injected, 10 ⁶ bbls										
			Maximum Pressure, psi										
			1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
E. Lake Palourde/ Union	12/70	2584-2624					1.3 650	1.8 750	1.6 600	1.5 600	1.6 700	1.4 800	

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SALT WATER DISPOSAL STATISTICS FOR WELLS IN CALCASIEU PARISH, LOUISIANA
INTO WHICH AT LEAST 1,000,000 BARRELS HAVE BEEN INJECTED IN A SINGLE YEAR

APPENDIX F

Field/Operator	Start Date	Latest Perf. Depth, ft.	Annual Volume Injected, 10 ⁶ bbls										
			Maximum Pressure, psi										
			1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Beckwith Creek/ Sun	9/67	3315- 37		<u>1.3</u>	<u>.6</u> 1500	<u>.5</u> 500	<u>.4</u> 500	<u>.6</u> 1500	<u>.3</u> 1500	<u>.4</u> 1500	<u>.5</u> 1500	<u>.4</u> 1500	<u>.4</u> 1500
Bell City/Sohio	11/64	2209- 40	<u>1.2</u>						<u>.6</u> 0				<u>.5</u> 180
De Quincy/ Res O&G	5/74	4000-5100										<u>3.1</u> 400	<u>2.8</u> 500
De Quincy/ Res O&G		3100-3650	<u>.7</u>	<u>1.6</u>	<u>1.7</u> 1000							<u>.6</u> 500	<u>.3</u> 400
De Quincy/ Res O&G	4/51	3590-3690	<u>.7</u>	<u>.9</u>	<u>1.1</u>								
De Quincy/ Gen Am.		3250-3290		<u>.9</u>		<u>1.3</u> 500	<u>1.5</u> 550	<u>1.3</u> 720	<u>1.4</u> 425	<u>.9</u> 600	<u>1.1</u> 600		<u>1.2</u> 600
E. Moss Lake/ Conoco		2154-2222		<u>.1</u> 460	<u>.2</u> 460	<u>.1</u> 200	<u>.2</u> 450	<u>.1</u> 140		<u>1.2</u> 180	<u>.1</u> 450	<u>.2</u> 525	<u>.2</u> 260
E. Moss Lake/ Dawson	3/69	7080-7200			<u>.5</u> 500	<u>1.0</u> 250	<u>1.5</u> 250	<u>1.6</u> Vac					
Gillis-English Bayou/ Sun	8/63	3010- 30	<u>.2</u>	<u>.2</u>	<u>.2</u> 300	<u>.2</u> 300	<u>.2</u> 300	<u>.1</u> 300	<u>.2</u> 300	<u>.2</u> 300	<u>.2</u> 210	<u>1.8</u> 300	<u>.1</u>
Iowa/Shell	6/73	4220- 50							<u>2.7</u> 380	<u>6.0</u> 350	<u>2.7</u> 325	<u>3.4</u> 325	
Iowa/Shell	1/66	3008- 40	<u>1.3</u>	<u>1.1</u> 300	<u>1.7</u>	<u>.5</u> 300	<u>.9</u> 350	<u>1.9</u> 400	<u>1.1</u> 350	<u>.6</u> 420	<u>.8</u> 475	<u>1.0</u> 475	
Iowa/Shell	8/74	4240- 66								<u>.8</u> 350	<u>1.5</u> 350	<u>2.1</u> 350	

SALT WATER DISPOSAL STATISTICS FOR WELLS IN CALCASIEU PARISH, LOUISIANA
INTO WHICH AT LEAST 1,000,000 BARRELS HAVE BEEN INJECTED IN A SINGLE YEAR

APPENDIX F

Field/Operator	Start Date	Latest Perf. Depth, ft.	Annual Volume Injected, 10 ⁶ bbls										
			1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Iowa/Shell		2046-70	<u>.3</u>	<u>6.0</u>	<u>3.1</u> 300	<u>6.5</u> 300	<u>3.3</u> 360	<u>3.3</u> 385	<u>3.4</u> 385	<u>3.1</u> 350	<u>5.0</u> 350	<u>4.4</u> 350	
Iowa/Shell	8/68	3209- 24		<u>.2</u>	<u>1.7</u> 300	<u>1.3</u> 300	<u>5.2</u> 250	<u>6.1</u> 420	<u>3.7</u> 400	<u>.6</u> 350			
Iowa/Shell	4/65	3358-3463	<u>2.1</u>	<u>2.2</u>	<u>3.8</u> 300	<u>1.3</u> 300	<u>.8</u> 275	<u>.1</u> 750	<u>.9</u> 400	<u>.3</u> 350			
Manchester/ Pan Am.	7/68	4000-		<u>1.8</u>	<u>1.3</u>	<u>1.5</u>	<u>1.5</u>	<u>.3</u>	<u>.3</u>	<u>.7</u>		<u>.3</u>	<u>.3</u>
N. Chalkey/Sun	2/66	1705- 25				<u>1.0</u>	<u>1.4</u>	<u>1.3</u>	<u>.8</u>	<u>.8</u>	<u>1.0</u>	<u>.3</u>	<u>.6</u>
Perkins/ Gen Am	12/70	4385-4420				<u>2.6</u> 200	<u>2.8</u> 350	<u>2.2</u> 720					
Perkins/ Gen Am		4385-4420	<u>1.6</u>	<u>2.1</u>	<u>2.9</u>				<u>1.9</u> 310	<u>2.3</u> 400	<u>2.6</u> 400		<u>2.9</u> 400
Vinton/Union	2/70	2122-2211				<u>2.1</u> 550	<u>2.1</u> 600	<u>2.1</u> 600	<u>1.6</u> 600	<u>1.2</u> 900	<u>1.0</u> 375	<u>1.0</u> 375	<u>1.3</u> 400
Vinton/Union	1/69	2393-2580				<u>2.3</u> 550	<u>1.8</u> 600	<u>1.5</u> 600	<u>2.2</u> 550	<u>3.9</u> 450	<u>3.5</u> 375	<u>4.0</u> 375	<u>3.2</u> 400
Vinton/Union	5/73	2457- 87							<u>.2</u> 550	<u>1.0</u> 300	<u>2.2</u> 400	<u>2.3</u> 420	<u>1.6</u> 420
Vinton/Union	5/69	1879-2580				<u>1.3</u> 550	<u>1.1</u> 600	<u>1.7</u> 600	<u>1.6</u> 550	<u>2.3</u> 450	<u>1.5</u> 350	<u>1.5</u> 350	<u>1.3</u> 400
Vinton/Union	4/72	1862-1944							<u>3.4</u> 550	<u>3.3</u> 450	<u>2.2</u> 350	<u>1.6</u> 350	<u>1.4</u> 400

SALT WATER DISPOSAL STATISTICS FOR WELLS IN CAMERON PARISH, LOUISIANA
INTO WHICH AT LEAST 1,000,000 BARRELS HAVE BEEN INJECTED IN A SINGLE YEAR

Field/Operator	Start Date	Latest Perf. Depth, ft.	Annual Volume Injected, 10 ⁶ bbls										
			Maximum Pressure, psi										
			1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Cameron/Amoco	12/71	3250-3425						<u>1.6</u> 850	<u>3.0</u> 700	<u>3.1</u> 700	<u>2.9</u> 700	<u>2.3</u> 700	<u>2.1</u> 700
Chalkley/ Consol Gas	4/69	1780- 95				<u>.1</u> 190	<u>.6</u> 600	<u>.6</u> 575	<u>.8</u> 575	<u>1.4</u> 600			
Chalkley/Magnolia	5/57	1390-1415	<u>.6</u>	<u>.6</u>	<u>.6</u>	<u>.6</u> 100	<u>1.5</u> 280	<u>1.1</u> 280	<u>.8</u> 280				
Deep Lake/ Superior	6/65	2340-2400	<u>1.9</u>	<u>2.0</u>	<u>3.5</u> 50	<u>3.0</u> 75	<u>2.2</u> 100	<u>1.2</u> 80	<u>.1</u> 95	<u>1.2</u> 55	<u>1.6</u> 60	<u>.7</u> 115	<u>.6</u> 125
Grand Cheniere/ Conoco	3/72	2982-3012										<u>1.7</u> 1050	<u>.8</u> 750
Grand Cheniere/ Sohio	4/60	1229-1370	<u>.6</u>	<u>.7</u>	<u>.6</u> 0	<u>.9</u> 150	<u>1.2</u> 250	<u>1.5</u> 475	<u>.6</u> 500	<u>.7</u> 375	<u>.9</u> 510	<u>1.1</u> 350	<u>.9</u> 425
Grand Lake/ Amerada		1350- 60	<u>.7</u> 30	<u>1.1</u> 100	<u>1.2</u> 100	<u>.8</u> 150			<u>.3</u> 450	<u>.8</u> 400	<u>.8</u> 120	<u>.8</u> 200	<u>1.1</u> 200
Grand Lake/ Superior	11/66	2732- 74	<u>1.9</u>	<u>1.9</u>	<u>1.9</u> 300	<u>2.0</u> 300	<u>1.7</u> 290	<u>1.8</u> 480	<u>2.3</u> 560	<u>1.7</u> 450	<u>1.6</u> 590	<u>1.4</u> 650	
Grand Lake/ Superior	4/77	3500-3540											<u>3.1</u>
Little Pecan Lake/ Pan Am.	8/67	2240-2324		<u>.5</u>	<u>1.1</u> 290	<u>1.1</u> 450	<u>1.4</u> 600	<u>.9</u> 400	<u>1.4</u> 450	<u>1.4</u> 450	<u>1.1</u> 450	<u>1.0</u> 450	<u>.9</u> 450
Pecan Lake/ Superior	12/63	3850-3950	<u>1.4</u> Vac	<u>.6</u> Vac	<u>.8</u> Vac	<u>.9</u> Vac	<u>1.0</u> Vac	<u>1.8</u> Vac	<u>1.9</u> Vac	<u>1.7</u> Vac	<u>2.3</u> Vac	<u>2.5</u> Vac	<u>3.0</u> Vac

APPENDIX G

SALT WATER DISPOSAL STATISTICS FOR WELLS IN CAMERON PARISH, LOUISIANA
INTO WHICH AT LEAST 1,000,000 BARRELS HAVE BEEN INJECTED IN A SINGLE YEAR

Field/Operator	Start Date	Latest Perf. Depth, ft.	Annual Volume Injected, 10 ⁶ bbls										
			Maximum Pressure, psi										
			1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
S. Pecan Lake/ Pan Am.	3/68	2386-2525		<u>.9</u>	<u>1.8</u> 500	<u>.6</u> 500	<u>.3</u> 600	<u>.6</u> 800	<u>.9</u> 600	<u>.8</u> 600	<u>1.6</u> 600	<u>1.5</u> 600	<u>1.3</u> 350
S. Thornwell/ Pan Am.	7/64	2773-2786		<u>.4</u>	<u>.1</u> 1080	<u>.1</u> 1000	<u>.2</u> 1000	<u>.8</u> 800	<u>1.1</u> 300	<u>.5</u> 300	<u>.4</u> 300	<u>.3</u> 300	<u>.3</u> 300
Sweet Lake/ Union	8/72	2086-2126- 2398						<u>.3</u> 450	<u>.9</u> 380	<u>1.1</u> 380	<u>.3</u> 700		
Sweet Lake/ Union	12/70	6755-6974					<u>1.0</u> 400	<u>1.3</u> 400	<u>1.1</u> 450	<u>.5</u> 450	<u>.5</u> 450		
Sweet Lake/ Union	3/64	2050- 95 2260- 95	<u>.1</u>	<u>1.0</u>	<u>2.4</u>	<u>3.8</u> 270	<u>2.7</u> 400	<u>2.4</u> 400	<u>5.6</u> 380	<u>1.7</u> 380	<u>.2</u> 400		
Sweet Lake/ Union	6/70	1824-1865 1870-1927				<u>1.9</u> 300	<u>4.4</u> 350	<u>5.0</u> 350	<u>3.8</u> 320	<u>9.0</u> 350	<u>9.9</u> 400	<u>10.7</u> 700	<u>6.4</u> 480
Sweet Lake/ Union		1874-1898	<u>1.2</u>	<u>1.6</u>	<u>1.0</u>								
Sweet/Lake/ Union	8/59	1520-1545	<u>2.6</u>	<u>2.6</u>	<u>3.0</u> .50	<u>2.4</u> 180	<u>.6</u> 200						

SALT WATER DISPOSAL STATISTICS FOR WELLS IN IBERIA PARISH, LOUISIANA
INTO WHICH AT LEAST 1,000,000 BARRELS HAVE BEEN INJECTED IN A SINGLE YEAR

APPENDIX H

Field/Operator	Start Date	Latest Perf. Depth, ft.	Annual Volume Injected, 10 ⁶ bbls										
			1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Bayou Pigeon/Shell	2/67	5774-5788	<u>1.8</u> 20	<u>2.5</u> 20	<u>2.0</u> 20				<u>.7</u> 20	<u>1.1</u>			
Bayou Pigeon/Shell	2/67	5800-5900				<u>1.4</u> 20	<u>1.3</u> 20	<u>.8</u> 20	<u>1.1</u> 15		<u>1.0</u> 35		
Bayou Pigeon/Shell	3/67	1346- 78	<u>.9</u>	<u>1.2</u> 180	<u>1.3</u> 20		<u>1.8</u> 23	<u>1.0</u> 8	<u>.5</u> Vac	<u>.7</u> 15	<u>1.0</u> Vac	<u>.6</u> Vac	
Bayou Pigeon/Conoco	8/65	2060-2140	<u>.9</u> 100	<u>.8</u> 100	<u>1.0</u> 100	<u>1.4</u> 125	<u>.5</u> 60	<u>.6</u> 75	<u>.4</u> Vac	<u>.3</u> 25	<u>.6</u> 150	<u>1.0</u> 100	
Bayou Pigeon/Shell	10/66	2311- 28	<u>.2</u> 20	<u>2.3</u> 20	<u>2.7</u> 20	<u>2.7</u> 20	<u>2.2</u> 245	<u>2.6</u> 280	<u>1.5</u> 280	<u>2.1</u> 50	<u>1.4</u> 35	<u>1.0</u> 35	
Bayou Pigeon/Shell	3/72	1560- 80						<u>.8</u> 35	<u>1.4</u> 350	<u>1.5</u> 15	<u>1.5</u> 22	<u>.8</u> 22	
Big Bayou Pigeon/ Union	11/66	1329- 93 1436-1502	<u>1.7</u>	<u>4.0</u> 15	<u>4.4</u> 195		<u>2.0</u> 190	<u>2.0</u> 140	<u>2.1</u> 165	<u>2.6</u> 165	<u>2.9</u> 70	<u>2.2</u> 100	<u>1.6</u> 240
Fausse Point/ Texaco	4/69	2740- 80			<u>.1</u> 250	<u>.1</u> 260	<u>.3</u> 260	<u>.8</u> 250	<u>.1</u> 250	<u>.8</u> 250	<u>1.2</u> 250	<u>1.4</u> 240	
Fausse/Point/ Texaco	5/65	1260-1365	<u>1.8</u> 350	<u>1.9</u> 300	<u>1.8</u> 300	<u>.6</u> 310	<u>.7</u> 310	<u>1.4</u> 320	<u>1.3</u> 310	<u>1.2</u> 320	<u>1.3</u> 330	<u>1.0</u> 340	<u>1.3</u> 320
Iberia/Texaco		1590-1600	<u>.2</u> 300	<u>.2</u> 300	<u>.2</u> 300			<u>.4</u>	<u>.6</u> 180	<u>1.2</u> 250	<u>.9</u> 250	<u>.3</u> 250	<u>2.2</u> 250
Iberia/Texaco	6/66	1682-1702						<u>1.3</u> 130	<u>.4</u> 140	<u>1.3</u> 200	<u>.9</u> 200	<u>1.5</u> 210	<u>.3</u> 210

SALT WATER DISPOSAL STATISTICS FOR WELLS IN IBERIA PARISH, LOUISIANA
INTO WHICH AT LEAST 1,000,000 BARRELS HAVE BEEN INJECTED IN A SINGLE YEAR

APPENDIX H

<u>Field/Operator</u>	<u>Start Date</u>	<u>Latest Perf. Depth, ft.</u>	<u>Annual Volume Injected, 10⁶ bbls</u>										
			<u>Maximum Pressure, psi</u>										
			<u>1967</u>	<u>1968</u>	<u>1969</u>	<u>1970</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>
Iberia/Texaco	4/72	1570-1640								$\frac{1.1}{130}$	$\frac{1.2}{130}$	$\frac{.5}{130}$	$\frac{1.5}{130}$
Iberia/Texaco	9/74	1314- 34								$\frac{.7}{150}$	$\frac{.9}{150}$	$\frac{1.1}{140}$	$\frac{.3}{140}$
Iberia/Texaco	5/67	1460- 70	$\frac{.5}{100}$	$\frac{.4}{100}$	$\frac{.5}{100}$	$\frac{.7}{120}$	$\frac{1.0}{120}$						
Jefferson Island/ Texaco	5/68	3980-4015		$\frac{.1}{400}$	$\frac{.5}{400}$	$\frac{.7}{450}$	$\frac{1.3}{450}$	$\frac{.4}{425}$					

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APPENDIX I

SALT WATER DISPOSAL STATISTICS FOR WELLS IN JEFFERSON DAVIS PARISH, LOUISIANA
INTO WHICH AT LEAST 1,000,000 BARRELS HAVE BEEN INJECTED IN A SINGLE YEAR

Field/Operator	Start Date	Latest Perf. Depth, ft.	Annual Volume Injected, 10 ⁶ bbls Maximum Pressure, psi										
			1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Bon Air/ Freeport Oil	12/63	1720- 37	<u>2.0</u>	<u>1.8</u>	<u>1.2</u> 200	<u>1.1</u> 200	<u>1.1</u> 175	<u>.9</u> 50		<u>1.0</u> 50	<u>.4</u> 50	<u>.2</u> 50	
Lake Arthur/ Union Texas Pet.		2850-2930		<u>.3</u> 250	<u>.3</u> 250	<u>.4</u> 250	<u>.2</u> 200	<u>.4</u> 150		<u>.5</u> 380	<u>.3</u> 380	<u>.7</u> 380	<u>1.6</u> 380
Lake Arthur/ Union Texas Pet.	4/71	2250-2310					<u>.5</u> 180	<u>.4</u> 275		<u>.5</u> 450	<u>.3</u> 450	<u>.7</u> 450	<u>1.6</u> 450
Roanoke/		1989-2047							<u>.2</u> 60	<u>1.3</u> 60	<u>1.3</u> 250	<u>1.5</u> 250	<u>1.2</u> 250
Roanoke/ Humble		1460-4920	<u>.3</u>	<u>1.6</u>	<u>1.6</u>				<u>1.0</u> 500				
Roanoke/		1110-1190										<u>1.5</u> 250	<u>1.2</u> 250
Roanoke/		3830- 70										<u>1.3</u> 550	<u>2.1</u> 550
Roanoke/ Humble		5070-5100				<u>1.2</u> 200	<u>1.0</u> 500	<u>.8</u> 500					
Roanoke/ Humble		4990-5010	<u>1.8</u>			<u>.2</u> 300	<u>.1</u> 250	<u>.8</u> 250			<u>1.7</u> 550		
S. Jennings/ Amoco	8/77	3650- 90											<u>1.5</u> 175
S. Jennings/ Pan Am.		1320-1380		<u>1.1</u>	<u>1.0</u> 250	<u>.7</u> 225	<u>.8</u> 225	<u>.9</u> 150	<u>.9</u> 175	<u>1.6</u> 175	<u>1.5</u> 175	<u>1.5</u> 175	

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SALT WATER DISPOSAL STATISTICS FOR WELLS IN JEFFERSON DAVIS PARISH, LOUISIANA
INTO WHICH AT LEAST 1,000,000 BARRELS HAVE BEEN INJECTED IN A SINGLE YEAR

APPENDIX I

Field/Operator	Start Date	Latest Perf. Depth, ft.	<div>Annual Volume Injected, 10⁶bbls</div> <div>Maximum Pressure, psi</div>										
			1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
S. Jennings/ Sun	12/63	1985- 95	<u>1.1</u>	<u>1.8</u>	<u>2.2</u>	<u>1.6</u> 150	<u>1.8</u> 150	<u>1.5</u> 150	<u>.9</u> 150	<u>.2</u> 150			
Welsh/Gulf	12/65	1978- 98	<u>.3</u>	<u>.3</u>	<u>.9</u> 650	<u>2.1</u> 700				<u>1.6</u> 200	<u>1.2</u> 200	<u>1.0</u> 200	<u>1.5</u> 200
Welsh/Gulf	4/70	6060- 80				<u>1.2</u> 700		<u>1.5</u> 200	<u>1.7</u> 200	<u>.2</u> 200	<u>.2</u> 200	<u>.1</u> 200	<u>.2</u> 200
Welsh/Gulf	6/66	1455-1505	<u>.3</u>	<u>.4</u>	<u>.6</u>	<u>.6</u> 110	<u>1.0</u> 15	<u>.7</u> 15	<u>.8</u> 100	<u>.9</u> 100	<u>.9</u> 100	<u>1.2</u>	<u>1.6</u> 450
Woodlawn/ Texas Oil	9/71	1982- 94					<u>.3</u> 450	<u>.3</u> 600	<u>1.1</u> 500	<u>1.4</u> 500	<u>.4</u> 500	<u>.9</u> 500	<u>.6</u> 500
Woodlawn/ Sohio	12/70	1828- 38					<u>.5</u> 250	<u>1.1</u>	<u>1.2</u> 450	<u>1.6</u> 380	<u>1.0</u> 460	<u>1.0</u> 200	<u>.4</u> 200

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SALT WATER DISPOSAL STATISTICS FOR WELLS IN LAFOURCHE PARISH, LOUISIANA
INTO WHICH AT LEAST 1,000,000 BARRELS HAVE BEEN INJECTED IN A SINGLE YEAR

Field/Operator	Start Date	Latest Perf. Depth, ft.	Annual Volume Injected, 10 ⁶ bbls Maximum Pressure, psi										
			1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Bayou Des Allemands/ Amerada		1688-1980	<u>1.2</u> 298	<u>1.1</u> 165	<u>1.2</u> 280	<u>2.0</u> 400	<u>1.5</u> 420	<u>2.4</u> 425	<u>1.6</u> 425				
Bayou Des Allemands/ Amerada		1350-1400	<u>.4</u> 170	<u>.8</u> 180	<u>1.1</u> 170	<u>.6</u>							
Bayou Des Allemands/ Amerada	10/73	1800-1840							<u>.9</u> 375	<u>3.5</u> 400	<u>3.1</u> 475	<u>3.0</u> 475	
Bayou Des Allemands/ Amerada		1916-2055					<u>1.8</u> 500	<u>1.5</u> 500	<u>2.1</u> 500	<u>3.4</u> 250	<u>2.3</u> 300	<u>2.4</u> 380	
Bayou Des Allemands/ Amerada	10/67	1700-1710	<u>.2</u> 360	<u>.4</u> 360	<u>.3</u> 340	<u>.7</u> 55	<u>.5</u> 580	<u>.4</u> 550	<u>.6</u> 500	<u>.8</u> 550	<u>1.5</u> 425	<u>1.5</u> 400	
Chacahoula/Sun		650- 700		<u>1.2</u> 325	<u>1.1</u> 325	<u>.7</u>	<u>.1</u> 325						
Chacahoula/Sun	3/66	3165-3180	<u>2.7</u>	<u>.1</u> 200	<u>.7</u> 325	<u>.7</u> 375	<u>.9</u> 325	<u>.5</u> 325	<u>.6</u> 325	<u>.8</u> 325			
Chacahoula/Sun	8/71	3835-3850					<u>.2</u>	<u>.1</u>		<u>.2</u>	<u>1.1</u>	<u>1.2</u>	
Lake Long/Amoco	3/73*	2300-2475							<u>1.3</u> 250	<u>1.2</u>	<u>1.0</u> 250	<u>.8</u> 250	
Lake Long/ Pan Am.		980-1066	<u>2.6</u> 300	<u>1.8</u> 250	<u>3.5</u> 250	<u>3.0</u> 250	<u>2.5</u> 275	<u>2.2</u> 275	<u>1.4</u> 275	<u>1.2</u> 275	<u>1.0</u>	<u>.8</u> 275	
Raceland/ Amerada		830- 850	<u>2.6</u> 475	<u>3.0</u> 385	<u>3.1</u> 175	<u>3.0</u> 175	<u>3.0</u> 425	<u>2.2</u> 550	<u>2.9</u> 550	<u>3.1</u> 160	<u>2.7</u> 260	<u>2.7</u> 260	
Valentine/ Pan Am.		1700-1750	<u>.6</u> 200	<u>.7</u> 250	<u>.9</u> 250	<u>1.1</u> 450	<u>.6</u> 600	<u>.6</u> 600	<u>.5</u> 600	<u>.6</u> 600			
Valentine/ Gen. Am. Oil	5/68	1370-1400		<u>.5</u> 50	<u>.9</u> 50	<u>.5</u> 60	<u>.7</u> 80	<u>.7</u> 100	<u>1.0</u> 140	<u>1.6</u> 140	<u>1.3</u> 274	<u>1.2</u> 300	

* Well which was recompleted higher in a shallower sand.

APPENDIX K

SALT WATER DISPOSAL STATISTICS FOR WELLS IN ST. MARY PARISH, LOUISIANA
INTO WHICH AT LEAST 1,000,000 BARRELS HAVE BEEN INJECTED IN A SINGLE YEAR

Field/Operator	Start Date	Latest Perf. Depth, ft.	Annual Volume Injected, 10 ⁶ bbls										
			1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Charenton/Amoco	11/74	1400- 50								.2 Vac	.2 Vac	.2 Vac	1.2 Vac
Charenton/Tenneco	5/68	1326-1444				1.8 300			1.7 700	2.7 700		.7 700	
Charenton/Tenneco	4/68	1336- 86				.1 300			1.8 700	2.8 700		.6 700	
Charenton/Tenneco	6/68	800- 840				2.9 300			2.0 500	3.0 500		.7 500	
Charenton/Tenneco	5/68	740- 80 1345- 85 1700- 30				1.8 300			1.9 700	2.9 700		.6 700	
Charenton/Pan Am.	12/69	1400- 40				1.0 275	1.5 175	1.4 175	1.2 175	1.3 175	1.3 175	1.5 175	1.2 175
Charenton/Pan Am.		600- 720	1.6 100	2.0 200	2.6 275	1.8 275	1.5 250	1.4 250	1.2 250	1.3 250	1.3 250	1.5 250	1.0 250
Charenton/Pan Am.		600- 650	1.4 200	2.0 200	1.9 175	2.0 130	1.5 175	1.4 175	1.2 175	1.3 175	1.3 175	1.5 175	1.2 175
Charenton/Tenneco	4/68	1275-1305 1575-1608				1.3 380							
Franklin/So. Nat. Gas		1580-1630	.2 0	.4 0	.4 0	.9 12	1.7 12	.9 15	.8 15	.9 15	1.0 15	1.0 15	
Franklin/So. Nat. Gas	10/71	2055- 75						1.2 800	1.2 800	1.4 400	1.4 500	1.2 500	2.0 500

SALT WATER DISPOSAL STATISTICS FOR WELLS IN ST. MARY PARISH, LOUISIANA
INTO WHICH AT LEAST 1,000,000 BARRELS HAVE BEEN INJECTED IN A SINGLE YEAR

APPENDIX K

Field/Operator	Start Date	Latest Perf. Depth, ft.	Annual Volume Injected, 10 ⁶ bbls										
			1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Garden City/ Quintana	11/71	1710- 50						.8 Vac	.9 50	.5 50	.8 50	1.1 50	
Garden City/ Quintana	11/73	4690-4790								.7 100	.9 100	1.1 100	
Garden City/ Quintana	12/69						1.1 230	.8 230	1.3 230	1.4 230	.8 230	1.1 230	
Jeanerette/Arco		950-1000			1.2 300	1.1 300	.8 460	.5 300	.9 300	1.0 300	1.3 300	.8 300	1.0 300
Jeanerette/Arco		1332- 60			4.0 85	3.5 85	3.2 85	2.6 85	2.2 85	1.2 85	1.1 85	1.0 85	.5 85
Jeanerette/Arco		1060- 70			2.5 250	2.8 250		2.8 290	3.6 250	2.5 250	2.3 250	2.4 250	1.2 250
Jeanerette/Arco		1850- 60			2.9 200	2.9 200	2.4 200	2.3 200	2.4 200	1.3 200	2.6 200	1.6 200	1.5 200
Jeanerette/Arco		2120- 30			2.5 460	2.4 460	2.3 460	.7 460					
WCBB/Texaco		8662- 70						1.4 2000	.8 2000				
WCBB/Texaco		8784-8814					1.0 2700	1.0 2750	.7 2750				

APPENDIX L

SALT WATER DISPOSAL STATISTICS FOR WELLS IN TERREBONNE PARISH, LOUISIANA
INTO WHICH AT LEAST 1,000,000 BARRELS HAVE BEEN INJECTED IN A SINGLE YEAR

Field/Operator	Start Date	Latest Perf. Depth, ft.	Annual Volume Injected, 10 ⁶ bbls										
			Maximum Pressure, psi										
			1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Bayou Penchant/ Superior	7/68	3010- 60		.6 60	1.7 180	1.8 580	2.6 600	3.9 600	1.4 540	2.6 600	2.7 630	3.6 640	
Donner/Humble		2907- 72	.4	1.2 800	.6 800	.4 800	.6 800	.8 850	1.0 900		.7 250	.6 200	
Gibson/Shell		700- 870	2.4	2.7 20	2.6 22	1.1 22	.7 10	.3 25		1.6 20	.2 12		
Gibson/Shell		648- 898		2.6	2.0 20	2.4 22	2.6 22	2.0 10	1.9 20				
Gibson/Pennzoil	2/74	1590-1610									1.1 70	1.5 70	
Gibson/Shell	3/69	1800-1920			1.9 22	2.9 22	2.4 12	1.6 15	2.2 20	2.3 20	2.3 17	2.8 17	
Gibson/Shell		1400-1560	3.7	4.1 20	2.2 22	2.4 22	1.9 12	1.6 15	1.1 20	1.2 20	2.3 17	.7 17	
Gibson/Shell		834- 64	6.3	4.7 20	2.8 22	1.0 22	.6	.6 15	1.0 30	1.0 20	1.2 17	1.7 17	
Gibson/Shell	5/75	1935-1960										1.5 20	
Gibson/Shell		680- 720	2.0	1.4 20	1.2 22	1.5 22	1.3 12	.7 15	.6 30	1.4 22	3.2 18	2.0 18	
Gibson/Shell	10/75	3374-3403									1.1 35	.8 20	
Gibson/Shell		734- 884	.3		.3 22	.4 22	.1 30	.2 32	2.0 40	.8 25	1.4 20	1.1 20	

APPENDIX L

SALT WATER DISPOSAL STATISTICS FOR WELLS IN TERREBONNE PARISH, LOUISIANA
INTO WHICH AT LEAST 1,000,000 BARRELS HAVE BEEN INJECTED IN A SINGLE YEAR

Field/Operator	Start Date	Latest Perf. Depth, ft.	Annual Volume Injected, 10 ⁶ bbls										
			1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Hollywood/Tidewater		614- 82	<u>.2</u>	<u>.4</u>	<u>.4</u>	<u>1.2</u>	<u>1.1</u> 1200	<u>.4</u> 1200	<u>.1</u> 1200	<u>.1</u> 1200	<u>.2</u> 1200	<u>.5</u> 1200	
Houma/Union	7/66	650- 750	<u>.5</u>	<u>.5</u> 125	<u>1.1</u> 10	<u>1.6</u> 150							
Houma/Union	11/71	650- 750					<u>.8</u> 150	<u>1.4</u> 220	<u>.6</u> 300	<u>1.1</u> 250		<u>.6</u> 500	
Houma/Union	7/66	650- 750	<u>.3</u>	<u>.4</u> 125	<u>.9</u> 0	<u>1.3</u> 125	<u>1.9</u> 125	<u>.8</u> 250	<u>.6</u> 300	<u>1.1</u> 550	<u>2.6</u> 550	<u>.6</u> 550	
Lake Match/Union	3/74	2100-2130								<u>2.0</u> 250	<u>4.3</u> 250	<u>2.3</u> 250	
Lake Match/Union	8/72	2140- 70						<u>3.4</u> 150	<u>3.9</u> 300	<u>2.0</u> 100		<u>2.3</u> 100	
Montegut/ So. Nat. Gas		1593-1957	<u>.7</u> 1000	<u>1.1</u> 800	<u>1.4</u> 800	<u>1.2</u> 800	<u>.3</u> 800						

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SALT WATER DISPOSAL STATISTICS FOR WELLS IN VERMILION PARISH, LOUISIANA
INTO WHICH AT LEAST 1,000,000 BARRELS HAVE BEEN INJECTED IN A SINGLE YEAR

APPENDIX M

Field/Operator	Start Date	Latest Perf. Depth, ft.	Annual Volume Injected, 10 ⁶ bbls										
			Maximum Pressure, psi										
			1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Cow Island Plant/ Mobil	8/72	1520-1900						.7 110	1.6 110	1.3 110	1.8 110	1.3 110	2.3 110
E. White Lake/ Union		1430-1470	1.8 140	1.9 140	1.4 60	1.7 60	1.4 140	2.7 140	1.9 100	1.5 150	1.2 140	1.7 125	3.0 220
E. White Lake/ Union	2/73	1980-2020								2.8 130	4.1 120	4.4 120	3.8 190
E. White Lake/ Union	5/74	1580-2620								1.6 120	.9 150	.2 230	
E. White Lake/ Union		1895-1965	.4 140	.4 140	1.5 60	1.2 60	.9 140	1.8 140	.6 25	.3 25			
Erath/Phillips	3/75	1702-1732									.4 530	2.9 530	2.6 530
Erath/Texaco		1744-1784	1.7 120										
Erath/Texaco	11/73	2615- 40 1655- 75							1.5 180	1.9 110	1.4 110	1.1 110	1.1 110
Erath/Phillips		1540- 70	2.0	1.8 450	1.4 375			2.4 550	2.9 600	2.8 600	2.6 600	3.2 600	3.0 600
Erath/Phillips	1/68	1478-1524		1.7 150	1.9 150			2.4 150	2.2 160	1.8 160	1.9 160	2.0 700	1.8 300
Erath/Tidewater	4/67	2010- 60	.3	.8	.9	.8	1.1 400	.7 400	.4 400	.4 400	.3 400	.2 400	.2 400
Erath/Phillips		1790-1820	1.7	1.6 450	1.6 460			2.9 500	2.7 590	1.6 590	1.5 590	1.9 590	3.0 590
Erath/Phillips		1651- 90	1.2	1.0 50	2.1 160			.7 500	.9 100	1.7 100	1.6 100	1.9 100	1.9 100
Erath/Texaco		1530- 48	.7 150	.9 150	.8 150	.8 160	1.5 160	3.1 150	1.6 150	2.1 150	1.2 150	1.1 140	1.0 120

APPENDIX M

SALT WATER DISPOSAL STATISTICS FOR WELLS IN VERMILION PARISH, LOUISIANA
INTO WHICH AT LEAST 1,000,000 BARRELS HAVE BEEN INJECTED IN A SINGLE YEAR

Field/Operator	Start Date	Latest Perf. Depth, ft.	Annual Volume Injected, 10 ⁶ bbls										
			Maximum Pressure, psi										
			1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Erath/Texaco		1680-1700	<u>1.2</u> 150	<u>1.3</u> 150	<u>1.4</u> 150	<u>1.5</u> 150	<u>1.4</u> 150	<u>2.8</u> 160	<u>1.9</u> 160	<u>2.2</u> 160	<u>1.5</u> 160	<u>1.3</u> 150	<u>1.1</u> 150
Erath/Texaco		1666-1676	<u>5.3</u> 100	<u>3.1</u> 100	<u>3.0</u> 100	<u>3.0</u> 120	<u>1.9</u> 120	<u>3.5</u> 110	<u>1.5</u> 110	<u>1.7</u> 120	<u>1.3</u> 120	<u>1.2</u> 110	<u>1.2</u> 110
Erath/Texaco	2/74	1650-1700									<u>.8</u> 120	<u>.9</u> 120	<u>1.1</u> 140
Gueydan/Union	5/68	1499-2645		<u>.6</u> 40	<u>1.7</u> 200	<u>1.5</u> 150	<u>1.6</u> 160	<u>1.7</u> 230	<u>1.5</u> 200	<u>1.7</u> 400	<u>1.7</u> 400	<u>1.0</u> 450	<u>.8</u> 320
Lac Blanc/Superior		3200-3290	<u>.4</u> 290	<u>.4</u> 100	<u>.7</u> 100	<u>.6</u> 120	<u>1.2</u> 250	<u>1.5</u> 325	<u>1.3</u> 120	<u>.9</u> 135	<u>.7</u> 135	<u>.3</u> 135	<u>.4</u> 135
Maurice/Texaco		2324-2334	<u>.1</u> 250		<u>.2</u> 250	<u>.3</u> 250	<u>.2</u> 250	<u>.6</u> 225		<u>.8</u> 260	<u>1.3</u> 260		
N. Parcper Duc/ Phillips		2056- 76									<u>.3</u> 200	<u>.8</u> 200	<u>1.1</u> 200
S. Kaplan/Pan Am.	3/70	2020-2220				<u>.7</u> 150	<u>.2</u> 150	<u>.8</u> 525	<u>1.0</u> 525	<u>1.1</u> 525	<u>1.0</u> 525	<u>.7</u> 525	
Tigre Lagoon/Union		1520-1540	<u>1.4</u> 50	<u>2.5</u> 50	<u>2.8</u> 100	<u>3.9</u> 100	<u>3.6</u> 100	<u>3.7</u> 100	<u>3.7</u> 400	<u>2.6</u> 300	<u>.5</u> 300	<u>1.8</u> 250	<u>1.6</u> 200
Tigre Lagoon/Union	8/72	2670-2700						<u>.3</u> 15	<u>2.1</u> 170	<u>1.6</u> 400	<u>1.8</u> 400	<u>.4</u> 630	<u>.4</u> 620
Tigre Lagoon/Union	11/74	1482-2530								<u>.5</u> 100	<u>2.6</u> 125	<u>2.0</u> 150	<u>1.9</u> 185
W. Whitelake/Union		1330-1350	<u>2.2</u> 120	<u>1.8</u> 120	<u>1.9</u> 225	<u>1.6</u> 200	<u>2.5</u> 200	<u>.2</u> 200					
W. Whitelake/Union	1/72	1396-1426						<u>2.4</u> 250	<u>2.3</u> 250	<u>1.3</u> 100	<u>1.8</u> 130	<u>2.3</u> 225	<u>2.7</u> 225

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