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Well Videos, Cross Section, and Recommendations Lake Country Acres PWS ID # 1110059 Parker and Hood Counties, TX

Well Videos and Logging

A video of **Well 4** was recorded on November 11, 2003. The water was very agitated by gas and too murky to see the screen. The video was inconclusive as to the source of the gas production.

Dowell Water Well pulled the pump for the **Well 2** on November 21, 2003. The top of the pump was at 294 feet. The column pipe was slightly corroded with some slime above the water level. Below water level there was a large amount of biological growth on the outside of the column pipe along with several areas of severe corrosion. Dowell replaced the two lowest pieces because of their condition.

Downhole video was recorded for Well 2 on November 23, 2003. The water was very murky and limited visibility to the point that a second video was performed the next day using a side view attachment. The water level was 254 feet below ground level. The screen appeared to be torch slot from 260 to 300 feet. A large amount of biological growth was evident in the screened interval. In particular, the areas from 297 to 289 had significant amounts of buildup. Several gas bubbles were noted on the video, and were seen entering through the screen at 271.

A natural gamma ray log was also ran in the well. Results from the log are presented on the cross section. Records indicate this well to be 385 feet deep with a second screen interval below the current level of fill.

Dowell Water Well pulled the pump for Well 1 on December 2, 2003. The top of the pump was at 341 feet. The column pipe was in good condition with only minor pitting in a few locations. Very little biologic material was attached to the pipe. A black coating was present, indicative of hydrogen sulfide known to be present in the well.

Downhole video was recorded for Well 1 on December 3, 2003. The water was somewhat murky but visibility was good enough to make out torch slots and gas production. The water level was 284 feet below ground level. The screen appeared to be torch slotted from 346 to 363. Gas production was at a rate similar to Well 2 and

was seen entering the Well from 346 to 350.

A natural gamma ray log was also ran in the well. Results from the log are presented on the cross section.

Cross Section

Geophysical logs were available for LCA Wells 3 and 4. As previously mentioned, LCA Wells 1 and 2 were logged when the pumps were removed. Several logs were ordered for surrounding petroleum wells. Two petroleum wells arrived in time for inclusion in this report. The Carl Brite #1 is located 3,000 feet south of the LCA well field. The Brite #3 is located 4,000 feet south-southwest of the LCA well field.

The Carl Brite #1 was logged to within 370 feet of the ground surface. The log indicates the Base of Trinity formation to be approximately 440 feet below ground level. This data will be incorporated the final cross section(s) after the additional well logs arrive.

The Brite #3 was logged to within 330 feet of the ground surface. The log indicates the Base of Trinity formation to be approximately 435 feet below ground level. The log data also has neutron porosity and density porosity data. When properly calculated, these curves together are used to prospect for free phase gas entrained in the formation. Unfortunately this data was not acquired all the way to the top of the log. What is important is that free phase gas is indicated at depths as shallow as 850 to 900 feet. The presence of gas at this depth can be natural or it can be from gas leaking into some of the Trinity aquifer sands from poor petroleum well completion practices.

The preliminary cross section includes only the LCA wells. The screened sections are marked, along with static water levels. Any gas producing areas seen on video are also noted. Sand packages are depicted as yellow areas.

Three distinct sand packages occur in all four wells. Well 4 has a fourth sand package deeper in the well, below the depths to which Wells 1-3 were drilled. The sand packages may or may not be laterally continuous. Some interpretation of the lateral continuity of the sands was made based on the shape of the curves. However, the only definitive method for identifying lateral continuity (i.e. pathways for gas migration) is pumping tests. Each well is screened across different sands. This makes it impossible to compare rates of gas production among wells. On the other hand, it makes it possible to determine the lateral continuity of each sand package and identify the gas-bearing sands.

Recommendations

Both proper well location and proper screen depth are required to reduce gas in the LCA area. At present, the combination of data available does not allow selection of either. The continuity (or lack thereof) of the sands between the wells must be better established. The gas producing zone in Well 4 must also be established. After these questions are answered, a test well can be properly located to minimize gas production.

A packer should be set in Well 4 between the two screen sections. This will allow determination of which screen section is producing the greatest amount of gas. It will also test the lateral continuity between wells 3 and 4. The packer can be set on column pipe already present at the well site.

Two pumping tests should be performed, one pumping well 1 and one pumping well 3. The tests can be performed without disturbing production or distribution at the LCA plant. Personnel will be present at the site throughout the test to monitor the water levels in the 4 wells and the two GST's.

Cost of the pumping tests, analysis, and report is estimated to be \$14,000. This work can be accomplished before Christmas.



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Pumping Tests Results and Hydrogeological Interpretation Lake Country Acres PWS ID # 1110059 Parker and Hood Counties, TX

This document is an analysis of data collected to date at the LCA site. Data from the December 11, 2003 report, **Well Videos, Cross Section, and Recommendations**, has been incorporated into this report. The data and its interpretation will be discussed with AquaSource staff at a subsequent meeting. Recommendations at the end of this document will be further detailed at that time.

Available Well Data

A map titled **Gas Production Near Lake Country Acres** is presented on page 2. It shows the location of various wells, the cross section line, and gas production data for the area.

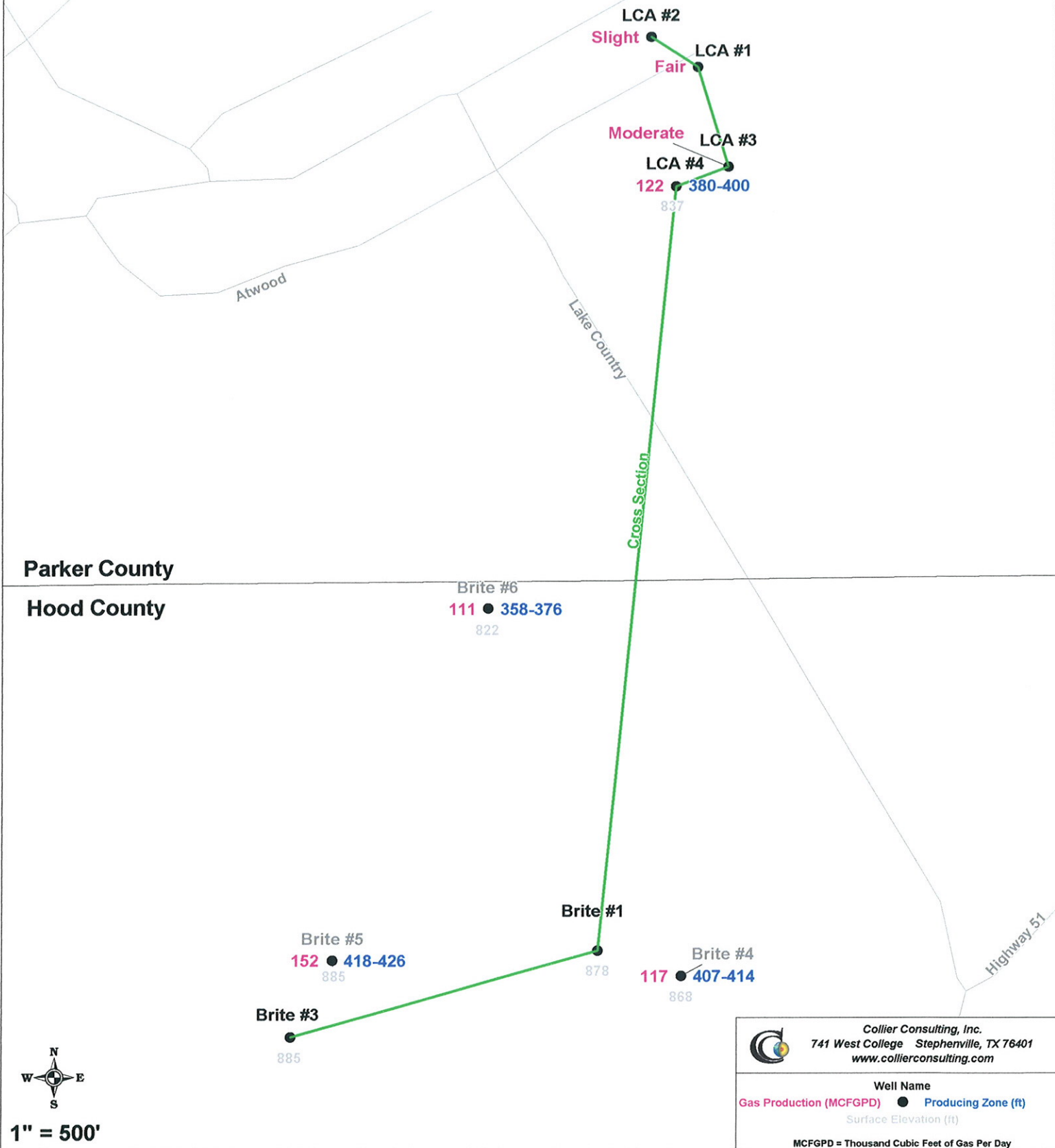
LCA Well 1 data include a video and natural gamma ray log. The screen appears to be torch slotted from 346 to 363. Gas production is at a rate somewhat greater than Well 2 and was seen entering the well from 346 to 350 on the video. Well 1 was both pumped and monitored during the LCA pumping tests.

LCA Well 2 data include a drillers log, video, and natural gamma ray log. The screen appears to be torch slot from 260 to 300 feet. A large amount of biological growth was evident in the screened interval. In particular, the area from 297 to 289 had a significant amount of buildup. Several gas bubbles were noted on the video entering through the screen at 271. Well 2 was pumped and monitored during the LCA pumping tests.

LCA Well 3 data include material setting, formation description, production test, natural gamma ray, sp, and resistivity logs. The well was not videoed. Gas production is greater in this well than in either Well 1 or Well 2. Well 3 was pumped and monitored during the LCA pumping tests.



Gas Production Near Lake Country Acres PWS# 1110059 Hood and Parker Counties, Texas



LCA Well 4 data include a video, natural gamma ray, sp, and resistivity logs. Well 4 could not be included in the LCA pumping tests because of its gas production. Gas production was very high in this well, 122 MCFGPD (thousand cubic feet of gas/day). Well 4 was filled with drilling mud in order to shut off the gas production.

Completion cards and borehole geophysical logs from a number of gas wells in the area were examined. Gas wells closest to the LCA plant are the **Brite #1, #3, #4, #5, and #6**. **Brite #1 and #3** are the only ones with available logs. The top of the logged interval in the two wells is 330 and 360 feet below ground level. These two wells were drilled for deeper targets and have no production tests for the shallow sands. **Brite #4, #5, and #6** were drilled to test and produce shallow sands. Completion cards are the only available records.

Pumping Tests

The LCA pumping tests began on December 21, 2003. Three pumping tests were conducted. The lengths of the pumping and recovery time spans were dictated by the demands of the system. Water levels were measured using pressure transducers attached to airlines. Air pressure in the lines had to be periodically recharged due to leakage. Therefore, it was necessary to edit out the erroneous data prior to analysis and graphing. Data obtained from the pumping tests are presented in graphical form on the following page. The data were also utilized to complete the cross section which appears later in this document.

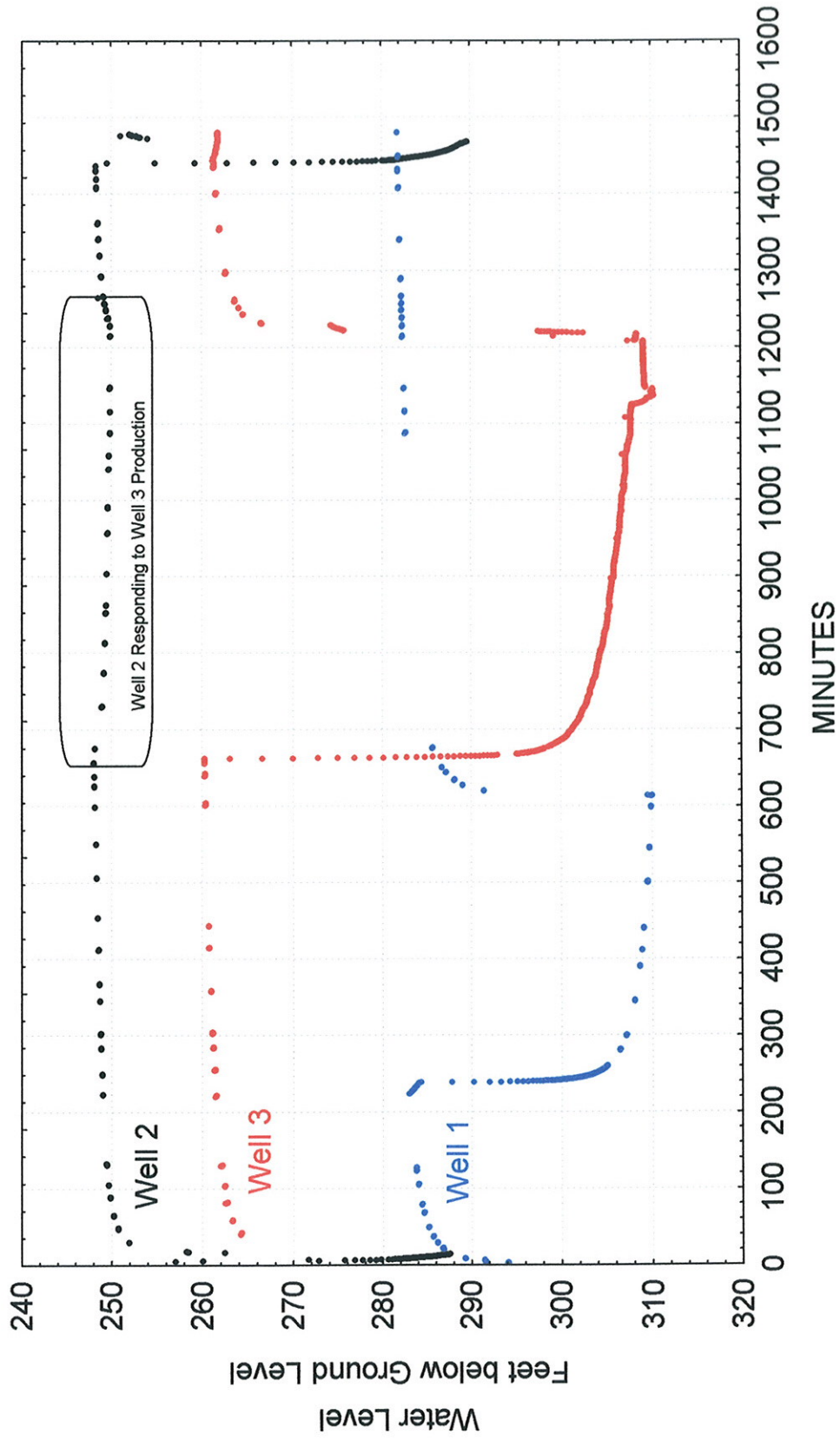
All wells were turned off at 15:45 for four hours. This permitted water levels to return to as near static conditions as possible, given the demands of the system. Well 1 was pumped from 19:45 to 2:00 December 22, 2003. Well 3 was pumped from 2:49 to 12:06. Well 2 was pumped briefly from 15:50 to 16:20. These pump cycles and resulting water level responses are graphed on the following page.

Well 1 produced 38 gpm with 28 feet of drawdown. Specific capacity is 1.35 gpm/ft of drawdown. Pumping from Well 1 did not appear to affect the water level in either Well 2 or Well 3. Therefore, the sand body screened in Well 1 does not appear to be connected to the sand bodies screened in Wells 2 or 3.

Well 2 produced 53 gpm with 41 feet of drawdown. Specific capacity is 1.28 gpm/ft of drawdown. Well 2 produces drawdown in Well 3. This means that the sand body screened in Well 2 is connected to a sand body screened in Well 3. This also means that the wells will interfere with each other when pumped simultaneously for extended periods.

Well 3 produced 42 gpm with 48 feet of drawdown. Specific capacity is 0.88 gpm/ft of drawdown. Well 3 produced 1.75 feet of drawdown in Well 2. The same interpretations in the preceding paragraph apply.

Lake Country Acres Pump Test



Time 0 is at 15:45 on December 21, 2003

Cross Section

Geophysical logs were available for all four LCA wells and five petroleum wells. Two petroleum wells are included on the cross section: the Carl Brite #1 located 3,000 feet south of the LCA well field and the Brite #3 located 4,000 feet south-southwest of the LCA well field. The three additional petroleum logs and other completion data from area petroleum wells were utilized to determine the areal extent of the gas production.

The cross section depicts pump settings, screened intervals, static and pumping water levels, production rates for water and gas, and base of useable quality water. Any screened intervals with visible gas production are also noted. Sand packages are depicted as yellow areas.

Three distinct sand packages occur in all four water wells. Well 4 has a fourth sand package deeper in the well, below the depths to which Wells 1-3 were drilled. Each well is screened across a different combination of sands. The sand packages are separated by shales. The sand packages are apparently not in vertical communication, based on the static water levels and the pumping tests. Interpretation of the lateral continuity of the sands was made based on the shape of the log curves and the pumping tests.

The uppermost sand could not be evaluated, since it is screened in only Well 3. The sand does not contribute any appreciable water since it is generally above static water level.

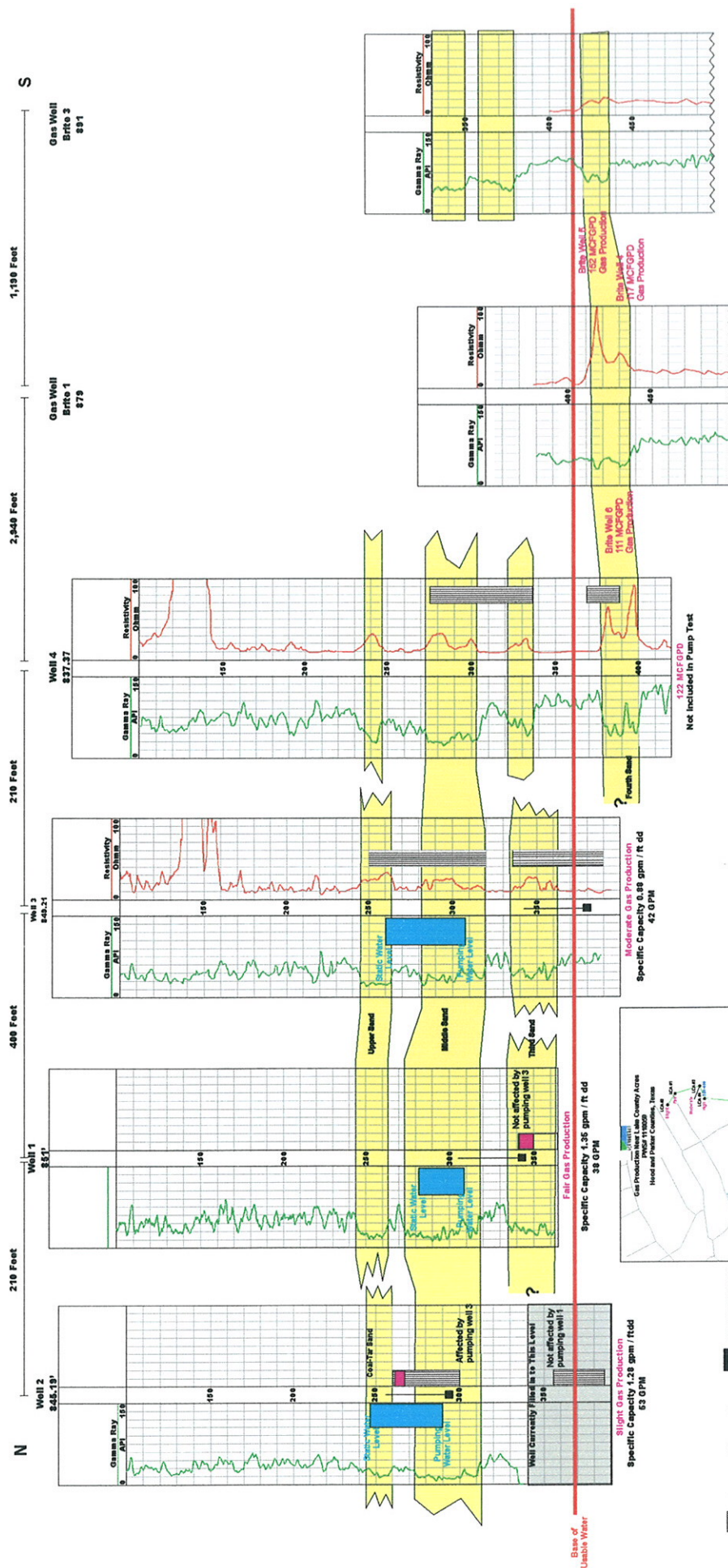
Results from the pumping tests indicate that the middle sand is continuous across the site. Wells 2 and 3 are screened across the middle sand and when one is pumped, the other responds. Since Well 2 is screened in only the middle sand and it has less gas than any of the other wells, it is reasonable to infer that the middle sand has a relatively small amount of gas.

The third sand was found to be discontinuous across the site. Wells 1 and 3 are both screened across this sand, but did not respond together to pumping. Wells 1 and 3 both have greater gas production than Well 2, which has open screen only across the middle sand. Even though the third sand is not laterally continuous, it appears to have a higher concentration of gas than the middle sand.

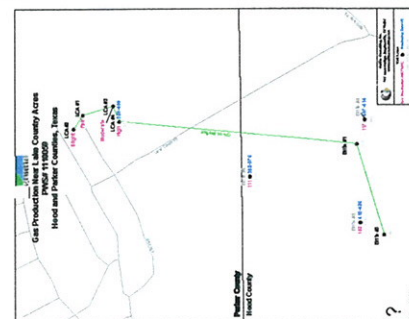
Well 2 has a second screened interval which appears to be across the third sand, but the wellbore has filled in to above this screen. Therefore, the lack of response in Well 2 to the pumping of Well 1 is because either the third sands are not connected or the screen is plugged in Well 2. Either scenario is possible.

No evaluation was made of the fourth and deepest sand during the pumping tests. A packer set in Well 4 above this sand (357 feet) showed the fourth sand to contain gas with a shut-in-pressure greater than 70 psi and virtually no water production. When the packer was closed, a significant amount of gas blew behind the

Cross Section



Prepared for:



Screened Interval	Pump Setting
Visible Gas Production on Video	



**Cross Section Created
by Lynn Smith
December 30, 2003**

by Lynn Smith
December 30, 2003

blank and reentered the well thru the upper screen above the packer. To prevent charging the middle and third sands with gas, the well was filled with drilling mud.

It appears that the fourth sand is producing almost 100% of the gas in Well 4. Although the well logs do not indicate the presence of this sand in the other wells, it is possible that it was topped in Wells 3 and 2. This would explain the increased gas production in Well 3. The **Brite #4, #5, and #6** wells produce from this same sand or at least a sand at the same stratigraphic position (refer to the cross section and map).

Recommendations

The recommendations for Well 4 should be implemented ASAP to insure that the middle sand is not being charged up with gas.

Well 4 Recommendations

- ▶ Remove casing and screen from the borehole.
- ▶ Pressure cement to surface utilizing Halliburton or another oilfield firm.
- ▶ While it is not our recommendation, it is possible that a well could be completed in the existing borehole. However, special care in the cement job would be imperative and cement should be placed up to 310 feet.

General LCA Site Recommendations

- ▶ Complete future test well(s) exclusively in the middle sand and run a density-neutron log to detect gas.
- ▶ Do not, under any circumstance, drill deeper than 480 feet above sea level (about 350 feet below ground level).
- ▶ Maintain well spacing as great as possible given the land parcel. (This will be addressed in the addendum).
- ▶ Utilize oversize screen (10-12 inches) to decrease the potential for gas locking pumps.
- ▶ Utilize stainless steel, rod-based screen or PVC based screen due to the corrosive nature of the water.
- ▶ Aquifer properties and well efficiencies will be detailed in an addendum.

Lynn Smith
Hughbert Collier, P.G.