



OCT 02 2012

August 31, 2012

DEPT OF ENVIRONMENT &  
NATURAL RESOURCES,  
GROUND WATER PROGRAM  
South Dakota DENR  
523 East Capital  
Pierre, SD 57501-3181

Attn: Mr. Brian Walsh

Re: West Buffalo B Unit  
Vertical injection well pressures  
Sections 16, 21, 22, 26, 27- T21N-R03E  
Harding Co., SD

Dear Mr. Walsh:

Citation Oil and Gas Corporation (COGC) currently has 5 water injection wells at West Buffalo B Unit (WBBU) in Harding Co., SD. The injectors available to COGC with their volumes and pressures are as follows in Table #1:

Table #1

WELL	Permitted INJ Volume	Permitted INJ pressure	11 month ave INJ Volume	11 month ave INJ pressure
Clarkson #6-21H**	1500 bpd	1550 psi	47 bpd**	1528 psi**
Clarkson #6-22	300 bpd	1540 psi	75 bpd	1515 psi
Olson #15-22	300 bpd	1540 psi	131 bpd	1531 psi
State #44-16H	1000 bpd	1550 psi	75 bpd	1520 psi

Note: \* Request excludes Clarkson #2-26H, separate documentation submitted.

\*\*Clarkson #6-21H is temporarily shut-in.

Current maximum pressure limits for all of the water injectors at WBBU range from 1540-1550 psi. Citation Oil and Gas Corporation requests maximum authorized injection pressures for the above WBBU water injection wells, *excluding the Clarkson #2-26H*, to be increased to **1,710 psi**. Estimated injection volumes corresponding to the requested maximum injection pressures are provided in Table #2:

Table #2

WELL	Requested INJ Volume	Requested INJ pressure	Estimated INJ Volume	Estimated INJ pressure
Clarkson #6-21H**	1500 bpd	1710 psi	170 bpd**	1710 psi**
Clarkson #6-22	300 bpd	1710 psi	200 bpd	1710 psi
Olson #15-22	300 bpd	1710 psi	270 bpd	1710 psi
State #44-16H	1000 bpd	1710 psi	200 bpd	1710 psi
Clarkson #2-26H				

Note: \*Request excludes Clarkson #2-26H, separate documentation submitted.

\*\*Clarkson #6-21H is temporarily shut-in.

Apache Corporation performed a step rate test for the State #14-16 (vertical injector) on August 16<sup>th</sup>, 1989. The results of the step rate test indicated a formation parting pressure of 1,710 psi at surface. Corresponding fracture gradient correlated to 0.617 psi/ft. Accordingly, Apache requested 90% of the resulting parting pressure for all of the water injection wells stemming from the State #14-16 step rate data. The three horizontal wells (Clarkson #6-21H, State #44-16H, & Clarkson #2-26H) were later granted a 10 psi higher injection pressure limit. COGC's current request to increase authorized maximum injection pressure is also based off the original State #14-16 step rate test (attached) but does not include the 90% factor. The Clarkson #2-26H is not included in this request and has been evaluated separately.

If, after reviewing the above information and attachments, you have any questions or concerns, please call.

Sincerely,



Jeremy Wagner  
 Operations Engineer  
 Citation Oil and Gas Corporation

Cc: Bob Christofferson  
 Region Manager  
 Citation Oil and Gas Corporation



303/837-5000

September 9, 1989

Mr. Fred Steece  
South Dakota Department of Water &  
Natural Resources  
Western Field Office  
36 East Chicago  
Rapid City, South Dakota 97701



Re: Step Rate Test  
W. Buffalo "B" Unit  
Harding County, South Dakota

Dear Mr. Steece:

This letter presents the results of the step rate test run according to Oil & Gas Order No. 15-88. The test was conducted on August 16, 1989 on the State 14-16 injection well in the W. Buffalo "B" (Red River "B") Unit. Foster Sawyer of the State of South Dakota Department of Water and Natural Resources witnessed a portion of this test.

The injection rates and final pressures for each injection period are presented in Table 1. Each injection period lasted 1 hour with the exception of the final rate which was discontinued after 13 minutes.

The State 14-16 was completed as a producing well in August, 1985. During this original completion, the well was acidized and apparently fractured as surface pressures exceeded 2300 psi. Because of this, a low finite conductivity (non propped) fracture existed at the start of this step rate test.

Figure 1 shows the linear plot of injection rate versus final injection pressures normally used in analysis of step rate test data. This plot indicates 2 distinct break points. The first break at 1150 psi corresponds to opening of the existing fracture described in the previous paragraph. The rate points prior to this break represent matrix response, while the points following this break correspond to an increase in fracture opening or fracture conductivity of the existing fracture. The second break at 1710 psi corresponds to the formation parting pressure, or the pressure at which new fracturing is initiated.

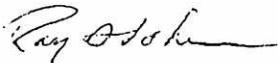
The results of this test were also analyzed using superposition analysis for linear flow. The resulting plot of normalized delta P versus the Odeh and Jones superposition term is shown on Figure 2. The first two rate steps fall on the same trend indicating the same flow regime. As the injection pressure increased, the points fall off to the right indicating a changing flow regime as the opening of the existing fracture increased.

The extension of the existing fracture occurred at a pressure of 1710 psi and 1013 BWP. The instantaneous shut in pressure (ISIP) corresponding to this pressure was 1540 psi. The difference between these two pressures represents the various friction losses associated with 1013 BWP injection. The bottomhole fracture pressure, determined by adding the ISIP and pressure associated with the fluid head, is 5160 psi. This translates to a fracture gradient of .617 psi./ft.

To optimize waterflood performance at the W. Buffalo "B" Unit, Apache Corporation requests that the South Dakota Department of Water and Natural Resources allow surface injection pressures at the Unit to be increased up to 1540 psi.

If there are any questions regarding this test or analysis, contact Ray Johnson at (303) 837-5471.

Sincerely,  
APACHE CORPORATION



Ray D. Johnson  
Reservoir Engineer

cc: A. Nash, Jr.  
D. Gibbons  
J. Murphy (Dickinson)

File RMR #0535

FIGURE 1.

W. Buffalo 'B' Unit  
Step Rate Test  
Injection Rate vs Pressure  
08/16/89

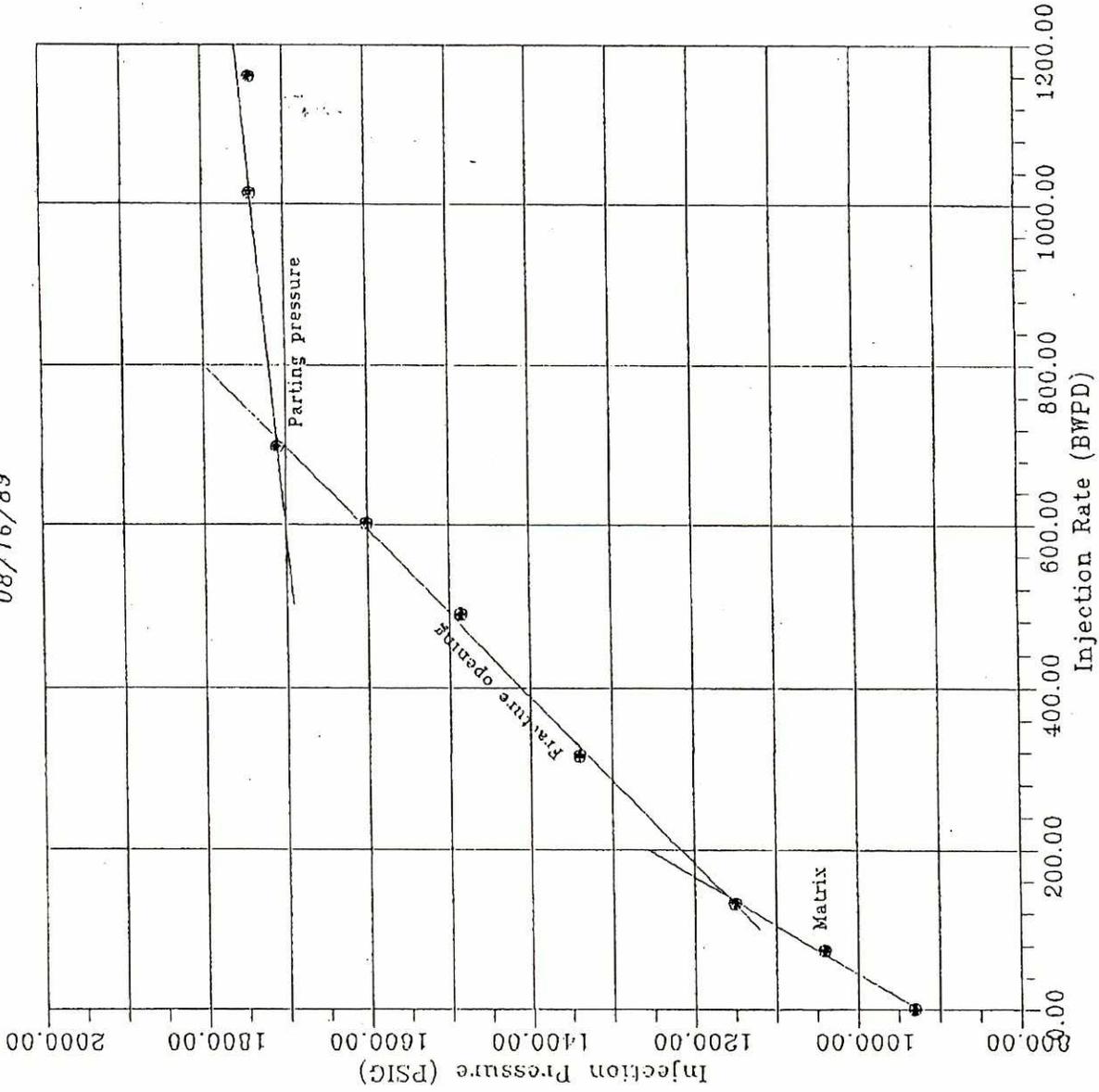


Table 1

W. Buffalo "B" Unit  
Step Rate Test  
State No. 14-16  
Injection and Pressure Data

<u>Injection</u> <u>Rate</u> (BWPD)	<u>Final</u> <u>Injection</u> <u>Pressure</u> (PSIG)
75	1040
132	1150
316	1340
489	1485
601	1600
697	1710
1013	1740
1160	1740

STATE OF SOUTH DAKOTA  
SECRETARY OF THE  
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

IN THE MATTER OF THE APPLICATION OF CITATION OIL & GAS CORP., HOUSTON, TEXAS, TO INCREASE MAXIMUM INJECTION PRESSURES AT THE EXISTING CLARKSON 6-21H INJECTION WELL LOCATED IN THE SE ¼ NW ¼ SECTION 21, TOWNSHIP 21 NORTH, RANGE 3 EAST; THE CLARKSON 6-22 INJECTION WELL LOCATED IN THE SE ¼ NW ¼ SECTION 22, TOWNSHIP 21 NORTH, RANGE 3 EAST; THE OLSON 15-22 INJECTION WELL LOCATED IN THE SW ¼ SE ¼ SECTION 22, TOWNSHIP 21 NORTH, RANGE 3 EAST; AND THE STATE 44-16H INJECTION WELL LOCATED IN THE SE ¼ SE ¼ SECTION 16, TOWNSHIP 21 NORTH, RANGE 3 EAST, IN THE WEST BUFFALO "B" RED RIVER UNIT, HARDING COUNTY, ABOUT 15 MILES NORTHWEST OF BUFFALO, SOUTH DAKOTA.

NOTICE  
OF  
RECOMMENDATION  
FOR MAJOR MODIFICATION TO  
A PERMIT TO INJECT

OIL AND GAS  
CASE NO. 16-2012

Notice is hereby given to the public and to all interested persons that pursuant to South Dakota Codified Laws (SDCL) Chapter 1-26 and Chapter 45-9 and further pursuant to the Administrative Rules of South Dakota (ARSD) 74:12:07 and 74:12:09, the following matter has come to the attention of the Secretary of the Department of Environment and Natural Resources, hereinafter "Secretary."

Citation Oil & Gas Corp. has submitted an application to the Secretary requesting an increase in the injection pressure at the Clarkson 6-21H injection well, the Clarkson 6-22 injection well, the Olson 15-22 injection well, and the State 44-16H injection well to 1,710 pounds per square inch. No other permit condition changes were requested. The requested pressure increase will not cause new fractures or propagate existing fractures in the confining zone and will not affect any underground sources of drinking water.

The Secretary recommends approval of the application with the following conditions:

- 1) Injection operations authorized under the permit to inject must be conducted in accordance with SDCL Chapter 45-9, ARSD 74:12 and any applicable orders or rules promulgated by the board;
- 2) The maximum injection rate at the Clarkson 6-21H injection well must not exceed 1,500 barrels of water per day, the maximum injection rate at the Clarkson 6-22 injection well must not exceed 300 barrels of water per day, the maximum injection rate at the Olson 15-22 injection well must not exceed 300 barrels of water per day, and the maximum injection rate at the State 44-16H injection well must not exceed 1,000 barrels of water per day;
- 3) The maximum pressure at the above referenced wells must not exceed 1,710 pounds per square inch during injection operations;
- 4) A mechanical integrity test must be successfully conducted prior to increasing the tubing injection pressure to 1,710 pounds per square inch. The well casing must pass the mechanical

integrity test at 1,000 pounds per square inch surface pressure. The operator is required to notify the Secretary a minimum of 72 hours prior to running a mechanical integrity test;

- 5) Once mechanical integrity is established, the well must be retested at least once every five years to ensure that mechanical integrity is maintained, unless the department indicates differently;
- 6) If an unsuccessful pressure test occurs, the operator must cease operations immediately if it is determined the injection will threaten any underground source of drinking water. If the failure is not threatening ground water, the operator must cease operations within 48 hours after receipt of the department secretary's notice, and take corrective action on the well as soon as feasible. Corrective action options include repairing the well so that a successful test result can be obtained, plugging and abandoning the well, or any other action approved by the department.

Authority for the Secretary to approve this application is contained in ARSD 74:12:07 and 74:12:09. Unless a person files a petition requesting a hearing on the above application pursuant to the provisions of ARSD 74:09:01 on or before November 27, 2012, the Secretary's recommendation will be considered final and the Secretary will approve the application in accordance with that recommendation. For additional information about the application, please contact Brian Walsh, Environmental Scientist III, Ground Water Quality Program, Department of Environment and Natural Resources, 523 East Capitol Avenue, Pierre, SD 57501; 605.773.3296 or email [brian.walsh@state.sd.us](mailto:brian.walsh@state.sd.us).

October 29, 2012



Steven M. Pirner  
Secretary

Published once at the total approximate cost of \_\_\_\_\_.