

Considered: _____

WATER PERMIT NO. 1350-1

MAP No. same

Name of Applicant Harper Oil Co.

Post Office Address P.O. Box 5928, T.A., Denver, Co. 80217

Amount of Water Claimed 0.10 cfs Total Acres —

Source of Water Supply Dakota Formation ~ 4680 ft. deep

Water to be used for IND County Harding

About 18 miles W of Judlow.

PROOF OF PUBLICATION: Received _____ Not Received _____

APPLICATION: Approved _____ Subject to _____

F.F. & C.L. Adopted _____ Not Approved _____ Deferred _____

PRIORITY _____ Date Received 2-18-86 Fee \$50.00 Remarks _____

Corrected Application Received _____ Period of Annual Use Jan. 1 to Dec. 31

WATER QUALITY APPROVAL RECEIVED N.A. APPROVED/CONDITIONAL (Circle one)

WI-1 Description same as Application YES _____ NO _____ REMARKS _____

Diversion Point SW⁴ SW⁴ sec. 22 T21N-R3E

Land to be Irrigated no

	22				
⊗					

Well Log: Driller _____ Licensed YES _____ NO _____

Depth of Well ~ 4680 ft. REMARKS _____

Type of Map Drawn PREPARED BY Roy Ruel Reviewed and the Number

assigned on _____ By Ron D. Darrall

No. 1350-1 Hydrologic Unit 10130302
 Map No. Same Basin Grand River
 Newspaper Nations Center News, Box 107, Buffalo (Wed)

Application For Permit To Appropriate Water Within The State Of South Dakota

Check use of water: Industrial ☒ Commercial ☐ Municipal ☐ Other Common Distribution System ☐
 Rural Water System ☐ Suburban Housing ☐ Geothermal Heat ☐ Institutional ☐ Recreational ☐
 Domestic ☐ (above 18gpm) Other ☐

Type of Application: Check one or more of the following

New ☒ Vested Right ☐ Future Use ☐ Change Use ☐☒ Amend Permit No. 1342-1 with old priority date retainedChange diversion point(s) ☒ Add diversion point(s) ☐ Other ☐☒ Application to: Change diversion point(s) ☐ Add diversion point(s) ☐ on Permit No. 1342-1☐ Construction to use water reserved by Future Use Permit No. _____1. Name of Applicant Harper Oil Company Phone No. (303) 825-4771Post Office Address P.O. Box 5928, T.A. Denver, Colorado State 80217
(Street, RR or Box) Zip Code2. Amount of water claimed (c.f.s) .1 C.F.S. or approximately 45 gpm3. Source of water supply Well to be drilled - Dakota Sandstone4. Location of point of diversion 1148' FWL - 781' FSLSec 22- T21N- R3EHarding County, South Dakota County _____5. Counties where water will be used Harding6. Annual period during which water is to be used Year Around beginning approximately November 1, 1986

7. Give a brief description of proposed project. When available include any preliminary engineering report or other reports or information that will help explain the project. (Attach sheet if more space is needed)

SEE ATTACHED SHEET

Attachments: Attach Form 2A if diversion from a well or dugout, or if storage of water, is proposed. Attach map (see instruction)

STATE OF SOUTH DAKOTA ss COLORADO
County of DenverI, MICHAEL E. WARD the applicant, certify that I have read the foregoing application, have examined the attached map and that the matters therein stated are true and that I intend, and am able to complete the necessary construction.Signed Michael E. WardSubscribed and sworn to before me this 12th day of February 19 86
My Commission Expires Dec. 26, 19881625 Broadway, Ste. 1200
Denver, CO 80217Carolyn D. Hepp
Carolyn D. Hepp (or other qualified officer)

WATER PERMIT

The Water Management Board hereby approves Water Permit Application No. 1350-1
Harper Oil Company P.O. Box 5928 T.A. Denver
(Applicants) (Post Office Address)
Colorado 80217 With the following qualifications.
(State) (Zip Code)

1. That the well casing be pressure grouted with cement (bottom to top) above the water producing formation and that construction comply with Water Management Board Well Construction Rules, Chapter 74:02:04.

2. That if the test hole for this well or if the well is abandoned, that it be plugged with neat cement (bottom to top) according to Board Rules 74:02:04.

Date of first receipt of application February 18, 1986

Date of return to applicant for correction, amendments or changes required _____, 19____

Date of receipt of corrected application _____, 19____. Approved July 1, 1986

The Water Management Board hereby approves this Water Permit No. 1350-1 authorizing the construction of the water use system and the placing of water to beneficial use as stated in the Application and as qualified in the Water Permit approval, subject, however, to the following limitations and conditions:

1. The date from which applicant may claim right is February 18, 1986
2. The equivalent of at least one-fifth of the specified work is to be completed on or before December 1, 1988
3. The whole of said work is to be completed on or before July 1, 1991
4. The limit of time from proof of beneficial use of water appropriated in accordance herewith is July 1, 1995
5. The water appropriated shall be used for the purpose of industrial use
6. The prior right of all persons who, by compliance with the laws of the State of South Dakota, have acquired a right to the use of water must not be unlawfully impaired by this appropriation.
7. The amount of the appropriation herein granted shall not exceed .10 cubic feet per second; neither shall it exceed the capacity of the above described water supply system nor shall it exceed the amount of water needed for beneficial uses served and to which water is actually and beneficially applied for industrial use on or before July 1, 1995; said water to be used during the following described annual period: Jan 1 - Dec 31

WATER MANAGEMENT BOARD

By: John H. [Signature]
Chief Engineer

Division of Water Rights
Dept. of Water and Natural Resources

AUG 18 1986

_____, 19____

Supplemental Information

(type or print in ink)

1. Well Information - Proposed construction

- a) Drill Hole Diameter 7-7/8" Depth 4680'
- b) Casing Type Steel Diameter 5-1/2" OD Thickness .244"
- c) Screen Type None Diameter N/A Thickness N/A
- d) Gravel Pack Thickness None Length of Gravel Pack _____
- e) Depth to Top of Water Bearing Material Approximately 120'
- f) Depth of Water (ground surface to water level) Approximately 4450-4560'
- g) Distance to nearest existing domestic well:
- On applicants property None On property owned by others 2 Miles

2. Dugout Information Estimates

- a) Surface Dimensions _____ Depth _____
- b) Depth to water (ground surface to water level) _____

3. Water Storage Dams

If the proposed water use system contains one or more storage dams, please furnish the information requested below. The locations of each dam should be shown on the map submitted with the application.

- a) If a private engineering firm or government agency was involved in the design of this dam please give their name and address

b) Freeboard _____

c) Crest Width _____

Crest Length _____

d) Height _____

e) Outlet Dimensions:
Pipe diameter _____

Spillway width _____

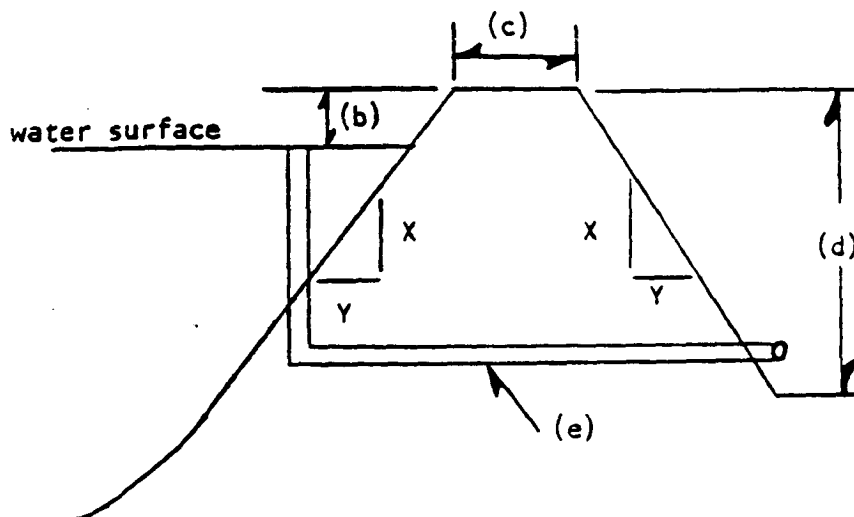
f) X & Y Slope
Upstream _____

Downstream _____

Surface Area of Impoundment _____

Storage _____ acre feet

Drainage area above dam _____



Michael E. Ward

Signature of Applicant

Harper Oil Company plans to drill a 7-7/8" hole to approximately 4680' to test water quality and production rate from the Dakota sandstone. The water is to be used for an oilfield waterflood project currently undergoing unitization. As the project is currently planned, there will be 5 injection wells and 8 producers. Maximum injection is estimated to be 1500 barrels per day total, with total injection per day to be decreasing throughout the projected 15 year life of the project. Water produced from the 8 producing wells will be gathered, filtered, and treated for reinjection, thus further reducing water requirements from the Dakota sandstone.

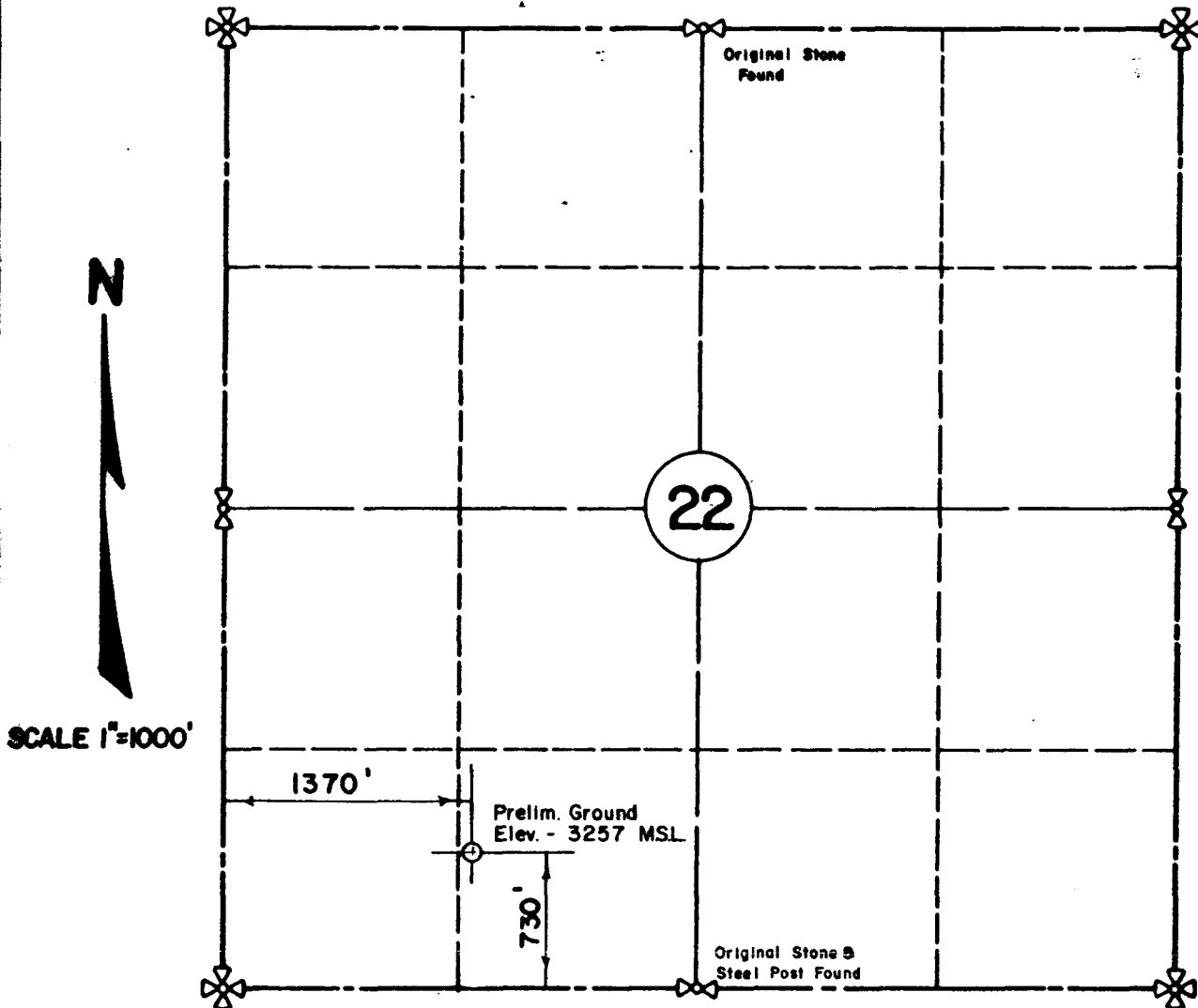
If the Dakota sandstone tests adequate quality and quantity of water suitable for a waterflood, 5-1/2" API casing will be run to TD and cemented to surface using the plug displacement method.

The planned unit will include lands as described below:

Sections 15, 16, 21, 22, 26, 27 and 28
T21N- R3E
Harding County, South Dakota

WELL LOCATION PLAT

Applicant Apache Corp.
 Address 1660 Lincoln St., Suite 2300, Denver, Colorado 80264
 Well Name & No. Clarkson 13-22 W Source Well
730 feet from South Line and 1370 feet from West Line
 Section 22, T. 21 N., R. 3 E.,
Harding County, South Dakota

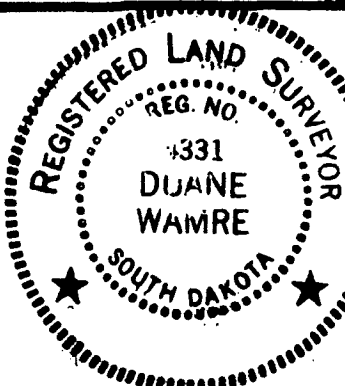


I certify that this plat correctly represents work performed by me or under my responsible charge, and is true and correct to the best of my knowledge and belief.

NOTE: all land corners are assumed corners unless otherwise noted.

Duane Wamre
 R.L.S. # 4331 Date

Jerard Jacob 7-7-87
 Surveyed By Date



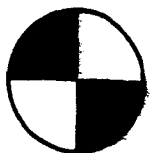
VERTICAL CONTROL DATUM USED	
NW Corner of Section 22,	
spot elevation - 3187 MSL	
Proj. No. 48092	
Book M 293 Pg. 64	Staking
Book M 293 Pg. 64	levels

PROFESSIONAL CONSULTING ENGINEERS AND SURVEYORS
 REGISTERED IN N. DAK., S. DAK., MONTANA, MINNESOTA AND WYOMING

KADRMAS, LEE & JACKSON P.C.
 VESEL ENGINEERING

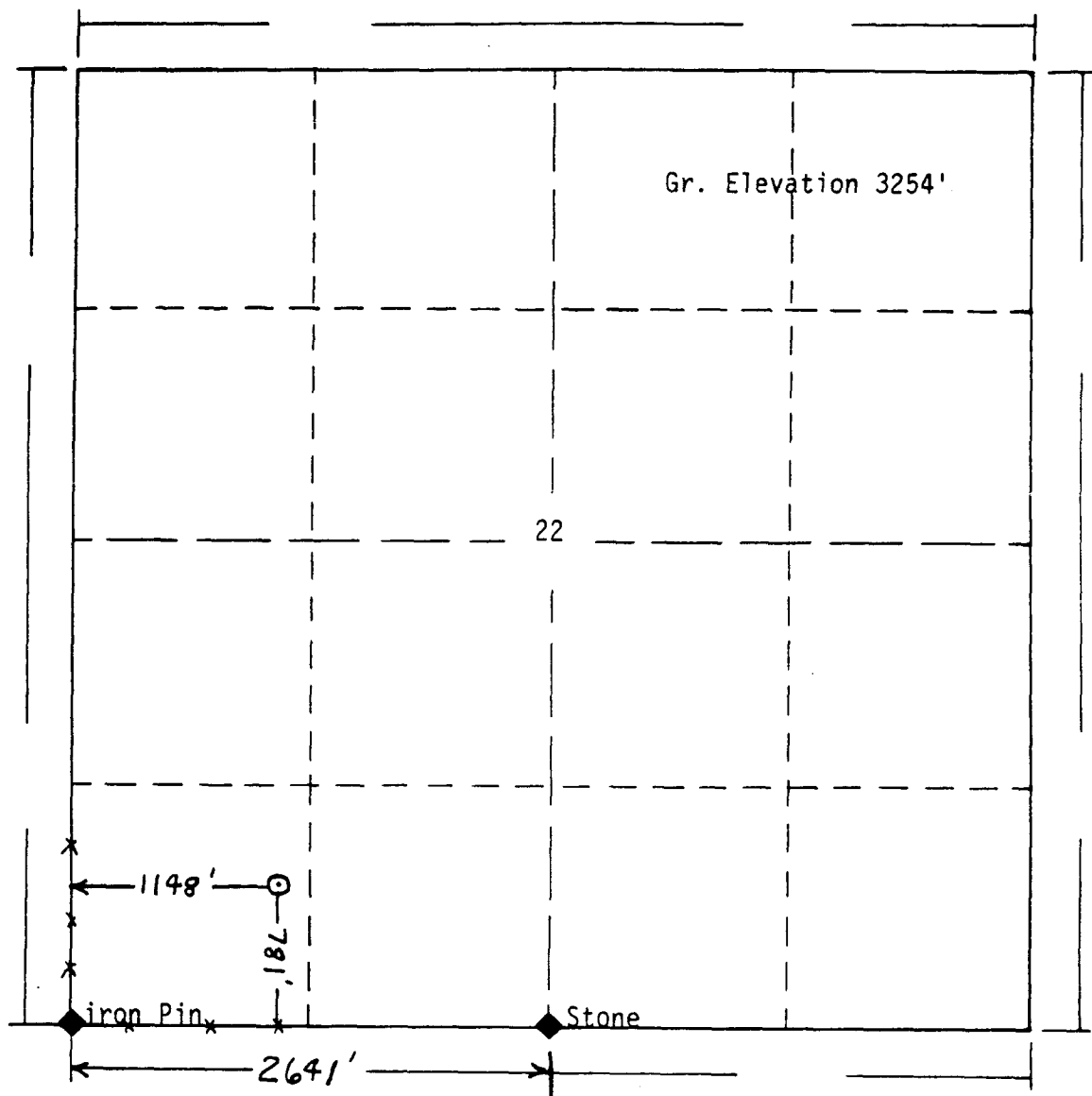
Bu.: 701-227-1284
 P.O. Box 290
 Dickinson, N.D. 58602-0290

Office in:
 Bismarck, Valley City
 Hazen, Bowman, Grafton



Form PS-102

R. 3 E



N

T.
21
N

Scale: 1"=1000'

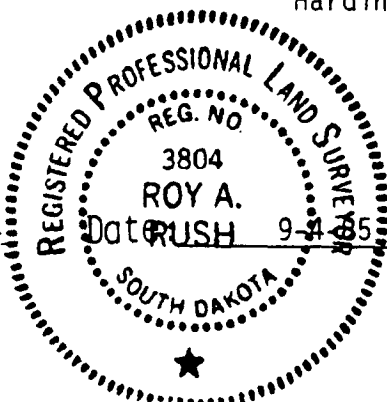
Powers Elevation of Denver, Colorado has in accordance with a request
from Paul Holthus for Harper Oil Co
determined the location of Water Well
to be 781fs1, 1148fw1 Section 22 , Township 21 N
Range 3 E of the Black Hills Meridian,
Harding County, South Dakota

I hereby certify that this plat is an
accurate representation of a correct
survey showing the location of

Water Well

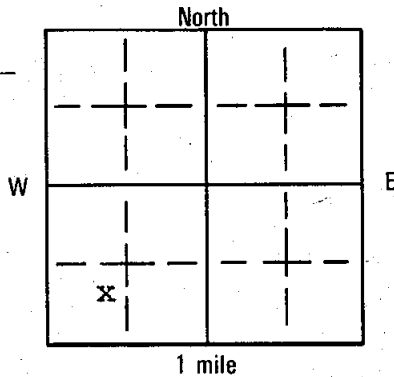
Roy A. Rush
Licensed Land Surveyor No. 3804
State of South Dakota

APP # 1350-1



SOUTH DAKOTA WATER WELL COMPLETION REPORT

10-85

Location 1/4 1/4 Sec 22 Twp 21N Rg 3ECounty
HardingPlease mark well
location with
an "X"920' FSL
1120' FWLWell Completion Date Finished swab testing on 10/20/87

PROPOSED USE:

☐ Domestic ☐ Municipal ☐ Test Holes
☐ Irrigation ☒ Industrial ☐ Stock

Method of Drilling:

Oil well rotary drilling rig

CASING DATA:

☒ Steel ☐ Plastic ☐ Other

If other describe _____

PIPEWEIGHT	DIAMETER	FROM	TO	HOLE DIAMETER
36 LB/FT	9-5/8 IN	sfc FT	1500 FT	12-1/4 IN
26&29 LB/FT	7 IN	sfc FT	4740 FT	8-3/4 IN
_____ LB/FT	_____ IN	_____ FT	_____ FT	_____ IN
_____ LB/FT	_____ IN	_____ FT	_____ FT	_____ IN

GROUT:

Was the well grouted? ☒ YES ☐ NOTo what depth? 9-5/8" csg @ 1500 5 1/2" @ 4740 FEETWhat is grouting material? Cement CementIf cement, number of sacks? 565 sx 600 sxDescribe grouting procedure Circ cnt to Circ cnt asas follows: Pump 415 sx lite follows: Pumpcnt, followed by 150 sx Class 450 sx liteG cnt. then pump 150 sxWhat was grout weight? Lite Cnt=12.7 ppg LB/GALClass G = 15.8SCREEN: ☒ Perforated pipe ☐ ManufacturedDiameter 7 IN Length 90 FEETMaterial 7" 29#/ft csg

Slot Size _____ Set From _____ Feet To _____ Feet

Slot Size _____ Set From _____ Feet To _____ Feet

Slot Size _____ Set From _____ Feet To _____ Feet

Other information 7" csg ran to bottom thenjet perforated from 4420'-4510' w/4 jsp (362 holes)Was a packer or seal used? ☒ YES ☐ NOIf so, what material? Metal packer with rubber elementsDescribe packer(s) and location? Set Baker model Aretrievable packer in the 7" csg at 4396'.Production tbg is 2-7/8" tubing.Was well disinfected upon completion? ☐ YES ☒ NO

Explain _____

Bacteriological analysis ☐ YES ☒ NO

Laboratory sent to _____

Well Owner:

Name Apache Corporation1700 Lincoln Street, Suite 1900Address Denver, CO 80203Well Log: Gamma Ray-Cement Bond Log Depth

Formation	From	To
Tertiary undifferentiated	Surface	1491'
Pierre	1491'	2952'
Niobrara	2952'	3110'
Carlile	3110'	3396'
Greenhorn	3396'	3472'
Belle Fourche	3472'	3910'
Mowry	3910'	4065'
Muddy	4065'	4117'
Skull Creek	4117'	4340'
Dakota Silt	4340'	4367'
Dakota Sand	4367'	4740'
Total Depth at 4740'		

STATIC WATER LEVEL 2000 FeetIf flowing: closed in pressure 0 PSIGPM flow _____ through 2-7/8" inch pipeControlled by ☐ Valve ☐ Reducers ☐ OtherIf other, specify Well is currently swabbed with oil
well completion unit.Can well be completely shut in? yes

WELL TEST DATA:

☐ Pumped☒ Bailed☐ OtherDescribe: Perforated csg, then swab
tested.See Below

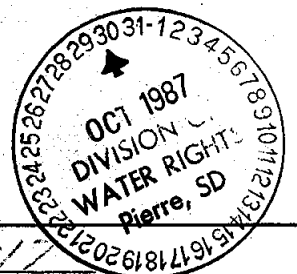
Pumping Level Below Land Surface

_____ ft. After _____ Hrs. pumped _____ GPM

Class G ft. After _____ Hrs. pumped _____ GPM

_____ ft. After _____ Hrs. pumped _____ GPM

REMARKS:

The well will be equipped with a submersible
pump. The well was swabbed at a rate of
+/- 30 gpm, with the fluid level remaining
at 1100'.This well was drilled under license # 547

And this report is true and accurate.

Drilling firm Cemented Well Co.

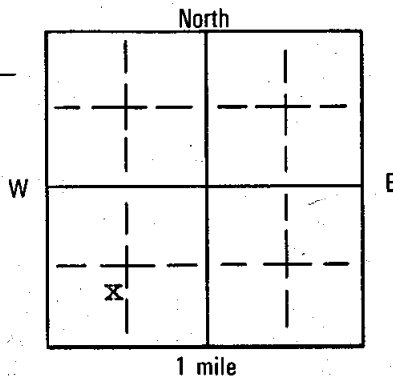
Signature of License Representative: _____

Signature of Well Owner: _____

Date _____

SOUTH DAKOTA WATER WELL COMPLETION REPORT

10-85

Location $\frac{1}{4}$ $\frac{1}{4}$ Sec 22 Twp 21N Rg 3ECounty
HardingPlease mark well
location with
an "X"920' FSL
1120' FWLWell Completion Date Finished swab testing on 10/20/87

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Oil well rotary drilling rig

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26&29 LB/FT	7 IN	Sfc FT	4740 FT	8-3/4 IN
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Explain _____

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well completion unit.Can well be completely shut in? yes

WELL TEST DATA:

☐ Pumped Perforated csg, then swab☒ Bailed Describe: tested. See Below☐ Other

Pumping Level Below Land Surface

_____ ft. After _____ Hrs. pumped _____ GPM

sx Class Gt. After _____ Hrs. pumped _____ GPM

_____ ft. After _____ Hrs. pumped _____ GPM

REMARKS:

The well will be equipped with a submersible pump. The well was swabbed at a rate of +/- 30 gpm, with the fluid level remaining at 1100'.

This well was drilled under license # 547

And this report is true and accurate.

Drilling firm Capitol Drilling Co.

Signature of License Representative:

H. Thompson

Signature of Well Owner:

Date _____

RECEIPT

Division of Water Rights

South Dakota Department of Water and Natural Resources

410349

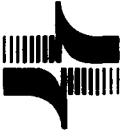
Pierre, March 10, 1986

RECEIVED OF Harper Oil Co., P.O. Box 5928 T.A., Denver, CO 80217

the following amount in fees for services rendered as provided for by law:

Fee for Application for Permit No. <u>1350-1</u> to Appropriate Water, to construct works and to put water to beneficial use _____	50	00
Fee for Application for Permit No. _____ to Appropriate Water for Future Use _____		
Fee to retain Future Use Permit No. _____ after period of seven years.		
Fee for Inspecting Constructed Works, confirming beneficial use and issuing Water License No. _____		
Fee for Filing Transfer Form _____		
Fee for Filing Extension Request _____		
Fee for Certified Copy of _____		
Fee for Print Copy of Map _____		
Fee for Certifying _____		
Fee for _____		
(Any Other Work Provided by Law)	Total	50 00

By John Hatch
Chief Engineer
JOHN HATCH ms



Harper Oil Company

Rocky Mountain Division
Dome Tower, Suite 1200
1625 Broadway
P.O. Box 5928, T.A.
Denver, Colorado 80217
(303) 825-4771



February 12, 1986

DWNR
Joe Foss Building
Pierre, South Dakota 57501

RE: Appropriation of Ground Water
Proposed West Buffalo 'B' Unit Waterflood
Harding County, South Dakota

Dear Gentlemen:

Enclosed are resubmitted copies of Forms 2 and 2A as application to drill and test the Dakota Sandstone Formation for use as a water supply well as outlined in the enclosed information.

We would like to schedule an appearance before the Water Management Board's next hearing in May of this year. We understand we will be responsible for cost of publishing the Notice of Application in local newspapers prior to the meeting. It is my understanding that we do not have to resubmit the \$50.00 application fee which was paid previously.

If you have any questions, please call me.

Sincerely,

Michael E. Ward

Michael E. Ward
Production Engineer
Rocky Mountain Division

MEW:cr

cc Alex Nash, Jr.
Ceci Leonard
'B' Unit Well File



MIDCON CORP.

Harper Oil Company plans to drill a 7-7/8" hole to approximately 4680' to test water quality and production rate from the Dakota sandstone. The water is to be used for an oilfield waterflood project currently undergoing unitization. As the project is currently planned, there will be 5 injection wells and 8 producers. Maximum injection is estimated to be 1500 barrels per day total, with total injection per day to be decreasing throughout the projected 15 year life of the project. Water produced from the 8 producing wells will be gathered, filtered, and treated for reinjection, thus further reducing water requirements from the Dakota sandstone.

If the Dakota sandstone tests adequate quality and quantity of water suitable for a waterflood, 5-1/2" API casing will be run to TD and cemented to surface using the plug displacement method.

The planned unit will include lands as described below:

Sections 15, 16, 21, 22, 26, 27 and 28
T21N- R3E
Harding County, South Dakota



Water & Natural Resources

Joe Foss Building
523 East Capitol
Pierre, South Dakota 57501-3181

Water Rights Division
605 773-3352

February 27, 1986

Harper Oil Co.
ATTN: Michael Ward
PO Box 5928, T.A.
Denver CO 80217

Mr. Ward:

I have received your water permit application for the water flood project in Harding County. When I spoke to you by phone I told you that another \$50.00 fee would not be required. I was mistaken, the \$50.00 fee submitted with your previous permit cannot be applied to the new one as it has been forfeited. Jim Goodman a hydrologist with our staff would also like some type of electric or lithologic log as he will need it for his report. We will continue processing your application pending receipt of the \$50.00 filing fee and the geologic information. If you have any questions, please contact this office.

Thank you,

KEVIN C LARSON
Natural Resources Engineer

KCL:ks



Harper Oil Company

Rocky Mountain Division
Dome Tower, Suite 1200
1625 Broadway
P.O. Box 5928, T.A.
Denver, Colorado 80217
(303) 825-4771

2-18

March 5, 1986

South Dakota Department of
Water & Natural Resources
Water Rights Division
Joe Foss Building
523 East Capitol
Pierre, South Dakota 57501-3181



ATTN: Mr. Kevin C. Larson

Dear Kevin:

Enclosed is a check for \$50.00 to cover filing fees for our recently submitted application to use Dakota Sandstone water for our proposed West Buffalo "B" Unit waterflood project in Harding County, South Dakota.

I cannot provide an original copy of the DLL/MSFL log run across the Dakota Sand in the #13-22 Clarkson well located SWSW of Section 22- T21N- R3E, the location upon which we plan to drill the source well. I have included a copy of the well log showing the zone of interest from 4380' to 4600'. It appears the Dakota Sand is clean of shale, fine to medium fine, moderately sorted.

If you need further information, please call me.

Sincerely,

M.E. Ward

Michael E. Ward
Production Engineer
Rocky Mountain Division

MEW:cr

Enclosure

cc West Buffalo "B" Unit Wellfile



MIDCON CORP.

K KOCH

KOCH EXPLORATION COMPANY

March 5, 1986

RECEIVED

MAR 10 1986

Department of Water and Natural Resources
Joe Foss Building
523 East Capitol
Pierre, SD 57501

SOUTH DAKOTA DEPARTMENT OF
WATER AND NATURAL RESOURCES
OFFICE OF WATER QUALITY

Attention: Mr. Jim Nelson

RE: Application for Permit to Dispose of Produce Water

Dear Jim:

Koch Exploration Company respectfully submits this application for a permit to dispose of produced water into the Dakota Formation of the South Buffalo Red River Unit, Harding County, South Dakota. The attached information is requesting an exempted aquifer status for the Dakota Formation into the area of the proposed disposal well as outlined in Section 1425 of the Underground Injection Control Program of the South Dakota Department of Water and Natural Resources. Also, an affidavit showing the names and addresses of all operators of the Buffalo Field (Red River Pool) to whom a copy of this application has been furnished is provided.

If additional information is required, then please contact me at 316-832-5077.

Sincerely,

Koch Exploration Company

Ronald J. Miller

Ronald J. Miller
Project Manager

RJM:es

enc.

xc: Scott Sumner
Randy Whipple
Fred Steece
Bob Buettner

AFFIDAVIT OF MAILING

State of South Dakota)
) SS:
County of Harding)

Ronald J. Miller, of lawful age, being duly sworn, deposes and says that he is an employee of Koch Exploration Company, a subsidiary of Koch Industries, Inc., (Koch) and duly authorized to make this affidavit in its behalf.

That Koch has served notice pursuant to ARSD 74:10:09:03 by forwarding a true and correct copy of the application for underground injection dated March 5, 1986, pertaining to the authorization of injection for the disposal of fluids in an area known as the South Buffalo Red River Unit. Certified mailings with return receipts requested were deposited in the U. S. mail to the following operators of the pool on or before March 7, 1986.

Alpar Resources, Inc.
P. O. Box 1046
Perryton, TX 79070

Attn: Land Manager

Luff Exploration Company
1580 Lincoln Street, Suite 850
Denver, CO 80203

Attn: Mr. J. Allen Gardner

Depco, Inc.
110 - 16th Street, Suite 1000
Denver, CO 80202

Attn: Mr. Phil Wood

Monarch Energy Corporation
1536 Cole Boulevard, Suite 225
Golden, CO 80401

Attn: Mr. Leo K. Birkby

Gulf Oil Corporation (Chevron)
P. O. Box 599
Denver, CO 80201

Attn: Mr. Leon Fergus

NRM Petroleum Corporation
500 West Illinois, Suite 800
Midland, TX 79701

Attn: Land Manager

Harper Oil Company
Box 5928 TA
Denver, CO 80217

Attn: Mr. Kelly Krattenmaker

Phillips Oil Company
P. O. Box 2920
Casper, WY 82602

Attn: Land Manager

The preceeding operators were obtained from the Office of the State Geologist, State of South Dakota, Rapid City, South Dakota.

Affidavit of Mailing
Page 2.

In witness whereof, this affidavit is executed this 5 day of March, 1986.

KOCH EXPLORATION COMPANY

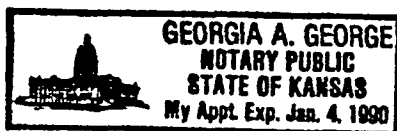
By: Ronald J. Miller
Ronald J. Miller,
Project Manager

STATE OF KANSAS)
) SS:
COUNTY OF SEDGWICK)

Before me, the undersigned, a Notary Public, in and for said County and State, on this 5th day of March, 1986, personally appeared Ronald J. Miller, to me known to be the identical person described in and who executed the within and foregoing instrument of writing and acknowledged to me that he duly executed the same as his free and voluntary act and deed for the uses and purposes therein set forth.

In witness whereof, I have hereunto set my hand and affixed my notarial seal the day and year last above written.

Seal:



Georgia A. George
Notary Public

APPLICATION FOR DISPOSAL PERMIT

SOUTH BUFFALO RED RIVER UNIT

WELL 34-32

Harding County, South Dakota

The following information is being submitted to fulfill the requirements for a permit to disposed produced water into the Dakota formation at the South Buffalo Red River Unit.

Item 1: The proposed disposal well, SBRRU 34-32, is located 660' FSL & 1980' FEL of Section 32-T21N-R4E, Harding County, South Dakota. Figure 1 shows the location of SBRRU 34-32, the area of review which includes one (1) active oil producing well, SBRRU 11-4, located 660' FNL & 660' FWL, Section 4-T20N-R4E, Harding County, SD. The only other well in the area of review is Travers 32-32, located 1980' FNL & 1982' FEL, Section 32-T21N-R4E, Harding County, SD which was plugged and abandoned by Shell Oil Company in ¹⁹⁶¹1960. No fresh water wells or off-set operators are located within the area of review of the proposed disposal well.

Item 2: The Red River zone is currently being produced at the project and no other formations have been produced.

Item 3: The Dakota zone is the proposed disposal formation. The Dakota formation is a fine to coarse quartzose sandstone located at a depth of approximately 4530'.

Item 4: The well history for SBRRU 34-32 is summarized as follows:

Current status: Observation well.

Date completed: January 2, 1981.

TD: 8585' PBD: 8531'

Completion: Perforated Red River formation.

8516'-8520' w/2 spf, acidized w/1000 gal. 15% HCl, oil fractured w/27,000 gal. w/15,000# sand. Pumped 20 BOPD and 200 BWP. No cores or DSTs were taken.

August 2, 1983 - Shut-in for observation well after pumping 0.25 BOPD and 177 BWP.

January 21, 1986 - Pull rods and tubing. Perf. Dakota 4659-66' w/2 spf. See Figure 2 for GR-N, CBL, TIH w/ RBP and pkr. Set RBP @ 4765'. Set pkr @ 4573. Test casing to 1000#. Held OK. Swabbed 85 bbl. Dakota water. Took field sample NaCl 4898 ppm. TOH w/tbg, pkr, and RBP. Took injection test w/ 160 bbl @ 1.88 BPM @ 600#. Surface casing on strong blow. Got state approval to plug Red River & squeeze Dakota. Set CIBP @ 8450'. Dump 1 sx cmt on CIBP. TIH w/ tbg & pkr. Set pkr @ 4747'. Test csg below pkr. to 1000 psi, held OK.

TOH w/ tbg & pkr. Set Mod K cmt. retainer @ 4530'. TIH w/tbg & stinger. Sting into retainer & test casing to 1000#. Held OK. Cement w/300sx Class G. Returns to surface after 7 bbl cmt. pumped. Good circulation throughout. Unstung from retainer. Reverse out 2-1/2 bbl cmt slurry. TOH. WOC. TIH w/ bit and tubing. DO retainer and 138' cmt. TOH. Perf. Dakota 4536-4624 w/2spf. TIH w/ tbg & pkr. Set pkr @ 4468'. Test casing to 1000#. Held OK. Swab 140 bbl. & took sample. See Figure 3 for analysis. Took injection test 0.25 BPM @ 800#. No blow on surface csg. TOH w. tbg & pkr. TIH w/ tbg, pkr, & tailpipe. Set pkr @ 4464', TP @ 4625 in preparation to acidize. WO state approval to acidize and initiate disposal. No bond log was run after cementing the Dakota because good circulation was maintained throughout the cement job, the calculated cement top (3455') was well above the Dakota, and the subsequent injection test showed no communication to the surface casing.

The well history for SBRRU 11-4 is summarized as follows:

Current status:	Producing well making 10 BOPD and 40 BWPD.		
Date completed:	December 5, 1978		
TD:	8544'	PBTD:	8535'
Completion:	Perforated	8493'- <u>8509'</u>	w/2 spf
acidized w/2000 gal - 15%. No DSTs taken.			
Pumped 32 BOPD and 48 BWPD. See attached well completion report, Figure 4.			

Travers 32-32 is summarized as follows:

Current status: Plugged and abandoned by Shell Oil Company. See attached Well Plugging Report (Figure 5) and Well Completion Report (Figure 6).

Date completed: January 26, 1960.

Date Plugged and Abandoned: March 25, 1961.

Item 5:

Casing Description SBRRU 34-32.

Surface casing - 8-5/8", 24#, K-55, set @ 1598'. Cemented with 550 sx lite w/2% CC, followed by 250 sx G w/2% CC and 1/4#/sx flocele. Cement circulated to surface.

Production casing - 4-1/2", 11.6#, K-55, set @ 8585'. Cemented with 350 sx G w/18% salt, 0.75% CFR 2, 1/4# flocele per sx. DV tool @ 5939'. Cement with 1000 sx lite, salt saturated with 0.6% Halad-9.

Casing integrity test - Pressure tested casing 1000 psi three separate times. Held OK. It is proposed to set packer above Dakota perforations and retest casing to 1000 psi, bleed the pressure, and monitor annulus pressure after disposal commences.

Item 6: The freshwater resources in the area of the project include the Fox Hills sand at a depth of approximately 400'. No freshwater wells exist within the area of review.

Item 7: The operator of the South Buffalo Red River Unit and the proposed disposal well is:

Koch Exploration Company
PO Box 2256
Wichita, KS 67201

Item 8: Figure 7 and 8 are surface and sub-surface schematics of the proposed well. The well will be completed with a packer and 2-3/8" OD internally plastic-coated tubing as the injection string.

Item 9: The disposal water source will be Red River produced water (see Figure 9 for a typical water analysis) from the South Buffalo Red River Unit. The Dakota water analysis (see Figure 3) indicates that the total dissolved solids are 4553 mg/l. No compatibility problems with the Dakota formation water and the Red River formation water are expected. However, some minor scale formation of calcite or anhydrate could exist which can be handled by wellbore acid treatments. The average injected volume is estimated to be 1500 barrels per day. The maximum injection volume is estimated to be 3000 barrels per day.

Item 10: The average injection pressure is estimated at 1000 psi and the maximum injection pressure is estimated at 1200 psi surface pressure with no friction pressure. It is proposed to run a step-rate test to determine the actual fracture pressure.

Item 11: The proposed stimulation program will be to acidize the Dakota perforations to eliminate any wellbore skin effects.

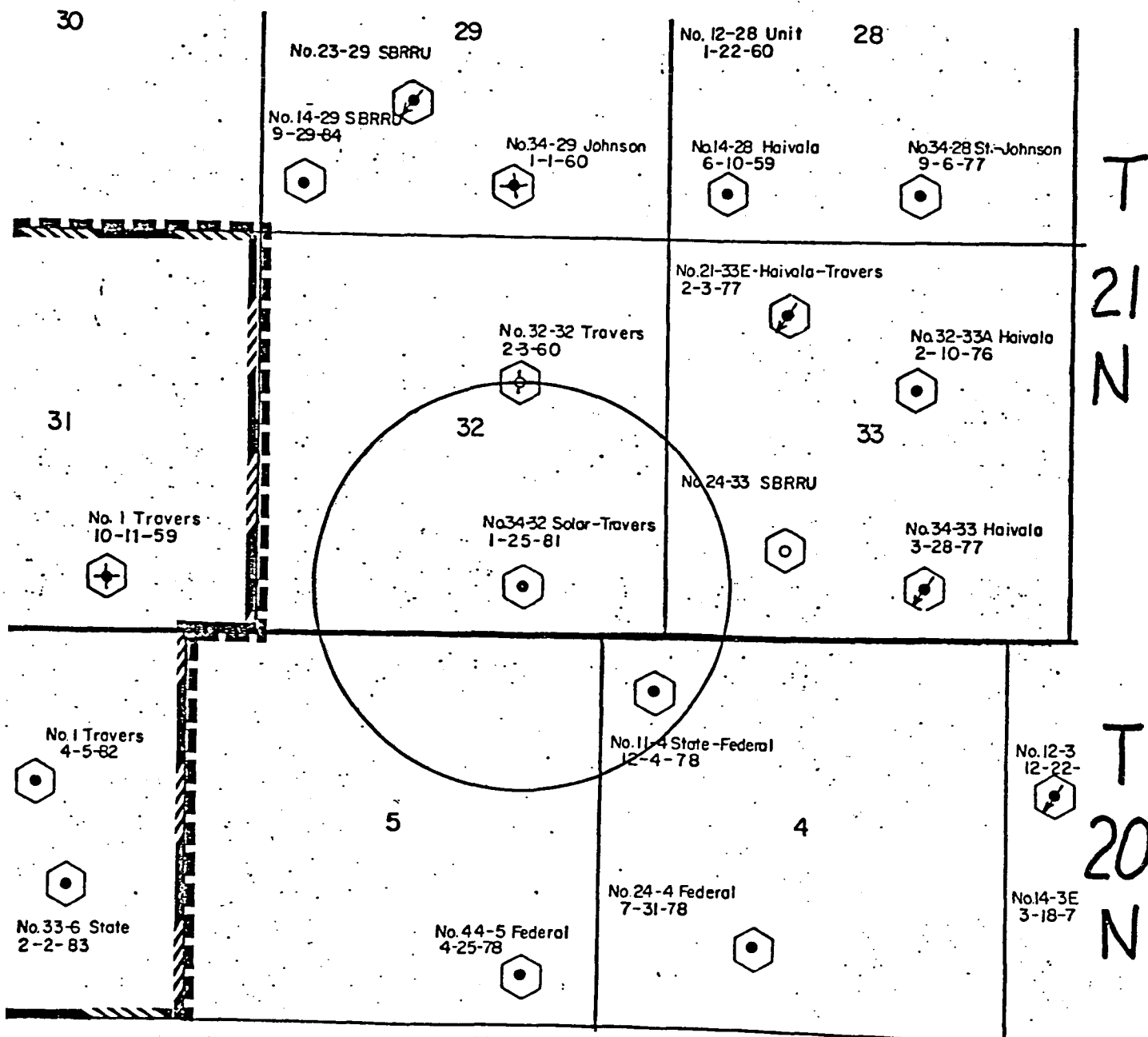
Item 12: No corrective action on wells in the area of review are necessary to protect the fresh water source. Travers 32-32 had surface casing through the Foxhills sand and cement plugs above the Dakota and below the Foxhills. SBRRU 11-4 also has surface casing set through the Foxhills sand. In addition, it is proposed to monitor the 8-5/8" - 4-1/2" annulus pressure for any pressure changes on well SBRRU 11-4. The Dakota formation is a continuous zone found in all wells in the Buffalo Field. The impact of injecting approximately 1500 barrels per day in the Dakota formation is expected to be insignificant as related to the reservoir pressure. No degradation of the fresh water zone is expected because all wells have surface casing protecting the Foxhills formation.

Koch Exploration requests that the Dakota formation in the area of review for XBRRU 34-32 be designated an exempted aquifer because it is situated at a depth ³(4530') which makes recovery of water for drinking water economically or technologically impractical and the total dissolved solids content of the Dakota (4553 m/l) is more than 3000 and less than 10,000 mg/l, and it is not expected to supply a public water system.

RJM:es

Figure 1 -

R 4 E



: Area of Review

Operator within Area of Review: Koch Exploration Company.

Owners of Surface within Area of Review: Kathryn Ann Hight, Alyce (Travers) Smolnik, Bank of Belle Fourche, Trustee of the Edgar Gardner Estate, John Niemi, and Mike Butler.

Owners of Minerals with Area of Review: SBRRU: Tracts 16, 18, 33, 38, 39, 40, 40A.

Offset Operator(s) within Area of Review: Koch Exploration Company.

JAN 31 1980

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WATER ANALYSIS REPORT

COMPANY Koch Expl. Co. ADDRESS Buffalo S.D. DATE: 1-18-82

SOURCE SBRU 34-32 PERFS 4536/4624 DATE SAMPLED _____ ANALYSIS NO. _____

Analysis

Mg/L

* Meq/l.

- | | | | |
|--|------------------|----------------------|-----------------------------|
| 1. PH | <u>6.5</u> | | |
| 2. H ₂ S (Qualitative) | <u>NEG</u> | | |
| 3. Specific Gravity | <u>1.005</u> | | |
| 4. Dissolved Solids | | <u>455.3</u> | |
| 5. Suspended Solids | | | |
| 6. Phenolphthalein Alkalinity (CaCO ₃) | | | |
| 7. Methyl Orange Alkalinity (CaCO ₃) | | <u>350.0</u> | |
| 8. Bicarbonate (HCO ₃) | HCO ₃ | <u>427.0</u> ÷ 61 | <u>7.0</u> HCO ₃ |
| 9. Chlorides (Cl) | Cl | <u>1701.6</u> ÷ 35.5 | <u>47.9</u> Cl |
| 10. Sulfates (SO ₄) | SO ₄ | <u>825.0</u> ÷ 48 | <u>17.2</u> SO ₄ |
| 11. Calcium (Ca) | Ca | <u>81.2</u> ÷ 20 | <u>4.1</u> Ca |
| 12. Magnesium (Mg) | Mg | <u>49.3</u> ÷ 12.2 | <u>4.0</u> Mg |
| 13. Total Hardness (CaCO ₃) | | <u>406.0</u> | |
| 14. Total Iron (Fe) | | <u>< 1.0</u> | |
| 15. Barium (Qualitative) | | <u>NEG.</u> | |
| 16. | | | |

*Milli equivalents per liter

PROBABLE MINERAL COMPOSITION

4.1	Ca	←	HCO ₃	7.0
4.0	Mg	→	SO ₄	17.2
64.0	Na	→	Cl	47.9

Saturation Values	Distilled Water 20°C
Ca CO ₃	13 Mg/L
Ca SO ₄ • 2H ₂ O	2,090 Mg/L
Mg CO ₃	103 Mg/L

Compound	Equiv. Wt.	X	Meq/L =	Mg/L
Ca (HCO ₃) ₂	81.04		<u>4.1</u>	<u>332.3</u>
Ca SO ₄	68.07		<u> </u>	<u> </u>
Ca Cl ₂	55.50		<u> </u>	<u> </u>
Mg (HCO ₃) ₂	73.17		<u>2.9</u>	<u>212.2</u>
Mg SO ₄	60.19		<u>1.1</u>	<u>66.2</u>
Mg Cl ₂	47.62		<u> </u>	<u> </u>
Na HCO ₃	84.00		<u> </u>	<u> </u>
Na ₂ SO ₄	71.03		<u>16.1</u>	<u>1143.6</u>
Na Cl	58.46		<u>47.9</u>	<u>2800.2</u>

REMARKS _____

Respectfully submitted
TRETOLITE COMPANY

Bob ANDERSON

Figure 7

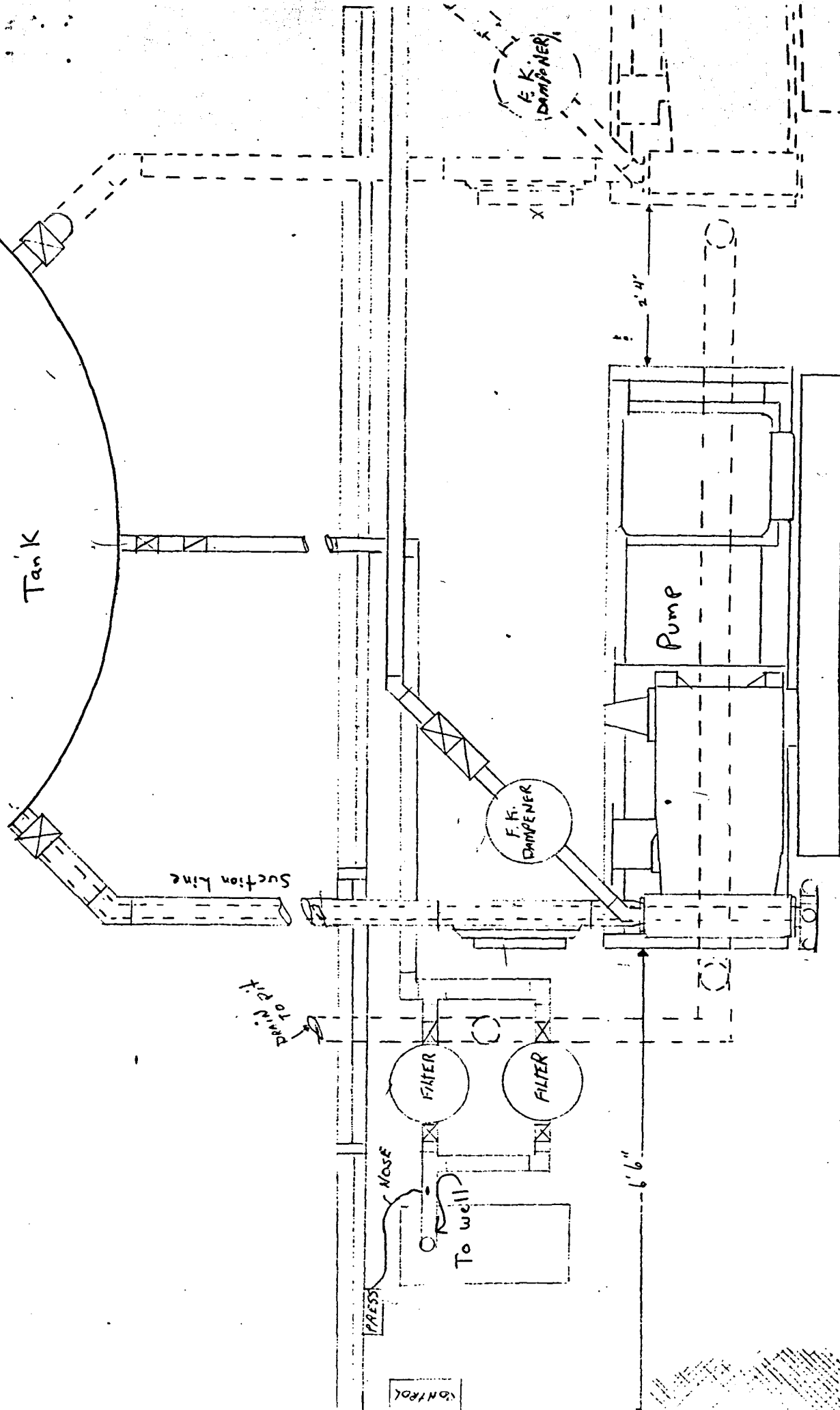


Figure 7
SBREV 34-32
Schematic Drawing of Surface Construction

Control
Panel

FIGURE 8
SBRRU NO. 34-32
SCHEMATIC DRAWING OF SUBSURFACE INJECTION WELL

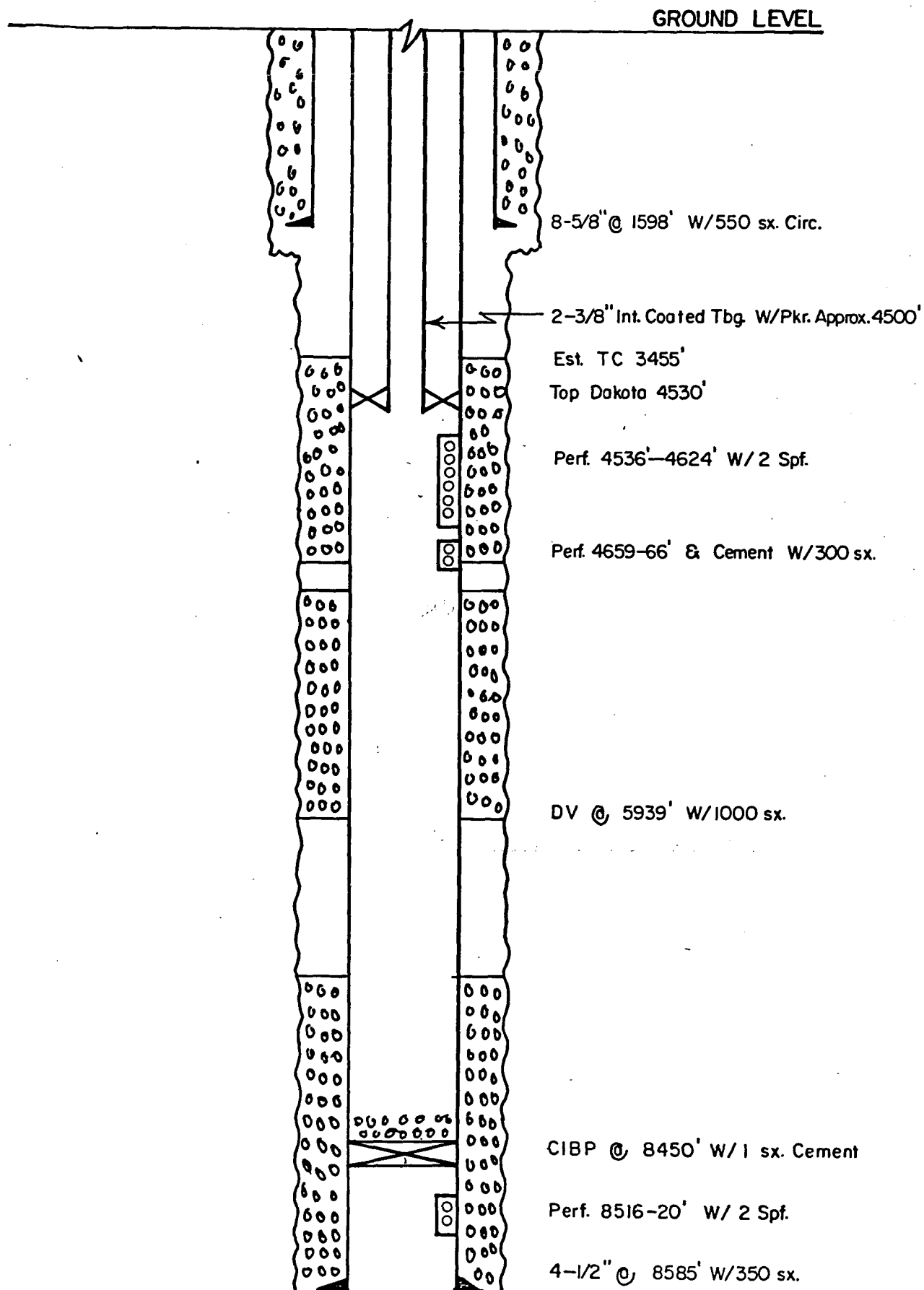




Figure 9

369 Marshall Avenue • St. Louis, Missouri 63119
314 961-3500 • TWX 910-760-1660 • Telex 44-2417

Produced
Water

WATER ANALYSIS REPORT

Company: KOCH EXPLORATION

Sampling Date: 12/20/84

Analysis Date: 01/09/85

Sample ID: F14265

Sample Source

Lease: S. BRRU

Well: #13

Sample Pt: PRODUCED WATER

Submitted by: CLARK, J.G.

Sampled by: DARRELL

Chem. Treatment:

Sample Condition: GRAY PPT

ANALYTICAL RESULTS

pH at the time of sampling: 8.10

pH at the time of analysis: 8.10

Density: 1.006

Hydrogen Sulfide (H₂S):

TDS: Calculated 7842.5 mg/L

CONSTITUENT		mg/L	meq/L	method	comments
ANIONS					
*Bicarbonate	HCO ₃ -	554.0	9.08	FIA	
Boron	B(OH)4-	141.4	1.79	ICP	
*Carbonate	CO ₃ --	.0	.00	N.A.	
*Chloride	Cl-	2450.0	69.11	FIA	
Phosphate	PO ₄ ---	0.0	0.00	ICP	DL= 2.020
*Sulfate	SO ₄ --	1970.0	41.02	FIA	
SUM OF ANIONS=			121.00		
CATIONS					
Aluminum	Al+++	27.9	3.10	ICP	
*Barium	Ba++	10.2	.15	ICP	
*Calcium	Ca++	225.0	11.23	ICP	
Chromium	Cr+++	0.0	0.00	ICP	DL=10.100
Copper	Cu++	0.0	0.00	ICP	DL= 2.020
*Iron	Fe++	0.0	0.00	ICP	DL= 2.020
Lead	Pb++	0.0	0.00	ICP	DL=10.100
Lithium	Li+	0.0	0.00	N.A.	
*Magnesium	Mg++	166.0	13.66	ICP	
Manganese	Mn++	0.0	0.00	ICP	DL= 2.020
Nickel	Ni++	0.0	0.00	ICP	DL= 2.020
Potassium	K+	148.0	3.79	ICP	
Silica	SiO ₂	0.0	0.00	ICP	DL= 2.020
*Sodium	Na+	2150.0	93.52	ICP	
*Strontium	Sr++	0.0	0.00	ICP	DL= 2.020
Vanadium	V++	0.0	0.00	N.A.	
SUM OF CATIONS=			125.44		

Ratio of ANIONS:CATIONS .96

Produced
Water

WATER ANALYSIS REPORT

COMPANY Koch Expl. ADDRESS Buffalo, S.D. DATE: 3/21/86

SOURCE SBRRU 1 DATE SAMPLED 3/18/86 ANALYSIS NO

Analysis

Mg/L

* Meg/L

- | | | | | |
|--|--------------|-------------------------------|--------|-----------------------------|
| 1. PH | <u>6.4</u> | | | |
| 2. H ₂ S (Qualitative) | <u>11.0</u> | | | |
| 3. Specific Gravity | <u>1.008</u> | | | |
| 4. Dissolved Solids | | <u>6193.9</u> | | |
| 5. Suspended Solids | | <u> </u> | | |
| 6. Phenolphthalein Alkalinity (CaCO ₃) | | <u> </u> | | |
| 7. Methyl Orange Alkalinity (CaCO ₃) | | <u>390.0</u> | | |
| 8. Bicarbonate (HCO ₃) | | HCO ₃ <u>475.8</u> | ÷ 61 | <u>7.8</u> HCO ₃ |
| 9. Chlorides (Cl) | | Cl <u>1914.3</u> | ÷ 35.5 | <u>54.2</u> Cl |
| 10. Sulfates (SO ₄) | | SO ₄ <u>1650.0</u> | ÷ 48 | <u>34.4</u> SO ₄ |
| 11. Calcium (Ca) | | Ca <u>202.9</u> | ÷ 20 | <u>10.1</u> Ca |
| 12. Magnesium (Mg) | | Mg <u>49.4</u> | ÷ 12.2 | <u>4.0</u> Mg |
| 13. Total Hardness (CaCO ₃) | | <u>710.5</u> | | |
| 14. Total Iron (Fe) | | <u>6.0</u> | | |
| 15. Barium (Qualitative) | | Neg. | | |
| 16. | | | | |
- *Milli equivalents per liter

PROBABLE MINERAL COMPOSITION

10.1	Ca	←	HCO ₃	7.8
4.0	Mg	→	SO ₄	34.4
82.3	Na	→	Cl	54.2

Saturation Values	Distilled Water 20°C
Ca CO ₃	13 Mg/L
Ca SO ₄ • 2H ₂ O	2,090 Mg/L
Mg CO ₃	103 Mg/L

Compound	Equiv. Wt.	X	Meq/L	=	Mg/L
Ca (HCO ₃) ₂	81.04		7.8		632.1
Ca SO ₄	68.07		2.3		156.6
Ca Cl ₂	55.50				
Mg (HCO ₃) ₂	73.17				
Mg SO ₄	60.19		4.0		240.8
Mg Cl ₂	47.62				
Na HCO ₃	84.00				
Na ₂ SO ₄	71.03		28.1		1995.9
Na Cl	58.46		54.2		3168.5

REMARKS _____

Respectfully submitted
TRETOLITE COMPANY

Bob Anderson

WATER ANALYSIS REPORT

COMPANY Koch Expl. ADDRESS Buffalo, S.D. DATE: 3/21/86

SOURCE SBRRU 3 DATE SAMPLED 3/18/86 ANALYSIS NO.

Analysis

Mg/L

*Meq/L

1. PH	<u>6.4</u>				
2. H ₂ S (Qualitative)	<u>4.0</u>				
3. Specific Gravity	<u>1.010</u>				
4. Dissolved Solids		<u>5639.8</u>			
5. Suspended Solids					
6. Phenolphthalein Alkalinity (CaCO ₃)					
7. Methyl Orange Alkalinity (CaCO ₃)		<u>340</u>			
8. Bicarbonate (HCO ₃)		<u>414.8</u> ÷ 61	<u>6.8</u>	HCO ₃	
9. Chlorides (Cl)		<u>1914.3</u> ÷ 35.5	<u>54.2</u>	Cl	
10. Sulfates (SO ₄)		<u>1350.0</u> ÷ 48	<u>20.1</u>	SO ₄	
11. Calcium (Ca)		<u>202.9</u> ÷ 20	<u>10.1</u>	Ca	
12. Magnesium (Mg)		<u>74.1</u> ÷ 12.2	<u>6.1</u>	Mg	
13. Total Hardness (CaCO ₃)		<u>812.0</u>			
14. Total Iron (Fe)		<u>3.0</u>			
15. Barium (Qualitative)		Neg.			
16.					

*Milli equivalents per liter

PROBABLE MINERAL COMPOSITION

Compound	Equiv. Wt.	X	Meq/L	=	Mg/L
Ca					
Ca (HCO ₃) ₂	81.04		6.8		551.2
Ca SO ₄	68.07		3.3		224.6
Ca Cl ₂	55.50				
Mg (HCO ₃) ₂	73.17				
Mg SO ₄	60.19		6.1		367.2
Mg Cl ₂	47.62				
Na HCO ₃	84.00				
Na ₂ SO ₄	71.03		18.7		1328.3
Na Cl	58.46		54.2		3168.5

Saturation Values	Distilled Water 20°C
Ca CO ₃	13 Mg/L
Ca SO ₄ • 2H ₂ O	2,090 Mg/L
Mg CO ₃	103 Mg/L

REMARKS

Respectfully submitted
TRETOLITE COMPANY

Bob Anderson

Bob Anderson

WATER ANALYSIS REPORT

COMPANY Koch Expl. ADDRESS Buffalo, S.D. DATE: 3/21/86

SOURCE	<u>SBRRU 8</u>	DATE SAMPLED	<u>3/18/86</u>	ANALYSIS NO.	<u> </u>
	Analysis		Mg/L		*Meq/L

- | | | | |
|--|------------------|----------------------|-----------------------------|
| 1. PH | | <u>6.3</u> | |
| 2. H ₂ S (Qualitative) | | <u>5.0</u> | |
| 3. Specific Gravity | | <u>1.010</u> | |
| 4. Dissolved Solids | | <u>5621.1</u> | |
| 5. Suspended Solids | | <u> </u> | |
| 6. Phenolphthalein Alkalinity (CaCO ₃) | | <u>340.0</u> | |
| 7. Methyl Orange Alkalinity (CaCO ₃) | | <u> </u> | |
| 8. Bicarbonate (HCO ₃) | HCO ₃ | <u>414.8</u> ÷ 61 | <u>6.8</u> HCO ₃ |
| 9. Chlorides (Cl) | Cl | <u>1808.0</u> ÷ 35.5 | <u>50.1</u> Cl |
| 10. Sulfates (SO ₄) | SO ₄ | <u>1500.0</u> ÷ 48 | <u>31.3</u> SO ₄ |
| 11. Calcium (Ca) | Ca | <u>243.5</u> ÷ 20 | <u>12.2</u> Ca |
| 12. Magnesium (Mg) | Mg | <u>74.0</u> ÷ 12.2 | <u>6.1</u> Mg |
| 13. Total Hardness (CaCO ₃) | | <u>913.5</u> | |
| 14. Total Iron (Fe) | | <u>6.0</u> | |
| 15. Barium (Qualitative) | | Neg. | |
| 16. | | | |
- *Milli equivalents per liter

PROBABLE MINERAL COMPOSITION

12.2	Ca	←	HCO ₃	6.8
6.1	Mg	→	SO ₄	31.3
69.9	Na	→	Cl	50.1

Saturation Values	Distilled Water 20°C
Ca CO ₃	13 Mg/L
Ca SO ₄ • 2H ₂ O	2,090 Mg/L
Mg CO ₃	103 Mg/L

Compound	Equiv. Wt.	X	Meq/L =	Mg/L
Ca (HCO ₃) ₂	81.04		<u>6.8</u>	<u>551.1</u>
Ca SO ₄	68.07		<u>5.4</u>	<u>367.6</u>
Ca Cl ₂	55.50		<u> </u>	<u> </u>
Mg (HCO ₃) ₂	73.17		<u> </u>	<u> </u>
Mg SO ₄	60.19		<u>6.1</u>	<u>367.2</u>
Mg Cl ₂	47.62		<u> </u>	<u> </u>
Na HCO ₃	84.00		<u> </u>	<u> </u>
Na ₂ SO ₄	71.03		<u>19.8</u>	<u>1406.4</u>
Na Cl	58.46		<u>50.1</u>	<u>2928.8</u>

REMARKS _____

Respectfully submitted
TRETOHITE COMPANY

Bob Anderson

WATER ANALYSIS REPORT

COMPANY Koch Expl. ADDRESS Buffalo, S.D. DATE: 3/21/86

SOURCE SBRRU 10 DATE SAMPLED 3/18/86 ANALYSIS NO.
Analysis Mg/L *Meq/L

1. PH	<u>6.3</u>		
2. H ₂ S (Qualitative)	<u>3.0</u>		
3. Specific Gravity	<u>1.012</u>		
4. Dissolved Solids		<u>7669.2</u>	
5. Suspended Solids			
6. Phenolphthalein Alkalinity (CaCO ₃)			
7. Methyl Orange Alkalinity (CaCO ₃)		<u>390.0</u>	
8. Bicarbonate (HCO ₃)		<u>475.8</u> ÷ 61	<u>7.8</u> HCO ₃
9. Chlorides (Cl)		<u>2977.8</u> ÷ 35.5	<u>83.9</u> Cl
10. Sulfates (SO ₄)		<u>1500.0</u> ÷ 48	<u>31.3</u> SO ₄
11. Calcium (Ca)		<u>324.6</u> ÷ 20	<u>16.2</u> Ca
12. Magnesium (Mg)		<u>74.1</u> ÷ 12.2	<u>6.1</u> Mg
13. Total Hardness (CaCO ₃)		<u>1116.5</u>	
14. Total Iron (Fe)		<u>5.0</u>	
15. Barium (Qualitative)		Neg.	
16.			

*Milli equivalents per liter

PROBABLE MINERAL COMPOSITION

	Compound	Equiv. Wt.	X	Meq/L	=	Mg/L
16.2	Ca (HCO ₃) ₂	81.04		7.8		632.1
6.1	Ca SO ₄	68.07		8.4		571.8
100.7	Ca Cl ₂	55.50				
	Mg (HCO ₃) ₂	73.17				
	Mg SO ₄	60.19		6.1		367.2
	Mg Cl ₂	47.62				
	Na HCO ₃	84.00				
	Na ₂ SO ₄	71.03		16.8		1193.3
	Na Cl	58.46		83.9		4904.8

Saturation Values	Distilled Water 20°C
Ca CO ₃	13 Mg/L
Ca SO ₄ • 2H ₂ O	2,090 Mg/L
Mg CO ₃	103 Mg/L

REMARKS _____

Respectfully submitted
TRETOLITE COMPANY

Bob Anderson

WATER ANALYSIS REPORT

COMPANY Koch Expl. ADDRESS Buffalo, S.D. DATE 3/21/86
SOURCE SBRRU 11 DATE SAMPLED 3/18/86 ANALYSIS NO. _____
Analysis Mg/L *Meq/L

1. PH	<u>6.5</u>				
2. H ₂ S (Qualitative)	<u>3.0</u>				
3. Specific Gravity	<u>1.008</u>				
4. Dissolved Solids		<u>4564.4</u>			
5. Suspended Solids					
6. Phenolphthalein Alkalinity (CaCO ₃)					
7. Methyl Orange Alkalinity (CaCO ₃)		<u>240.0</u>			
8. Bicarbonate (HCO ₃)		<u>292.8</u>	÷ 61	<u>4.8</u>	HCO ₃
9. Chlorides (Cl)		<u>1488.9</u>	÷ 35.5	<u>41.9</u>	Cl
10. Sulfates (SO ₄)		<u>1200.0</u>	÷ 48	<u>25.0</u>	SO ₄
11. Calcium (Ca)		<u>284.1</u>	÷ 20	<u>14.2</u>	Ca
12. Magnesium (Mg)		<u>24.7</u>	÷ 12.2	<u>2.0</u>	Mg
13. Total Hardness (CaCO ₃)		<u>812.0</u>			
14. Total Iron (Fe)		<u>Tr.</u>			
15. Barium (Qualitative)		<u>Neg.</u>			
16.					

*Milli equivalents per liter

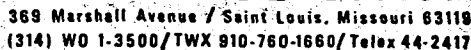
PROBABLE MINERAL COMPOSITION

Compound	Equiv. Wt.	X	Meq/L	=	Mg/L
Ca					
Ca (HCO ₃) ₂	81.04		<u>4.8</u>		<u>389.0</u>
Ca SO ₄	68.07		<u>9.4</u>		<u>639.9</u>
Ca Cl ₂	55.50				
Mg (HCO ₃) ₂	73.17				
Mg SO ₄	60.19		<u>2.0</u>		<u>120.4</u>
Mg Cl ₂	47.62				
Na HCO ₃	84.00				
Na ₂ SO ₄	71.03		<u>13.6</u>		<u>966.0</u>
Na Cl	58.46		<u>41.9</u>		<u>2449.5</u>

Saturation Values	Distilled Water 20°C
Ca CO ₃	13 Mg/L
Ca SO ₄ • 2H ₂ O	2,090 Mg/L
Mg CO ₃	103 Mg/L

REMARKS _____

Respectfully submitted
TRETOLITE COMPANY
Bob Anderson



Respectfully submitted
TRETOLITE COMPANY
Bob Anderson

WATER ANALYSIS REPORT

COMPANY Koch Expl. ADDRESS Buffalo, S.D. DATE 3/21/86

SOURCE SBRRU 13 DATE SAMPLED 3/18/86 ANALYSIS NO.

Analysis

Mg/L

*Meq/L

1. PH	<u>6.3</u>			
2. H ₂ S (Qualitative)	<u>4.0</u>			
3. Specific Gravity	<u>1.008</u>			
4. Dissolved Solids		<u>5079.4</u>		
5. Suspended Solids				
6. Phenolphthalein Alkalinity (CaCO ₃)				
7. Methyl Orange Alkalinity (CaCO ₃)		<u>280.0</u>		
8. Bicarbonate (HCO ₃)		<u>341.6</u> ÷ 61	<u>5.6</u>	HCO ₃
9. Chlorides (Cl)		<u>1488.9</u> ÷ 35.5	<u>41.9</u>	Cl
10. Sulfates (SO ₄)		<u>1500.0</u> ÷ 48	<u>31.3</u>	SO ₄
11. Calcium (Ca)		<u>284.1</u> ÷ 20	<u>14.2</u>	Ca
12. Magnesium (Mg)		<u>24.7</u> ÷ 12.2	<u>2.0</u>	Mg
13. Total Hardness (CaCO ₃)		<u>812.0</u>		
14. Total Iron (Fe)		<u>.3</u>		
15. Barium (Qualitative)		<u>Neg.</u>		
16.				

*Milli equivalents per liter

PROBABLE MINERAL COMPOSITION

Compound	Equiv. Wt.	X	Meq/L	=	Mg/L
Ca (HCO ₃) ₂	81.04		<u>5.6</u>		<u>453.8</u>
Ca SO ₄	68.07		<u>8.6</u>		<u>585.4</u>
Ca Cl ₂	55.50				
Mg (HCO ₃) ₂	73.17				
Mg SO ₄	60.19		<u>2.0</u>		<u>120.4</u>
Mg Cl ₂	47.62				
Na HCO ₃	84.00				
Na ₂ SO ₄	71.03		<u>20.7</u>		<u>1470.3</u>
Na Cl	58.46		<u>41.9</u>		<u>2449.47</u>

Saturation Values	Distilled Water 20°C
Ca CO ₃	13 Mg/L
Ca SO ₄ • 2H ₂ O	2,090 Mg/L
Mg CO ₃	103 Mg/L

REMARKS

Respectfully submitted
TRETOLITE COMPANY

Bob Anderson

WATER ANALYSIS REPORT

COMPANY Koch Expl. ADDRESS Buffalo, S.D. DATE 3/21/86

SOURCE SBRRU 14 DATE SAMPLED 3/18/86 ANALYSIS NO.

Analysis

Mg/L

*Meq/L

1. PH	<u>6.8</u>			
2. H ₂ S (Qualitative)	<u>3.0</u>			
3. Specific Gravity	<u>1.008</u>			
4. Dissolved Solids		<u>5865.7</u>		
5. Suspended Solids				
6. Phenolphthalein Alkalinity (CaCO ₃)				
7. Methyl Orange Alkalinity (CaCO ₃)		<u>300.0</u>		
8. Bicarbonate (HCO ₃)		<u>366.0</u>	<u>÷ 61</u>	<u>6.0</u> HCO ₃
9. Chlorides (Cl)		<u>1701.6</u>	<u>÷ 35.5</u>	<u>47.9</u> Cl
10. Sulfates (SO ₄)		<u>1800.0</u>	<u>÷ 48</u>	<u>37.5</u> SO ₄
11. Calcium (Ca)		<u>243.5</u>	<u>÷ 20</u>	<u>12.2</u> Ca
12. Magnesium (Mg)		<u>74.0</u>	<u>÷ 12.2</u>	<u>6.1</u> Mg
13. Total Hardness (CaCO ₃)		<u>913.5</u>		
14. Total Iron (Fe)		<u>1.0</u>		
15. Barium (Qualitative)		Neg.		
16.				

*Milli equivalents per liter

PROBABLE MINERAL COMPOSITION

Compound	Equiv. Wt.	X	Meq/L =	Mg/L
Ca (HCO ₃) ₂	81.04		<u>6.0</u>	<u>486.3</u>
Ca SO ₄	68.07		<u>6.2</u>	<u>422.0</u>
Ca Cl ₂	55.50			
Mg (HCO ₃) ₂	73.17			
Mg SO ₄	60.19		<u>6.1</u>	<u>367.2</u>
Mg Cl ₂	47.62			
Na HCO ₃	84.00			
Na ₂ SO ₄	71.03		<u>25.2</u>	<u>1790.0</u>
Na Cl	58.46		<u>47.9</u>	<u>2800.2</u>

Saturation Values	Distilled Water 20°C
Ca CO ₃	13 Mg/L
Ca SO ₄ • 2H ₂ O	2,090 Mg/L
Mg CO ₃	103 Mg/L

REMARKS

Respectfully submitted
TRETOLITE COMPANY

Bob Anderson

Respectfully submitted
TRETOLITE COMPANY
Bob Anderson



TRETOLITE DIVISION

369 Marshall Avenue / Saint Louis, Missouri 63119

(314) WO 1-3500/TWX 910-760-1660/Telex 44-2417

WATER ANALYSIS REPORT

COMPANY Koch Expl. ADDRESS Buffalo, S.D. DATE: 3/21/86

SOURCE Piekkola 31-18 DATE SAMPLED 3/18/86 ANALYSIS NO.

Analysis

Mg/L

* Meq/L

- | | | | |
|--|-------------------------------|--------|-----------------------------|
| 1. PH | <u>6.6</u> | | |
| 2. H ₂ S (Qualitative) | <u>4.0</u> | | |
| 3. Specific Gravity | <u>1.007</u> | | |
| 4. Dissolved Solids | <u>4775.7</u> | | |
| 5. Suspended Solids | <u> </u> | | |
| 6. Phenolphthalein Alkalinity (CaCO ₃) | <u> </u> | | |
| 7. Methyl Orange Alkalinity (CaCO ₃) | <u>320.0</u> | | |
| 8. Bicarbonate (HCO ₃) | HCO ₃ <u>390.4</u> | ÷ 61 | <u>6.4</u> HCO ₃ |
| 9. Chlorides (Cl) | Cl <u>1701.6</u> | ÷ 35.5 | <u>47.9</u> Cl |
| 10. Sulfates (SO ₄) | SO ₄ <u>1050.0</u> | ÷ 48 | <u>21.9</u> SO ₄ |
| 11. Calcium (Ca) | Ca <u>202.9</u> | ÷ 20 | <u>10.1</u> Ca |
| 12. Magnesium (Mg) | Mg <u>98.7</u> | ÷ 12.2 | <u>8.1</u> Mg |
| 13. Total Hardness (CaCO ₃) | <u>913.5</u> | | |
| 14. Total Iron (Fe) | <u>.5</u> | | |
| 15. Barium (Qualitative) | Neg. | | |
| 16. | | | |

*Milli equivalents per liter

PROBABLE MINERAL COMPOSITION

10.1	Ca	←	HCO ₃	6.4
8.1	Mg	→	SO ₄	21.9
58.0	Na	→	Cl	47.9

Saturation Values	Distilled Water 20°C
Ca CO ₃	13 Mg/L
Ca SO ₄ • 2H ₂ O	2,090 Mg/L
Mg CO ₃	103 Mg/L

Compound	Equiv. Wt.	X	Meq/L	=	Mg/L
Ca (HCO ₃) ₂	81.04		6.4		518.7
Ca SO ₄	68.07		3.7		251.9
Ca Cl ₂	55.50				
Mg (HCO ₃) ₂	73.17				
Mg SO ₄	60.19		8.1		487.5
Mg Cl ₂	47.62				
Na HCO ₃	84.00				
Na ₂ SO ₄	71.03		10.1		717.4
Na Cl	58.46		47.9		2800.2

REMARKS _____

Respectfully submitted
TRETOLITE COMPANY

Bob Anderson



Bob Anderson

WATER ANALYSIS REPORT

COMPANY Koch Expl. ADDRESS Buffalo, S.D. DATE: 3/21/86

SOURCE State CTB 3 DATE SAMPLED 3/18/86 ANALYSIS NO. _____

Analysis

Mg/L

*Meq/L

1. PH	<u>6.5</u>			
2. H ₂ S (Qualitative)	<u>14.0</u>			
3. Specific Gravity	<u>1012</u>			
4. Dissolved Solids	<u>12212.6</u>			
5. Suspended Solids				
6. Phenolphthalein Alkalinity (CaCO ₃)				
7. Methyl Orange Alkalinity (CaCO ₃)	<u>280.0</u>			
8. Bicarbonate (HCO ₃)	HCO ₃ <u>341.6</u>	÷ 61	<u>5.6</u>	HCO ₃
9. Chlorides (Cl)	Cl <u>5317.5</u>	÷ 35.5	<u>149.8</u>	Cl
10. Sulfates (SO ₄)	SO ₄ <u>2100.0</u>	÷ 48	<u>43.8</u>	SO ₄
11. Calcium (Ca)	Ca <u>405.8</u>	÷ 20	<u>20.3</u>	Ca
12. Magnesium (Mg)	Mg <u>74.1</u>	÷ 12.2	<u>6.1</u>	Mg
13. Total Hardness (CaCO ₃)	<u>1319.5</u>			
14. Total Iron (Fe)	<u>.9</u>			
15. Barium (Qualitative)	Neg.			
16.				

*Milli equivalents per liter

PROBABLE MINERAL COMPOSITION

Compound	Equiv. Wt.	X	Meq/L	=	Mg/L
Ca (HCO ₃) ₂	81.04		<u>5.6</u>		<u>453.8</u>
Ca SO ₄	68.07		<u>14.7</u>		<u>1000.6</u>
Ca Cl ₂	55.50				
Mg (HCO ₃) ₂	73.17				
Mg SO ₄	60.19		<u>6.1</u>		<u>367.2</u>
Mg Cl ₂	47.62				
Na HCO ₃	84.00				
Na ₂ SO ₄	71.03		<u>23.0</u>		<u>1633.7</u>
Na Cl	58.46		<u>149.8</u>		<u>8757.3</u>

Saturation Values	Distilled Water 20°C
Ca CO ₃	13 Mg/L
Ca SO ₄ • 2H ₂ O	2,090 Mg/L
Mg CO ₃	103 Mg/L

REMARKS _____

Respectfully submitted
TRETOLITE COMPANY
Bob Anderson



KOCH EXPLORATION COMPANY

March 27, 1986

Barb Hershley
Department of Water and Natural Resources
Joe Foss Building
523 E. Capitol
Pierre, SD 57501

RECEIVED

MAR 31 1986

SOUTH DAKOTA DEPARTMENT OF
WATER AND NATURAL RESOURCES
OFFICE OF WATER QUALITY

Dear Barb:

Please find the additional information which you requested concerning the disposal permit for SBRRU 34-32.

1. Additional compatibility information is found in Figure 1.
2. The cement slurry volumes for the wells in the area of review are as follows:

SBRRU 34-32

1st stage - 350 sx Class G w/18% salt + .75% CFR-2 -
(1.2 ft ³/sx).

2nd stage - 1000 sx lite w/0.6% Halad - 9 - (1.84 ft ³/sx)

SBRRU 11-4

1st stage - 250 sx lite (1.84 ft ³/sx) followed by 100 sx
Class G w/CFR-2, 1/2# celloflake/sx and 10#
gilsonite/sx (1.15 ft ³/sx).

2nd stage - 700 sx lite (1.84 ft ³/sx).

3. The swabbing method and sample collection method is as follows:

Tubing and a packer were run to 4468'. The packer was set and the annulus was tested to 1000 psi. The swab was rigged up to swab Dakota water samples. Samples were taken in



KOCH EXPLORATION COMPANY

bottles after swabbing 70 barrels, 120 barrels, and 140 barrels. All three samples were analyzed in the field and indicated the same sodium chloride content (4230 ppm). The last sample was analyzed by Tretolite and submitted with the disposal application.

4. Water samples are attached for the different batteries which will be mixed together at approximately equal volumes after the permit is approved. See Figure 2.

We would appreciate your timely consideration of this matter since the EPA approval and hearing process usually takes 2-3 months. Koch is presently hauling some water from the SBRRU at a substantial cost which adversely impacts the marginal economics of the SBRRU.

Respectfully,

Koch Exploration Company

A handwritten signature in cursive script that reads 'Ronald J. Miller'.

Ronald J. Miller
Project Manager

RJM:es
attchmts

PETROLITE

Petrolite Oil Field Chemicals Group

16010 Barker's Point Lane • Houston, Texas 77079
713 558-5200 • Telex 4620346

March 26, 1986

RECEIVED

MAR 27 1986

KOCH EXPLORATION

COMPATIBILITY STUDY

Mr. Ron Miller
Koch Exploration Company
P. O. Box 2256
Wichita, KS 67201

RE: SBRRU #13 and SBRRU #34-32

In reply to your request for Stability Index Calculations being run on the given water analysis, indications were noted positive for calcium carbonate and calcium sulfate precipitation.

Petrolite would recommend Scale Preventive SP-319 at a ratio of 10 ppm with optimum.

We appreciate your business and thank you for allowing Petrolite to submit this recommendation.

Respectfully,

Duane Meyeres/ms

Duane Meyeres
Region Accounts Representative

DM:ms

cc: J. Clark
D. McCloud
K. Noah

STABILITY INDEX CALCULATIONS
(Stiff-Davis Method)
CaCO₃ Scaling Tendency

SAMPLE

Sample Test No. _____

Company Koch Exploration Sample Date _____

Address _____ Submitted by _____

Sample SBRRU #13 Field _____

$$S. I. = pH - pCa - pAlk - K$$

where S. I. = stability index

pH = pH as measured on fresh sample

pCa = negative logarithm of calcium concentration

pAlk = negative logarithm of total alkalinity

K = constant, depends upon temperature and salt content

$$pH = \underline{8.1} \quad pCa = \underline{2.23} \quad pAlk = \underline{2.04}$$

CALCULATION OF IONIC STRENGTH AND K VALUE

$$Na \quad (\underline{2139}) \times (2.2 \times 10^{-5}) = \underline{0.05}$$

$$Ca \quad (\underline{225}) \times (5.0 \times 10^{-5}) = \underline{0.01}$$

$$Mg \quad (\underline{166}) \times (8.2 \times 10^{-5}) = \underline{0.01}$$

$$Cl \quad (\underline{2450}) \times (1.4 \times 10^{-5}) = \underline{0.03}$$

$$HCO_3 \quad (\underline{554}) \times (0.8 \times 10^{-5}) = \underline{0.004}$$

$$SO_4 \quad (\underline{1970}) \times (2.1 \times 10^{-5}) = \underline{0.04}$$

$$TOTAL \ IONIC \ STRENGTH = \underline{0.14}$$

$$K = \underline{\hspace{2cm}} @ \underline{80} \quad ^\circ F.$$

$$K = \underline{\hspace{2cm}} @ \underline{100} \quad ^\circ F.$$

$$SI \text{ at } (\underline{80})^\circ = (\underline{8.1}) - (\underline{2.23}) - (\underline{2.04}) - (\underline{2.35}) \text{ or } \underline{1.48}$$

$$SI \text{ at } (\underline{100})^\circ = (\underline{8.1}) - (\underline{2.23}) - (\underline{2.04}) - (\underline{2.15}) \text{ or } \underline{1.68}$$

SI = 0 or water is relatively stable at < 60 °F.

Remarks: Meyeres

$$K = 3.83 @ 60^\circ F = 0$$

Water has scaling tendency to < 60 °F. J. Ward

STABILITY INDEX CALCULATIONS

Tendency for $\text{CaSO}_4 - 2 \text{H}_2\text{O}$
(Gypsum) Scale

Stiff-Davis Method

Company Koch Exploration Address _____

Source SBRRU #13 Date _____

$$S = S_T \times F_1 \times F_2 \times F_3$$

where S = Solubility under Given Condition
 S_T = Solubility in Distilled water at the temperature T (mg/1 CaSO_4)
 F_1 = Common ion factor, or the influence of excess calcium or sulfate ions (meq. /1)
 F_2 = Magnesium ion factor (meq. /1)
 F_3 = Sodium factor (mg/1)

Factors:

Temperature 70 °F → $S_T =$ 2060

Temperature 104 °F → $S_T =$ 2120

$F_1 =$ 0.84 $F_2 =$ 1.3 $F_3 =$ 1.2

$$S = S_T \frac{2060}{2120} \times F_1 \frac{0.84}{1} \times F_2 \frac{1.3}{1} \times F_3 \frac{1.2}{1}$$

S = 2699 ppm CaSO_4 at 70 °F

S = 2778 ppm CaSO_4 at 104 °F

Remarks: Meyeres

J. Ward

STABILITY INDEX CALCULATIONS (Stiff-Davis Method) CaCO₃ Scaling Tendency

SAMPLE

Sample Test No. _____

Company Koch Exploration Sample Date _____

Address _____ Submitted by _____

Sample SBRRU 34-32 Field _____

$$S. I. = pH - pCa - pAlk - K$$

where S. I. = stability index

pH = pH as measured on fresh sample

pCa = negative logarithm of calcium concentration

pAlk = negative logarithm of total alkalinity

K = constant, depends upon temperature and salt content

$$pH = \underline{6.5} \quad pCa = \underline{2.67} \quad pAlk = \underline{2.15}$$

CALCULATION OF IONIC STRENGTH AND K VALUE

$$Na \quad (\underline{1472}) \times (2.2 \times 10^{-5}) = \underline{0.032}$$

$$Ca \quad (\underline{81}) \times (5.0 \times 10^{-5}) = \underline{0.004}$$

$$Mg \quad (\underline{49}) \times (8.2 \times 10^{-5}) = \underline{0.004}$$

$$Cl \quad (\underline{1701}) \times (1.4 \times 10^{-5}) = \underline{0.02}$$

$$HCO_3 \quad (\underline{427}) \times (0.8 \times 10^{-5}) = \underline{0.003}$$

$$SO_4 \quad (\underline{825}) \times (2.1 \times 10^{-5}) = \underline{0.02}$$

$$TOTAL \ IONIC \ STRENGTH = \underline{0.08}$$

$$K = \underline{\hspace{2cm}} @ \underline{80} \ ^\circ F.$$

$$K = \underline{\hspace{2cm}} @ \underline{100} \ ^\circ F.$$

$$SI \text{ at } (\underline{80})^\circ = (\underline{6.5}) - (\underline{2.67}) - (\underline{2.15}) - (\underline{2.16}) \text{ or } \underline{-0.48}$$

$$SI \text{ at } (\underline{100})^\circ = (\underline{6.5}) - (\underline{2.67}) - (\underline{2.15}) - (\underline{2.00}) \text{ or } \underline{-0.32}$$

$$SI = 0 \text{ or water is relatively stable at } \underline{130} \ ^\circ F.$$

Remarks: Meyeres

$$K = 1.68 @ 130^\circ F = 0$$

Water is corrosive up to 130° F.

J. Ward

STABILITY INDEX CALCULATIONS

Tendency for $\text{CaSO}_4 - 2 \text{H}_2\text{O}$
(Gypsum) Scale

Stiff-Davis Method

Company Koch Exploration Address _____

Source SBRRU 34-32 Date _____

$$S = S_T \times F_1 \times F_2 \times F_3$$

where S = Solubility under Given Condition
 S_T = Solubility in Distilled water at the temperature T (mg/1 CaSO_4)
 F_1 = Common ion factor, or the influence of excess calcium or sulfate ions (meq. /1)
 F_2 = Magnesium ion factor (meq. /1)
 F_3 = Sodium factor (mg/1)

Factors:

Temperature 70 °F → $S_T =$ 2060

Temperature 104 °F → $S_T =$ 2120

$F_1 =$ 0.85 $F_2 =$ 1.2 $F_3 =$ 1.2

$S = S_T$ $\frac{2060}{2120}$ $\times F_1$.85 $\times F_2$ 1.2 $\times F_3$ 1.2

$S =$ 2521 ppm CaSO_4 at 70 °F

$S =$ 2595 ppm CaSO_4 at 104 °F

Remarks: Meyeres

J. Ward

PETROLITE

Petrolite Oil Field Chemicals Group

16010 Barker's Point Lane • Houston, Texas 77079
713 558-5200 • Telex 4620346

April 10, 1986

RECEIVED

APR 15 1986

SOUTH DAKOTA DEPARTMENT OF
WATER AND NATURAL RESOURCES
OFFICE OF WATER QUALITY

Ms. Barb Hershly
South Dakota Dept. of Water and
Natural Resources
Joe Foss Bldg.
523 East Capital Avenue
Pierre, South Dakota 57501

Dear Ms. Hershly:

As per your request, we are enclosing herewith the following data sheet,
(one of SP-319).

If we may be of further service, please let me know.

Sincerely yours,



Larry Bailey
Product Manager

LB:lcr

Enclosure

CHEMICALS & SERVICES**SCALE PREVENTIVE****GENERAL DESCRIPTION**

SP-319 Scale Preventive is a phosphonate scale inhibitor which was developed especially for use in controlling barium sulfate scaling. It is also an excellent inhibitor for control of calcium carbonate and calcium sulfate deposition. This product prevents scale formation by chelation and crystal distortion mechanisms. It is completely soluble at high and low concentrations in most oilfield waters.

In addition to the above characteristics, this product is thermally stable and can be squeezed into high temperature formations.

APPLICATION

SP-319 scale preventive is recommended for the prevention of barium sulfate, calcium sulfate, and calcium carbonate at concentrations of 5-60 ppm. The treatment range depends on the severity of the problem and water characteristics. It is suitable for use in squeeze applications or continuous treatments.

This product can be monitored by field and laboratory testing.

HANDLING

Observe warning label on product container. Normal precautions for industrial chemicals apply. Storage tanks, feed lines, transfer lines, and chemical pumps handling this product should be made from (or coated with) polyethylene, polypropylene, PVC, plastic, "Teflon", ceramic, or acid/alkali resistant fiberglass. Mild steel, zinc, copper, aluminum, and their respective alloys are not recommended.

The low pH of this product requires basic safety precautions. Avoid breathing vapors. Avoid contact with eyes; wash with soap and large volumes of water. In case of contact with clothing, remove and launder before reuse. Protective goggles and rubber gloves should be worn when handling this product.

TYPICAL PHYSICAL PROPERTIES

Specific Gravity, 60°F(16°C) ..1.12
Weight, 60°F(16°C) lbs/gal9.36
Flash point, °F SFCC96(36°C)
Pour point °F-25(-32°C)
SolubilityWater Soluble
Ionic CharacterAnionic
pH (neat)1.5 - 2.5

AVAILABILITY

SP-319 scale preventive is available in drums and bulk quantities from any Petrolite distribution center.

369 Marshall Ave • St. Louis, MO 63119 • (314) 961-3500

PETROLITE

Nelson & Pirner copy



Department of Water & Natural Resources

Joe Foss Building
523 East Capitol
Pierre, South Dakota 57501-3181

April 22, 1986

Ronald J. Miller
Project Manager
Koch Exploration Co.
P.O. Box 2256
Wichita, Kansas 67201

Dear Ron:

Enclosed is a copy of the DWNR report for the aquifer exemption submitted to EPA. Please note that this report is only a draft, and is subject to change, upon EPA review. Any comments received by EPA will be forwarded to you, along with the department's response.

If you have any questions, I can be contacted at (605) 773-4050.

Sincerely,

Barbara K. Hershly

Barbara K. Hershly
Hydrologist
Office of Water Quality

cc: Scott Sumner
Fred V. Steece
Roxanne Gledde

Enclosures

SOUTH DAKOTA
Department of
Water & Natural Resources

Joe Foss Building
523 East Capitol
Pierre, South Dakota 57501-3181

April 18, 1986

Mike Liuzzi
Hydrologist
U.S. EPA - Region VIII
One Denver Place, Suite 1300
999 - 18th Street
Denver, Colorado 80202-2413

Dear Mike,

Please find enclosed the request for an aquifer exemption for the Koch #34-32 SBRRU for your review. Koch Exploration has satisfied the requirement of ARSD 74:10:09.

If you have any questions or comments, please contact me at (605) 773-3296.

Sincerely,

Barbara K. Hershly

Barbara K. Hershly
Hydrologist
Department of Water & Natural Resources

BKH/jb

Enclosure

Koch Exploration Company submitted an application to the South Dakota Department of Water Natural Resources to convert the Solar #34-32 Travers (SWSE 32-21N-4E) to the Koch #34-32 SBRRJ salt water disposal well. The Dakota Sandstone is named in the application as the intended receiving formation. This formation should be more properly referred to as the Inyan Kara Group. For many years, drillers have referred to this formation as the Dakota Sandstone when in fact, the Dakota Sandstone is actually the age equivalent of the Newcastle Sandstone in western South Dakota. The Newcastle Sandstone, also known as the Muddy Sandstone by drillers, is the first relatively continuous sandstone below the Greenhorn Limestone and extending to the top of the Skull Creek Shale. The Newcastle Sandstone is not well developed, if present at this locality. Where the Skull Creek is absent in central South Dakota, the Dakota Sandstone (Newcastle Sandstone) lies over the rocks of the Inyan Kara Group, which is the second sequence of continuous sandstone below the Greenhorn Limestone (Schoon, 1971). For the sake of consistency in this report, the aquifer requested for exemption will be referred to as the Inyan Kara Group, since the Inyan Kara Group will be the actual receiving formation and not the Dakota (Newcastle) Sandstone.

The Inyan Kara Group has been requested by Koch Exploration Company to be classified as an exempted aquifer for the following reasons:

- 1) It is not currently serving as a source of drinking water.
- 2) It is situated at a depth of 4530 feet, which makes recovery of water for drinking water purposes economically or technologically impractical
- 3) The total dissolved solids content is 4553 milligrams per liter, which is more than 3,000 and less than 10,000 milligrams per liter, and it is not expected to supply a public water system.

WELL CONSTRUCTION

Proposed Salt Water Disposal Well. The proposed disposal well is located 660' FSL and 1980' FEL of section 32-T21N-R4E, Harding County, South Dakota. The well was completed on January 1, 1981, as a producing oil well by Solar Petroleum, Inc. It was known as the Solar #34-32 Travers. Since that time, Koch Exploration Company has become the well operator and has subsequently renamed the well to Koch #34-32 SBRRJ. On August 13, 1983, Koch shut the well in when production dropped to .25 BOPD. The casing program is as follows:

Surface casing: 8-5/8", 24#, K-55, set at 1598' with 550 sacks of cement (sx). An additional 250 sx was later used to circulate the cement to the surface.

Production casing: 4-1/2", 11.6#, K-55, set from 1598' to 8585'. The first stage is cemented with 350 sx, and the second stage is cemented with 1000 sx, with the DV tool set at 5939'. The Red River was perforated from 8516' to 8520'.

Tubing: 2-3/8", 4.7#, set at 8516'. On January 21, 1986, the tubing was pulled and a cast iron bridge plug was set at 8450' with 1sx. The Inyan Kara Group was then perforated from 4536' to 4624', and from 4659' to

4666', and squeezed with 300 sx. The tubing and packer are now set to 4468'.

The Koch #34-32 SBRRU is currently on observation status. (See Figure AA).

Mechanical integrity. During the operations of January 21, 1986, the production casing was pressure tested to 1000 psi three separate times. Koch Exploration Company proposes to pressure test again, once the permit is approved. This mechanical integrity test will be performed at 1200 psi at the request of the Department of Water and Natural Resources (DWNR), and will be monitored by department personnel. Koch Exploration Company and DWNR will then monitor the annulus pressure after disposal commences.

Other Wells in the Area of Review. The Koch #11-4 SBRRU is located in the NW quarter of the NW quarter Section 4, T20N, R4E. It was completed by December 5, 1978, and is currently producing 10 BOPD and 40 BWPD. The casing record is as follows:

Surface casing: 8-5/8", 24#, set at 1532' with 740 sx cement.

Production casing: 4-1/2", 11.6# and 13.5#, set at 8542' with 1050 sx cement. The first stage is cemented with 350 sx, and the second stage is cemented with 700 sx, with the DV tool set at 5839'. The Red River is perforated from 8493' to 8504'.

Tubing: 2-3/8" production tubing is set to 8514' without a packer. (See Figure BB)

The Shell #32-32 Travers (NENE 32-21N-4E) was completed on January 26, 1960, as an oil test. The casing record is as follows:

Surface casing: 8-5/8", 24#, set at 776' with 275 sx cement.

Production casing: 4-1/2", 9.5# and 11.6#, set at 8518' with 650 sx cement, single stage.

The well was temporarily abandoned on February 3, 1960, but was later plugged on March 25, 1961, as follows:

Plug #1 - 25 sx plug from TD (8524') to 8224'.

Plug #2 - 50 sx plug at the production casing stub from 4320' to 4085'. The production casing was shot at 4220' and 132 joints were pulled.

Plug #3 - 75 sx plug at the base of the surface casing from 900' to 725'.

Plug #4 - 10 sx plug at the surface. (See Figure CC)

There are no water wells in the area of review.

RECEIVING FORMATION

As noted earlier, the receiving formation is the Inyan Kara Group. It is of early Cretaceous age and lies unconformably above the Morrison Formation. It

is generally a well-bedded, fine to coarse grained quartz sandstone with less abundant interbedded siltstone and claystone. Cross bedding is a common feature in this white to grayish sandstone. These rocks were deposited in shallow waters along the eastern shore of the Skull Creek sea and represent the first marine incursion of the Cretaceous. (Merewether, 1975)

A radial flow rate was determined for the Inyan Kara. The calculations assume operation of the injection well at maximum pressure and volume and a well life of 15 years. After one year, it was found that the effective radius would advance approximately 346 feet from the well bore. In 5 years it will be 774 feet from the well bore, and in 15 years the effective radius will be 1341 feet. When the well is abandoned, the radial flow will decrease exponentially (See Figure DD).

The pressure build-up within the formation was also calculated. This calculation also assumed maximum pressure and volume of injection, and a well life of 15 years. This equation shows that the formation pressure will increase 5.8 psi over a 15 year period. This value will also decrease once the well has reached maximum potential and is properly plugged and abandoned (see Figure EE). The equation did not take into account the skin or scaling effects at the well bore, because the company plans to stimulate the injected water to prevent precipitation of calcite and anhydrite.

Water Quality. The Inyan Kara Group is encountered at 4530' below ground level in the well bore. Petrolite Corporation determined a total dissolved solids content of 4553 mg/l, with the predominant ions being sodium, chlorides, and sulfates. The water used to determine this analysis was caught while swabbing the Koch #34-32 SBRRJ. Swabbing was conducted for approximately two days. Three samples were taken and field tested. The results are as follows:

<u>Volume H₂O swabbed (BBL)</u>	<u>Sodium Chloride (mg/l)</u>
270	4230
120	4230
140	4230

(See Koch letter dated March 27, 1986)

SOURCES OF INJECTED WATER

The source of the injected water is from 13 wells, each of which produces from the Red River Formation. The Red River "B" is the only producing zone. These Ordovician rocks are predominantly limestone that has in part been dolomitized. It is usually brown to red in color with a definite mottled appearance.

Water Quality. The Red River Formation has a total dissolved solids content of 4564.4 to 12212.6 mg/l, as determined by Petrolite Corporation for the 13 wells. The predominant ions are sodium, chlorides and sulfate. Samples were collected during regular production pumping operations of the 13 wells. (See Figure 2A of the Koch Application.)

When the water is injected, it will be a mixture of approximately equal volumes from the 13 wells. A representative sample of the mixed water can not be obtained at present because mixing facilities have not been constructed.

COMPATIBILITY

At the request of Koch Exploration Company, Petrolite calculated the Stability Indices for the submitted water samples. Calcium carbonate (Calcite) and Calcium Sulfate (Anhydrite) tested positive for precipitation. However, Petrolite recommended a scaling preventer, SP-319, which is a phosphonate inhibitor with a winterizing agent down to -30 degrees Fahrenheit, which will be used at the well head. (See Figure 1A of the Koch Application.)

CONFINING LAYER

The confining layer is 4030 (feet) thick. It extends from the base of the Fox Hills Formation to the top of the Inyan Kara Group. The confining layer is predominantly composed of shales, with lesser amounts of sandstone, siltstone and limestone. The layer is of Cretaceous age and occurs as follows, from youngest to oldest:

Pierre Shale - light to dark gray shale that is concretion-bearing, contains bentonite with lesser amounts of sandstone. The formation originated in the last Cretaceous sea.

Niobrara Formation - light to dark gray or white speckled calcareous shale with limestone and thin beds of bentonite and chalk, the formation was deposited in an inland sea and lies unconformably on the Carlile Shale.

Carlile Shale - soft, concretion-bearing, dark gray shale that grades laterally into a silty shale and then into interbedded siltstone, shale, and sandstone.

Greenhorn Limestone - white to light gray fossiliferous limestone with interbedded dark gray speckled shale.

Belle Fourche Shale - soft gray shale with lesser amounts of bentonite that contains dolomitic and ironstone concretions.

Mowry Shale - medium gray siliceous shale with interbedded bentonite and a predominant bentonite marker at the top.

Newcastle Sandstone - white to light gray, fine grained sandstone that is interbedded with lesser amounts of shale and bentonite.

Skull Creek Shale - dark gray, concretion-bearing shale with thin glauconitic siltstone near the middle of the interval.

The Belle Fourche Shale, Mowry Shale, Newcastle Sandstone, and Skull Creek Shale are also known collectively as the Graneros Shales. (Merewether, 1975)

A vertical flow rate was determined for the confining layer. Several assumptions were made in the calculations as follows:

- 1) "Dirty Sand" or soils with high clay or shale content have an intrinsic permeability which ranges from 10^{-3} to 10^{-6} darcy (Davis, et al., 1966). A value of 10^{-5} darcy was used because the confining layer is predominantly shale.

- 2) The piezometric surface of the Inyan Kara had to be estimated, since there is no known documentation of the value for Harding County.
- 3) The hydrostatic pressure of the formation was assumed to be relatively constant in the area of review.
- 4) The average porosity for the confining layer was estimated since there were many formations of variable porosity that make up the confining layer.

The vertical flow rate was calculated as .068 feet per year. At this rate, the injected fluid would reach a vertical height of 1 foot during the life of the well, assuming a maximum pressure of 1200 psi and a maximum injected volume of 3000 BWPD were maintained. (See Figure FF).

UNDERGROUND SOURCE OF DRINKING WATER (USDW)

The principal USDW used in this area is the Fox Hills. The Fox Hills is a grayish white sandstone with carbonaceous gray shale. The formation is commonly characterized by ironstone concretions at the top of the interval. The Fox Hills Formation in the Buffalo Field of Harding County, South Dakota, is approximately 100 feet thick, and usually occurs in the well bore from 400 to 500 feet below ground level.

Water Quality. The general water quality of the Fox Hills is as follows: (Meyers, 1984)

Total Dissolved Solids (TDS)	1194.2 mg/l
Sodium (Na)	309.38 mg/l
Sulfate (SO ₄)	341.31 mg/l
Chlorides (Cl)	49.61 mg/l

The Fox Hills aquifer is currently serving 1699 people. By the year 2020, it is expected to serve 3075 people. (Dykstra, 1985) It is estimated that the Fox Hills aquifer in Harding County has 12,307,200 acre-feet (4.0112×10^{12} gallons) of recoverable water (Allen, et al., 1982). This would indicate that there is currently 2.361×10^9 gallons of recoverable Fox Hills water per person in Harding County (see Figure GG), sufficient to serve the population of Harding County without the development of an alternative water supply from the exempted portion of the Inyan Kara.

STRUCTURE

The Buffalo Field, Harding County, South Dakota, lies on the western margin of the Williston Basin along the southeastern flank of the Cedar Creek Anticline. The structural history of the field is intimately related to the development of the anticline. During the late Devonian, normal faulting and uplift created the northwest-southeast trend of the anticline, along with significant structural closure (Clement, 1976). It appears that the hanging walls of the faults reached their furthest eastern advance during the Triassic, and since that time small scale deformation may have occurred (Nakanart, 1977) as a result of overburden compaction due to sediment thickening within the basin. Since the Inyan Kara Group and the confining layer are all of Cretaceous age, it is suggested that little, if any, deformation occurred during

deposition. Shallow dips within the area of review also suggest a lack of deformation. The Red River Formation in the Buffalo Field has an average dip of 1.4 degrees and the Inyan Kara Group was found to have a 2 degrees dip in the area of review (See Figure HH).

CONCLUSIONS

The Department of Water and Natural Resources requests a one mile radius of exemption for the Koch #34-32 SBRRJ based on the following:

- 1) The Inyan Kara Group is not expected to be used as a future underground source of drinking water because its depth (4530 feet) and total dissolved solids content (4553 mg/l) render recovery economically and technologically impractical.
- 2) Well records show that the proposed salt water disposal well and the other wells in the area of review are adequately constructed to confine the injected water to the zone of injection, and protect the Fox Hills from contamination. No corrective action is required.
- 3) The confining layer, which is 4030 feet thick, consists predominantly of shales and has a vertical flow rate of only .068 feet per year.
- 4) There is no structural influence in the area of review that would effect fluid migration.

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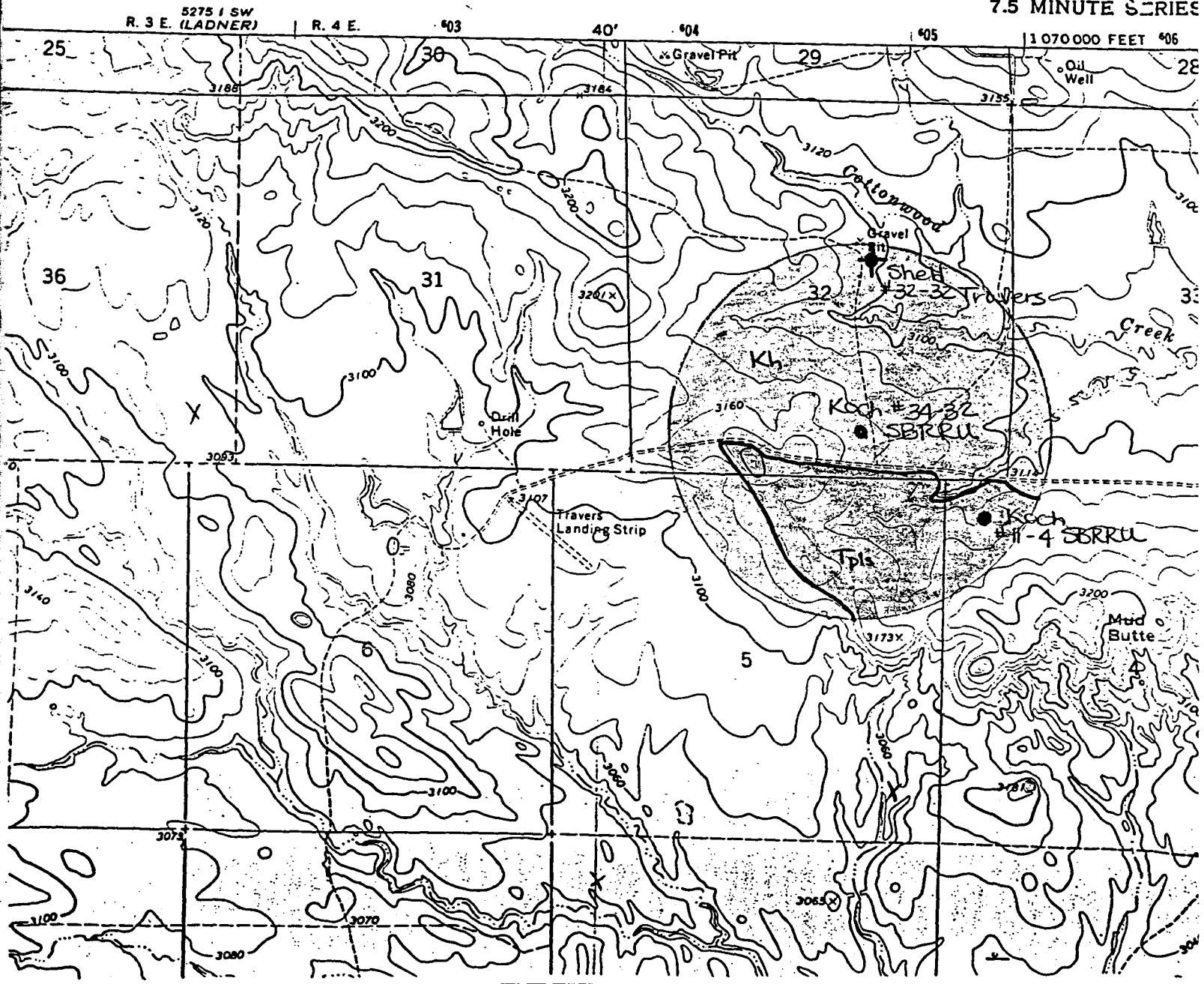
GEOLOGIC MAP OF AOR

EXPLANATION

Topic Ludlow Formation } Tertiary

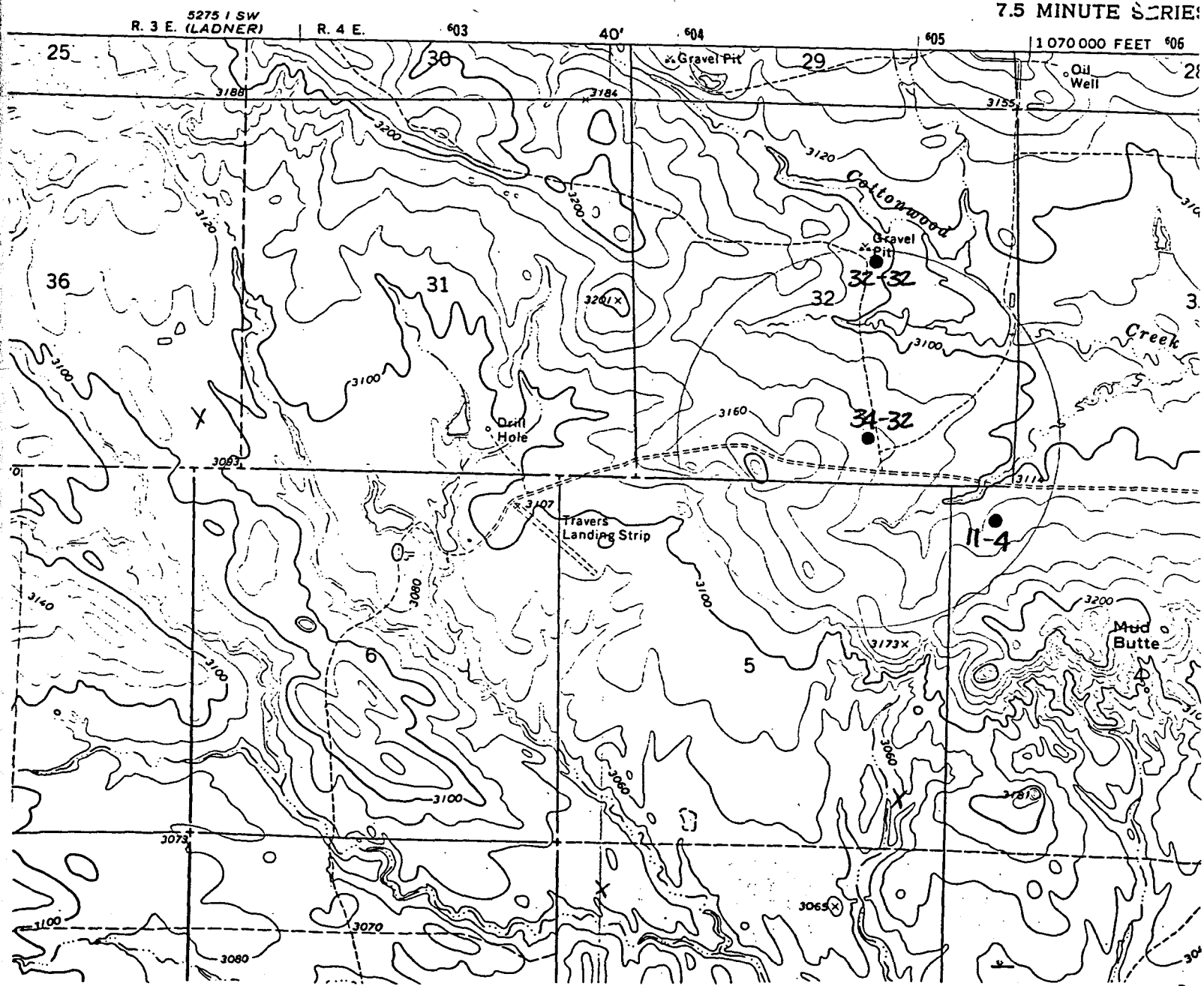
Kh Hell Creek Formation } Cretaceous

LAHTI BUTTE (SOUTH L. DIA-
7.5 MINUTE SERIES



TOPOGRAPHIC MAP OF THE AREA OF REVIEW

LAHTI BUTTE
SOUTH D. CO. IA
7.5 MINUTE SERIES



Surface casing: 8518' @ 1598'
 $550 \times 1.1 \times 2.4229 \times .8 = 1173'$
 $250 \times 1.1 \times 2.4229 \times .8 = 533'$
 $1173 + 533 = 1706'$

The 250sx was used later to circulate the cement to surface. Base of the Fox Hills $\approx$ 500' (Pierre Shale)

Production casing: 4 1/2" from 1598' $\rightarrow$ 8585'
 1st stage: $350 \times 1.2 \times 4.3899 \times .8 = 1475$

$$8585 - 1475 = 7110'$$

7110' $\rightarrow$ 8585' (Madison to Red River)

2nd stage: $1000 \times 1.84 \times 4.3899 \times .8 = 6462'$

$$DV = 5939'$$

$$6462 > 5939'$$

0 $\rightarrow$ 5939' (Surface to Opeche Shale)

Tubing: 2 3/8" @ 8516'

tubing was pulled and set to 4468 with a packer & Inyan Kara perfs are at 4536' - 4624' & 4659' - 4666' and cement tubing w/ 300sx (squeeze)

CIBP at 8450' w/ 1sx cement to confine Red River perfs at 8516' - 8520'

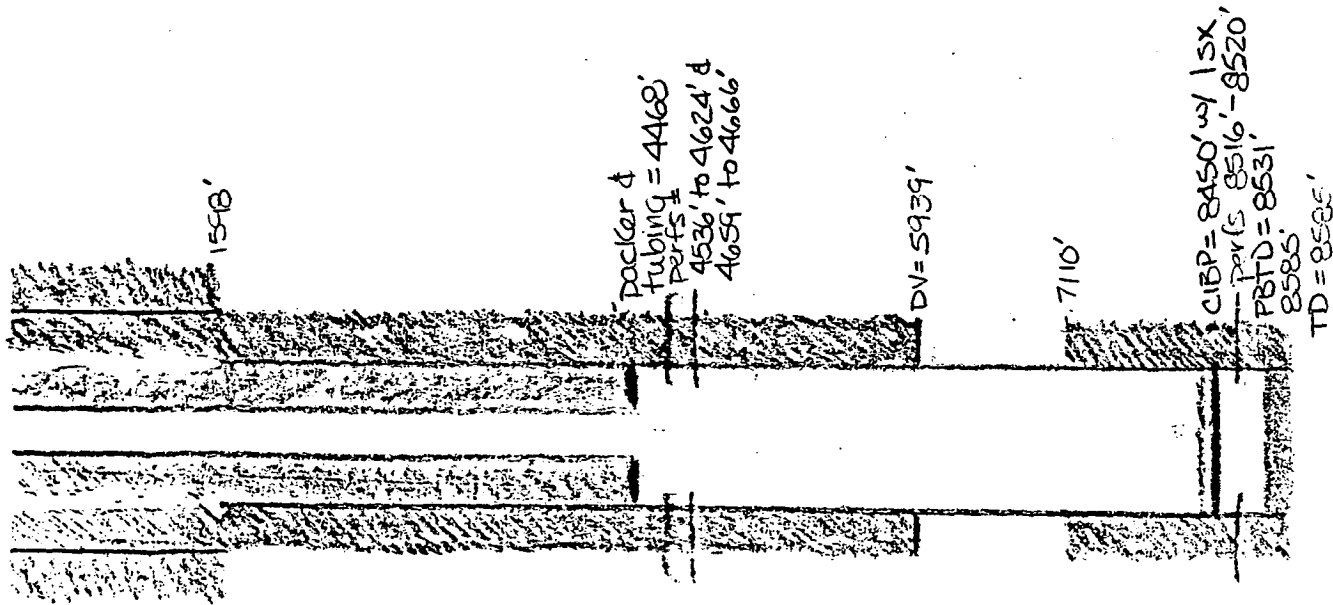
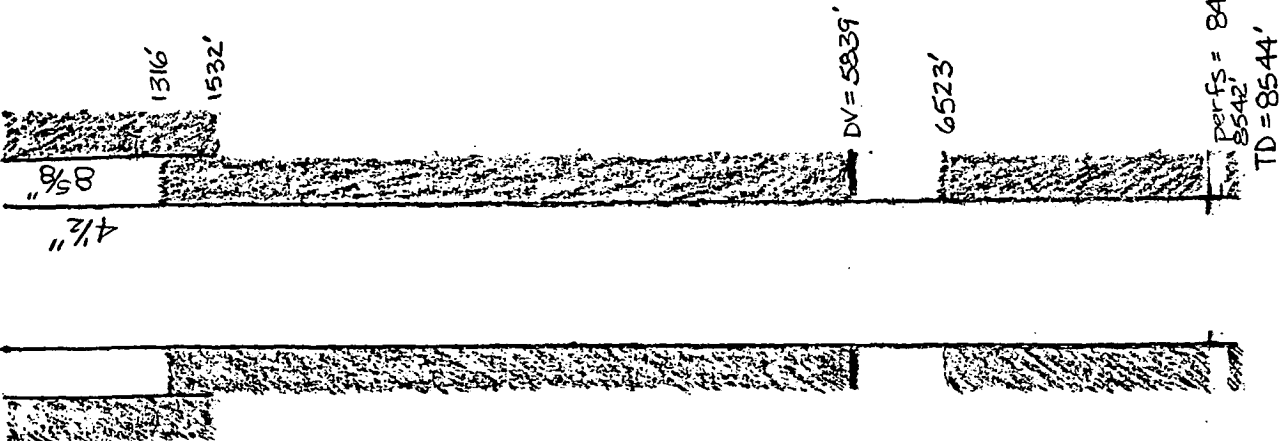


Figure AA - Technical Review of Koch #34-32 SBRU

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surface casing: 8 5/8" @ 1532'
 740 x 1.1 x 2.4229 x .8 = 1578'
 cement circulated to surface
 base of Fox Hills $\approx$ 500'
 (Pierre Shale)

Production casing: 4 1/2" @ 8542'
 1st stage: 250 x 1.84 x 4.3899 x .8 = 1615'
 100 x 1.15 x 4.3899 x .8 = 404'
 1615 + 404 = 2019'
 8542 - 2019 = 6523'
 6523' $\rightarrow$ 8542' (Base of Minnelusa to
 Red River)
 2nd stage: 700 x 1.84 x 4.3899 x .8 = 4523'
 DV = 5839'
 5839' - 4523' = 1316'
 1316' $\rightarrow$ 5839' (Pierre Shale to Lower
 Spartfish)

perfs = 8473' - 8504'
 TD = 8544'

11

Figure 4

WELL COMPLETION OR RECOMPLETION
 REPORT AND LOG

DATE OF LOG	FORM
WELL OR LEASE NAME	
State Federal	

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Figure BB - Technical Review of Koch #11-4 SBRRU

COMPLETION

Surface casing:

8 5/8" @ 776'

275 SX x 1.1 x 2.4229 x .8 = 586'

275 SX x 1.1 x 2.4229 = 732'

776 - 732 = 44'

776 - 586 = 190' (w/ washout)

Pierre Shale

production casing:

4 1/2" @ 8518'

650 SX x 1.1 x 4.3899 x .8 = 2511'

8518' - 2511' = 6007'

6007' → 8518'

(Minnelusa to Red River)

cement used for completion

cement plugs

mud-laden fluid

calculated top of cement

Top of cement

Bottom of cement

calculated bottom of cement

PLUGGING

3/24/61

#1: 25 x 11.459 x 1.1 =

315'

8524 - 8224 = 300'

315 > 300 ∴

good plug

8524 - 315 = 8209'

#2: 4320 - 4085 = 235'

4320 - 4220 = 100' x 1.1 x 11.459

SX = 8

50 SX - 8 SX = 42 SX

42 x 2.9565 x 1.1 x .8 = 109'

4220 - 109 = 4111'

w/o washout:

42 x 2.9565 x 1.1 = 123'

4220 - 123 = 4097'

#3: 900 - 776 = 124' x 1.1 x 2.9565 x .8

SX = 38

75 - 38 = 37 SX

37 x 1.1 x 2.797 = 114'

776 - 114 = 662'

TD = 8524'

#4: 10 x 1.1 x 2.797 = 31'

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4/16/86

Figure CC - Technical Review of Shell # 32-32 Travers (also Kach figures Sd6)

Figure DD - Radial Flow or Effective Radius

MAX. DAILY INJECTION = 3000 BWPD

$\phi = .12$ or 12%

$$\frac{3000 \text{ bbl}}{D} \left(\frac{42 \text{ gal}}{\text{bbl}} \right) \left(\frac{D}{1440 \text{ min}} \right) = 87.5 \text{ gpm}$$

$$87.5 \text{ gal/min} \left(\frac{4.42 \times 10^{-3} \text{ acre-feet}}{\text{gal/min } D} \right) = .3868 \frac{\text{acre-feet}}{D}$$

$$R^2 = \frac{\text{yrs} \times 365 \frac{D}{\text{yr}} \times .3868 \frac{\text{acre-ft}}{D} \times 43560 \frac{\text{ft}^2}{\text{acre}}}{(.12)(136 \text{ ft})\pi}$$

use yrs = 1

$$R^2 = 119,949.1497$$

$$R = 346.3368 \text{ ft after 1 yr.}$$

Years	Radial Flow(ft)
1	346.34
2	489.79
3	599.87
4	692.67
5	774.43
10	1095.21
15	1341.36
20	1548.87

This equation also assumes maximum injection at maximum pressure.

If the life of the well is 15 years, then the radial flow will be 1341.36 ft. away from the well bore. When the well is abandon, the radial flow or fluid advance will decrease exponentially.

Pressure Build-up Equation for a Single Well w/
constant injection rate

$$P_r = P_i + 70.6 \frac{q \mu \beta}{kh} \left[E_i \left(\frac{39.5 \phi \mu c r^2}{kt} \right) \right]$$

$$\text{but, } \frac{39.5 \phi \mu c r^2}{kt} < .01$$

$$\therefore P_r = P_i + 162.6 \frac{q \mu \beta}{kh} \log \left(\frac{kt}{70.4 \phi \mu c r^2} \right)$$

$$P_r = 0 + 162.6 \frac{(3000 \text{ B/D}) (.4 \text{ cp}) (1 \text{ B/B})}{(1100 \text{ md}) (136 \text{ ft})} \log \left[\frac{(1100 \text{ md}) (5475 \text{ D})}{(70.4) (.12) (.4 \text{ cp}) (2.2279 \times 10^{-6} \text{ 1/psi}) (5280 \text{ ft})} \right]$$

$$P_r = 1.3043 \log 28,694.5471$$

$$P_r = 1.3043 (4.4578)$$

$$\underline{P_r = 5.8142 \text{ psi}} \quad \text{— or —} \quad \underline{\Delta P_r = 5.8142 \text{ psi}}$$

This equation is assuming:

- 1) maximum injection pressure of 1200psi is constant
- 2) maximum volume of injection fluid = 3000 BPD
- 3) injection well life = 15 years

Variable Definitions

1.3043

- P_r - reservoir pressure at radius r (psi)
 P_i - initial reservoir pressure (psi) = 0
 q - flow rate, barrels/day = 3000 BPD MAX. (Koch Application)
 μ - viscosity, cp (centipoise) = .4 cp (Koch, communication w/ R. Miller)
 β - formation volume factor = 1 (Koch, commo. w/ R. Miller - assumed a value of one because the formation is laterally extensive)
 k - intrinsic permeability, md (millidarcy) = 1.1 darcys = 1100 md (from Hydrogeology, by Davis & DeWiest, page 164)
 h - reservoir thickness, ft (Koch Application)
 ϕ - porosity, fraction or percentage = .12 or 12% (from Analysis of Groundwater and Streamflow Data - Western, SD, by Allen, Iles, & Petris, C-3)
 c - compressibility, psi^{-1} = 2.2279×10^{-6} 1/psi (Koch, commo. w/ R. Miller)
 r - radial distance from well to point of investigation, ft. =

Figure FF

Vertical Flow Rate ($\bar{V}$)

$$\bar{V} = \frac{KP}{\mu L \phi}$$

K - intrinsic permeability, permeability for "dirty sands" or formation with high clay or shale content ranges from 10^{-3} to 10^{-6} darcys (from Davis and DeWiest, Hydrogeology, page 164), since the confining layer is more than 75% shales a value of 1×10^{-5} darcy was used

$$1 \text{ darcy} = \frac{\frac{\text{cp} \cdot \text{cm}^3}{\text{s}}}{\text{cm}^2} \cdot \frac{\text{cm}}{\text{atm}}$$

P - pressure P_i & P_n

P_i = induced

$$P_i = \left(\frac{\text{Depth to Top of Inyan Kara} - \text{Piezometric Surface of Inyan Kara}}{2.308 \text{ ft H}_2\text{O/psi}} \right.$$

+ MAXIMUM INJECTION PRESSURE) -

$$\left(\frac{\text{Depth to base of Fox Hills} - \text{Piezometric Surface of Fox Hills}}{2.308 \text{ ft H}_2\text{O/psi}} \right)$$

$$P_i = \left[\frac{4530 - (3150 - 2900)}{2.308} + 1200 \right] - \left[\frac{500 - (3150 - 2800)}{2.308} \right]$$

$$P_i = 2,902.77 \text{ psi}$$

$$P_i = 2,902.77 \text{ psi} \left(\frac{\text{psi}}{14.7 \text{ atm}} \right) = 197.47 \text{ atm}$$

Figure FF (continued)

P_n = natural

$$P_n = \left(\frac{\text{Depth to Top of Inyan Kara - Piezometric Surface of Inyan Kara}}{2.308 \text{ ft H}_2\text{O/psi}} \right)$$

$$- \left(\frac{\text{Depth to base of Fox Hills - Piezometric Surface of Fox Hills}}{2.308 \text{ ft H}_2\text{O/psi}} \right)$$

$$P_n = \left[\frac{4530 - (3150 - 2900)}{2.308} \right] - \left[\frac{500 - (3150 - 2800)}{2.308} \right]$$

$$P_n = 1,702.77 \text{ psi}$$

$$P_n = 1,702.77 \text{ psi} \left(\frac{\text{psi}}{14.7 \text{ atm}} \right) = 115.83 \text{ atm}$$

μ - viscosity of the injected fluid = .4 cp (from communications with R. Miller of Koch)

L - thickness of the confining layer
 Top of Inyan Kara - Base of the Fox Hills
 $4530 - 500 = 4030'$

$$4030 \text{ ft} \left(\frac{.3048 \text{ m}}{\text{ft}} \right) \left(\frac{100 \text{ cm}}{\text{m}} \right) = 122,834.4 \text{ cm}$$

ϕ - porosity of confining layer - estimated

Pierre Shale	67% (Davis & DeWiest, 1966, p. 375)
Niobrara	50% "
Carlile Shale	67% "
Greenhorn Ls	5% (Linsley & Franzini, 1972, p. 84)
Belle Fourche Shale	67% (Davis & DeWiest, 1966, p. 375)
Mowry Shale	67% "
Newcastle Sandstone	20% (Allen, et al., 1985, c-2)
Skull Creek Shale	67% (Davis & DeWiest, 1966, p. 375)

these formations consist of $\approx 80\%$ shale for which the porosity is $\approx 67\%$, the other 20% has an average porosity of 40% $\therefore$ the overall porosity is

$$\phi = 61\% \text{ - or - } .61$$

Figure FF (continued)

During Injection

$$\bar{V} = \frac{(1 \times 10^{-5} \text{ darcy})(197.47 \text{ atm})}{(.4 \text{ cp})(122,834.4 \text{ cm})(.61)}$$

$$\bar{V} = 6.59 \times 10^{-8} \text{ cm/s}$$

$$\bar{V} = \underline{\underline{.068 \text{ ft/yr}}}$$

Natural Conditions

$$\bar{V} = \frac{(1 \times 10^{-5} \text{ darcy})(115.83)}{(.4 \text{ cp})(122,834.4 \text{ cm})(.61)}$$

$$\bar{V} = 3.86 \times 10^{-8} \text{ cm/s}$$

$$\bar{V} = \underline{\underline{.04 \text{ ft/yr}}}$$

Time for injected fluid to reach Inyan Kara

Time = confining layer thickness $\div$ vertical Flow rate

$$T = \frac{4030 \text{ ft}}{.068 \text{ ft/yr}} = \underline{\underline{59,265 \text{ years}}}$$

If the expected life of the well is 15 years, and Koch injects at maximum pressure and volume during that time, the expected vertical flow would be:

$$\frac{X(\text{ft})}{.068 \text{ ft/yr}} = 15 \text{ yrs.}$$

$$\underline{\underline{X = 1.02 \text{ ft}}}$$

Calculations

Figure 66

population of Harding County as of 1985 = 1699
 Area of Harding County = $48 \times 54 = 2592 \text{ mi}^2$

$$\text{people}/\text{mi}^2 = \frac{1699}{2592} = .6555$$

projected population in 2020 = 3075

(from SD Population Projections 1985-2020, SDSDC, DyKstra, 1985)

$$\text{projected people}/\text{mi}^2 = \frac{3075}{2592} = 1.1863$$

Fox Hills Formation in Harding County

area of the aquifer = 1,640,960 acres

amount of recoverable water = 12,307,200 acre-feet
 (from Allen, Iles, & Petris, 1985)

$$1,640,960 \text{ acres} \left(\frac{1 \text{ mi}^2}{640 \text{ acres}} \right) = 2,564 \text{ mi}^2 = \text{area of Fox Hills}$$

$$\text{The aquifer now serves } \frac{1699 \text{ people}}{2,564 \text{ mi}^2} = .6626 \text{ people}/\text{mi}^2$$

The aquifer is expected to serve 3075 people by the year 2020 which would be:

$$\frac{3075 \text{ people}}{2,564 \text{ mi}^2} = 1.1993 \text{ people}/\text{mi}^2$$

$$12,307,200 \text{ acre-feet} \left(\frac{43,560 \text{ ft}^3}{\text{acre-ft}} \right) = 5.3610 \times 10^{11} \text{ ft}^3$$

$$5.3610 \times 10^{11} \text{ ft}^3 \left(\frac{28.32 \text{ L}}{\text{ft}^3} \right) \left(\frac{\text{gal}}{3.785 \text{ L}} \right) = 4.0112 \times 10^{12} \text{ gal H}_2\text{O}$$

1985

$$\frac{4.0112 \times 10^{12} \text{ gal}}{1699 \text{ people}} = \underline{\underline{2.361 \times 10^9 \frac{\text{gal H}_2\text{O}}{\text{person}}}}$$

2020

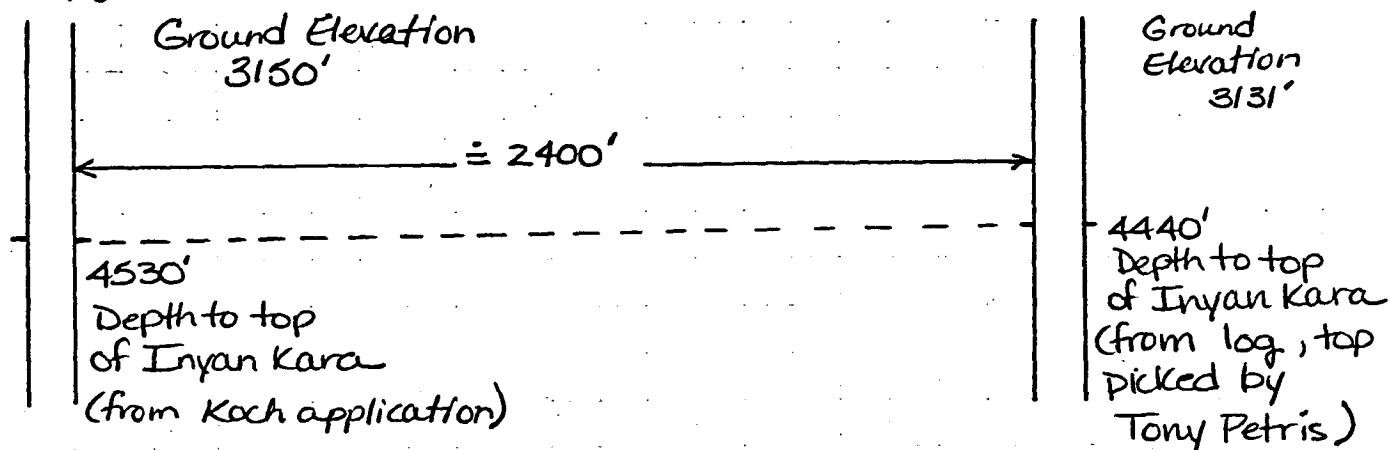
$$\frac{4.0112 \times 10^{12} \text{ gal}}{3075 \text{ people}} = \underline{\underline{1.304 \times 10^9 \frac{\text{gal H}_2\text{O}}{\text{person}}}}$$

Figure HH

Dip of the Inyan Kara

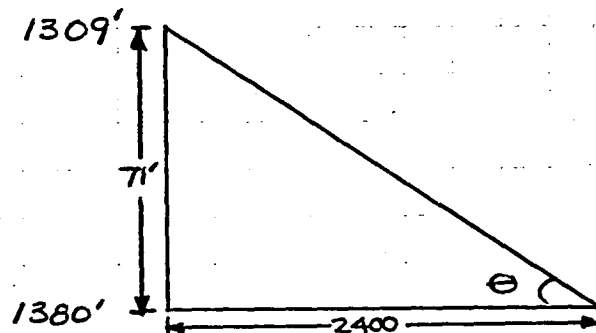
Solar #34-32 Travers
(Koch # 34-32 SBRRU)

Koch # 11-4 SBRRU



$$4530' - 3150' = 1380'$$

$$4440' - 3131' = 1309'$$



$$\tan \theta = 71/2400$$

$$\theta = \tan^{-1}.02958$$

$$\theta = 1.69^\circ$$

$$\underline{\underline{\theta = 2^\circ}}$$

Bibliography

Allen, J.C., D.L. Illes, A.K. Petres, 1984, Analysis of Groundwater and Streamflow Data Western Dakotas Region of South Dakota, For U.S. Army Corps of Engineers, SDGS, Vermillion SD, 57069.

Schoon, R.A., 1971, Geology and Hydrology of the Dakota Formation in South Dakota, Report of Investigations No. 104, SDGS, Vermillion SD 57069.

Schoon, R.A., 1972, Review of Oil Possibilities in Harding and Butte Counties With Emphasis on the Newcastle Sandstone, Report of Investigations No. 106, SDGS, Vermillion SD, 57069.

RECOMMENDATION OF CHIEF ENGINEER FOR WATER PERMIT
APPLICATION No. 1350-1, Harper Oil Company

Pursuant to SDCL 46-2A-2, the following is the recommendation of the Chief Engineer, Water Rights Division, Department of Water and Natural Resources concerning Water Permit Application No. 1350-1, Harper Oil Company, PO Box 5928 T.A., Denver CO.

The Chief Engineer is recommending APPROVAL of Application No. 1350-1 because 1) there is reasonable probability that there is unappropriated water available for the applicant's proposed use, 2) the proposed diversion can be developed without unlawful impairment of existing rights, 3) the proposed use is a beneficial use and 4) in the public interest with the following qualifications:

1. That the well casing be pressure grouted with cement (bottom to top) above the water producing formation and that construction comply with Water Management Board Well Construction Rules, Chapter 74:02:04.
2. That if the test hole for this well or if the well is abandoned, that it be plugged with neat cement (bottom to top) according to Board Rules Chapter 74:02:04.

See the attached report for additional information.


JOHN HATCH, Chief Engineer
March 24, 1986

BANKS & JOHNSON

A PROFESSIONAL CORPORATION

ATTORNEYS & COUNSELORS AT LAW

3202 WEST MAIN STREET

RAPID CITY, SOUTH DAKOTA ~~57702-2398~~ 57702-2398

RONALD W. BANKS
GLEN H. JOHNSON
GARY L. MONSERUD
JERRY D. JOHNSON
GARY G. COLBATH
RONALD R. KAPPELMAN
SCOTT SUMNER
WAYNE F. GILBERT
TOM LEHNERT
TIMOTHY J. BECKER
RICHARD E. HUFFMAN
RANDALL R. HODGE

TELEPHONE 346-7300
AREA CODE 605

May 1, 1986

Water Rights Division
Department of Water & Natural Resources
Joe Foss Building
Pierre, SD 57501

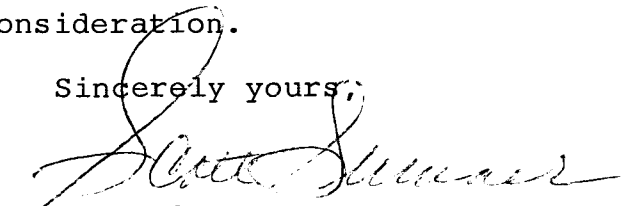
Re: Harper Oil Company Application No. 1350-1
to Appropriate Water

Ladies and Gentlemen:

In response to the public notice in the Nation's Center News on April 30, 1986, concerning the forthcoming July 1 hearing on the above-referenced water appropriation application, I would appreciate your providing me with copies of Harper's application and exhibits, the chief engineer's recommendation, and other information as is being made available to the public. I would be more than happy to reimburse for costs of reproduction.

Thank you for your consideration.

Sincerely yours;


Scott Sumner

SS/ca





Department of Water & Natural Resources

Joe Foss Building
523 East Capitol
Pierre, South Dakota 57501-3181

Water Rights Division
605 773-3352

May 7, 1986

1350-1

Banks & Johnson
3202 West Main St
Rapid City SD 57702-2398

ATTENTION: Scott Summer

This letter is in response to your letter dated May 1, 1986. Enclosed is the information you requested concerning the Harper Oil Company Permit Application No. 1350-1.

1. Recommendation of the Chief Engineer.
2. Report on Application No. 1350-1.
3. Permit Application Form 2 and 2A.
4. Map of proposed construction area.

Contact us if you have any further questions.

Sincerely,

A handwritten signature in cursive script that reads "Ron Duvall".

RON DUVALL
Natural Resources Engineer

RD:ks

enclosures

REVISED

REPORT ON APPLICATION NO.1350-1
HARPER OIL COMPANY
May 8, 1986

This application proposed to appropriate 0.10 cfs from one well approximately 4680 feet deep located in the SW 1/4 SW 1/4 of Section 22, T21N, R3E in Harding County. The water will be used for an oil field water flood project.

Aquifer: Dakota Sandstone (Inyan Kara)

Geology and Aquifer Characteristics

The name Dakota Sandstone is not accurate in actual geologic terms, but is a name commonly used to describe these rocks. Probably, a strict interpretation would lead to the name Newcastle Sandstone rather than the Dakota Sandstone (Schoon, 1972). There has been considerable debate by geologists concerning the Dakota and this is discussed in detail in a report entitled Geology and Hydrology of the Dakota Formation in South Dakota (Schoon, 1971). In Montana, the Newcastle would be called the Muddy Sandstone and in South Dakota, the Newcastle is basically the time equivalent of the basal Dakota Sandstone. The true Dakota Sandstone as described by Schoon does not extend as far west as Harding County. For purposes of this brief summary, the name is not that important as long as it is understood what zone the application is for.

After evaluating again the electric log submitted with this application and the plans for converting Solar No. 34-32 SBRRU salt water disposal well, I have concluded the zone of both the salt water injection and the zone Harper Oil wishes to produce water from are the same. This zone should be considered part of the Inyan Kara Group. The application for the injection well is included with this report.

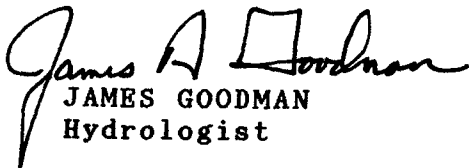
The Inyan Kara Group consists of interbedded sandstones and shales and is approximately 250 feet thick in this area. The aquifer underlies approximately 1.7 million acres in Harding County and contains an estimated 22.5 million acre feet of recoverable water (Allen, etal, 1984). The electric log submitted with this application indicates porous sandstone beginning about 4380 feet below land surface. Harper Oil proposes to drill a 7 7/8" hole to a depth of 4680 feet and test the water quality and production rate of the well. The well is to be cased with 5 1/2 API casing and grouted with neat cement using the plug displacement method.

Review of Existing Water Permits

There are no existing water permits from the Inyan Kara Group in the area. There is a reinjection permit application No. 34-32 SBRRU salt water disposal well for Koch Exploration into this formation about 4 miles southeast of this application.

Conclusions

1. The data suggests water is available from the "Dakota", Inyan Kara Group. Harper Oil will test to determine if a well can be satisfactorily completed both for water quality and quantity.
2. Interference will not be a problem. There may be an injection system 4 miles away, but no other water uses.
3. The proposed well construction must meet the new Well Construction Standards (74:02:04).


JAMES GOODMAN
Hydrologist

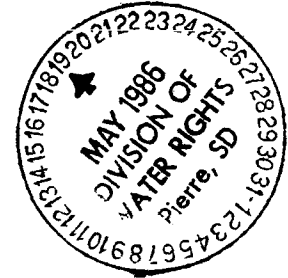
Bibliography

- Allen, J.C., D. L. Illes, A. K. Petres, 1984, Analysis of Ground water and Streamflow Data Western Dakotas Region of South Dakota, for U. S. Army Corps of Engineers, SDGS, Vermillion SD, 57069.
- Schoon, R. A., 1971, Geology and Hydrology of the Dakota Formation in South Dakota, Report of Investigations No. 104, SDGS, Vermillion SD 57069.
- Schoon, R. A., 1972, Review of Oil Possibilities in Harding and Butte Counties With Emphasis on Newcastle Sandstone, Report of Investigations No. 106, SDGS, Vermillion SD 57069.



CITIES SERVICE OIL AND GAS CORPORATION
P.O. BOX 3908 TULSA, OKLAHOMA 74102

May 15, 1986



Attention: Billing Department

As a result of the acquisition of MidCon Corporation by Occidental Petroleum Corporation, the following MidCon Companies' operations are being combined with Cities Service Oil and Gas Corporation.

MidCon Companies to be combined with
Cities Service Oil and Gas Corporation

MidCon Exploration Company
MidCon Central Exploration Company (Harper Oil - Okla. City)
MidCon Central Exploration Company (Harper Oil - Denver, Buckhorn)
MidCon Exploration Company - Gulf Coast (Texoma)
MidCon Exploration Company - Exeter Exploration
(not Exeter Drilling)

TPC Pipeline
Main Pass 151
Napeco
Anthrost
Cotton Petroleum Corporation
IONE Gas Processing Company
United Crude Company

Effective June 1, 1986, continue to invoice the above Companies for services or materials. The invoices should be addressed to the appropriate company, c/o Cities Service Oil and Gas Corporation. Please use the Cities Service region office whose area the services or materials were used, unless directed otherwise.

Attached for your reference is a map of the United States showing Cities Service's region boundaries. For divided states a list by county, showing the appropriate region, is also attached.

May 15, 1986
Page Two

Mailing addresses for these offices are:

Rocky Mountain Region (303) 861-2464	-	Cities Service Oil & Gas Corporation Finance & Administration Department 900 Colorado State Bank Building 1600 Broadway Denver, CO 80202-4990
Mid-Continent Region (405) 949-4400	-	Cities Service Oil & Gas Corporation Finance & Administration Department 3545 N.W. 58th Street Oklahoma City, OK 73112-4796
Southwest Region (915) 685-5600	-	Cities Service Oil & Gas Corporation Finance & Administration Department 6 Desta Drive Box 1919 Midland, TX 79701-1919
Southeast Region (601) 969-6970	-	Cities Service Oil & Gas Corporation Finance & Administration Department 620 North Street Box 12026 Jackson, MS 39211-0026
Gulf of Mexico/ Southern Region (713) 850-6100	-	Cities Service Oil & Gas Corporation Finance & Administration Department 1980 Post Oak Blvd. Houston, TX 77056-3892
West Coast Region (805) 861-6400	-	Cities Service Oil & Gas Corporation Finance & Administration Department 1800 Thirtieth Street Box 939 Bakersfield, CA 93302-0939

If you should have any questions, please contact the closest region office, Manager of Finance and Administration.

sld
Attachments

CITIES SERVICE OIL & GAS CORPORATION
Exploration and Production Group

★ AREA OFFICES

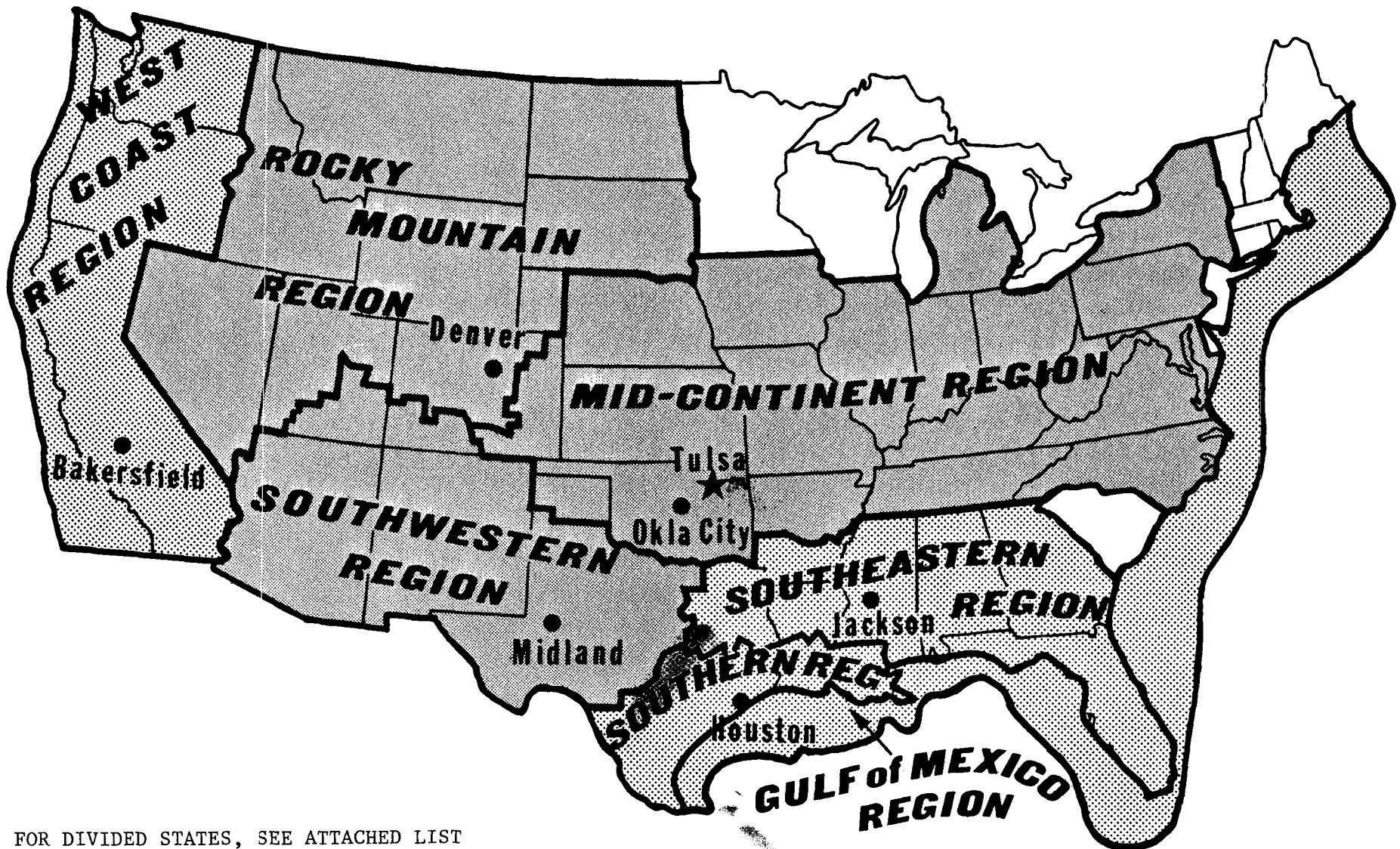
● REGION OFFICES



COASTAL AREA



INTERIOR AREA



FOR DIVIDED STATES, SEE ATTACHED LIST

COUNTY LIST BY STATE BY REGION

ARKANSAS/Mid-Continent Region Counties

Baxter	Conway	Franklin	Johnson	Marion	Pope	Searcy	Van Buren
Benton	Craighead	Fulton	Lawrence	Mississippi	Prairie	Sebastian	Washington
Boone	Crawford	Greene	Lee	Monroe	Pulaski	Sharp	White
Carroll	Crittenden	Independence	Logan	Newton	Randolph	St. Francis	Woodruff
Clay	Cross	Izard	Lonoke	Perry	Saline	Stone	Yell
Cleburne	Faulkner	Jackson	Madison	Poinsett	Scott		

ARKANSAS/Southeast Region Counties

Arkansas	Chicot	Dallas	Grant	Jefferson	Miller	Quachita	Polk
Ashley	Clark	Desha	Hempstead	Lafayette	Montgomery	Phillips	Sevier
Bradley	Cleveland	Drew	Hot Spring	Lincoln	Nevada	Pike	Union
Calhoun	Columbia	Garland	Howard	Little River			

COLORADO/Mid-Continent Region Counties

Baca	Cheyenne	Kiowa	Las Animas	Otero	Prowers	Washington	Yuma
Bent	Huerfano	Kit Carson	Lincoln	Phillips	Sedgwick		

COLORADO/Southwest Region Counties

Alamosa	Conejos	Dolores	La Plata	Montezuma	Ouray	Saguache	San Miguel
Archuleta	Costilla	Hinodale	Mineral	Montrose	Rio Grande	San Juan	

ALL other Colorado counties are in Rocky Mountain Region

LOUISIANA/Southeast Region Parishes

Bienville	Catahoula	East Carroll	Jackson	Madison	Ouachita	Sabine	Webster
Bossier	Claiborne	Franklin	La Salle	Morehouse	Red River	Tensas	West Carroll
Caddo	Concordia	Grant	Lincoln	Natchitoches	Richland	Union	Winn
Caldwell	De Soto						

All other Louisiana parishes are in Southern Region

NEBRASKA/Rocky Mountain Region Counties

Banner	Cheyenne	Duele	Kimball	Morrill	Scotts Bluff	Sheridan	Sioux
Box Butte	Dawes	Garden					

All other Nebraska counties are in Mid-Continent Region

TEXAS/Mid-Continent Region Counties

Carson	Gray	Hartley	Hutchinson	Moore	Potter	Sherman	Wheeler
Dallam	Hansford	Hemphill	Lipscomb	Ochiltree	Roberts		

TEXAS/Southeast Region Counties

Anderson	Dallas	Franklin	Houston	Limestone	Panola	Sabine	Upshur
Angelina	Delta	Freestone	Hunt	Marion	Rains	San Augustine	
Bowie	Ellis	Gregg	Kaufman	Morris	Red River	Shelby	Van Zandt
Camp	Falls	Harrison	Lamar	Nacogdoches	Robertson	Smith	Wood
Cass	Fannin	Henderson	Leon	Navarro	Rockwall	Titus	
Cherokee							

TEXAS/Southern Region Counties

Aransas	Burleson	Duval	Hardin	Kames	Matagorda	Polk	Walker
Atascosa	Caldwell	Fayette	Harris	Kenady	Maverick	Refugio	Waller
Austin	Calhoun	Fort Bend	Hays	Klegerg	Medina	San Jacinto	Washington
Bastrop	Cameron	Frio	Hidalgo	La Salle	Milam	San Patricio	Webb
Bee	Chambers	Galveston	Jackson	Lavaca	Montgomery	Starr	Wharton
Bell	Colorado	Goliad	Jasper	Lee	McMullen	Travis	Willacy
Bexar	Comal	Gonzales	Jefferson	Liberty	Newton	Trinity	Williamson
Brazoria	De Witt	Grimes	Jim Hogg	Live Oak	Nueces	Tyler	Wilson
Brazos	Dimmit	Guadalupe	Jim Wells	Madison	Orange	Victoria	Zapata
Brooks							Zavala

TEXAS/Southwest Region Counties

Andrews	Clay	Deaf Smith	Glasscock	Jones	Menard	Reagan	Taylor
Archer	Cochran	Denton	Grayson	Kendall	Midland	Real	Terrell
Armstrong	Coke	Dickens	Hale	Kent	Mills	Reeves	Terry
Bailey	Coleman	Donley	Hall	Kerr	Mitchell	Runnels	Throckmorton
Bandera	Collin	Eastland	Hamilton	Kimble	Montague	San Saba	Tom Green
Baylor	Collingsworth		Hardeman	King	Motley	Schleicher	Upton
Blanco	Comanche	Ector	Haskell	Kinney	McCulloch	Scurry	Uvalde
Borden	Concho	Edwards	Hill	Knox	McLennan	Shackelford	Val Verde
Bosque	Cooke	El Paso	Hockley	Lamb	Nolan	Somervell	Ward
Brewster	Coryell	Erath	Hood	Lampasas	Oldham	Stephens	Wichita
Briscoe	Cottle	Fisher	Howard	Llano	Palo Pinto	Sterling	Wilbarger
Brown	Crane	Floyd	Hudspeth	Loving	Parker	Stonewall	Winkler
Burnett	Crockett	Foard	Irion	Lubbock	Parmer	Sutton	Wise
Callahan	Crosby	Gaines	Jack	Lynn	Pecos	Swisher	Yoakum
Castro	Culberson	Garza	Jeff Davis	Martin	Presidio	Tarrant	Young
Childress	Dawson	Gillespie	Johnson	Mason	Randall		

UTAH/Southwest Region Counties

Emery	Garfield	Grand*	Kane	San Juan	Wayne
-------	----------	--------	------	----------	-------

All other Utah counties are in Rocky Mountain Region

*Southern portion, up to and including Township 21 South

No. **1350-1**

Instruction to Newspaper - Publish first publication of the following Notice on or before **April 2, 1986** with 2nd publication 1 week later. The applicant is responsible for payment.

NOTICE OF HEARING on Application No. **1350-1** to Appropriate Water
~~and/or to Amend Water Permit or Water Right No. _____~~

Notice is hereby given that **Harper Oil Company** whose mailing address is **P.O. Box 5928, T.A., Denver, Colorado**, ~~South Dakota~~ has made an application for a permit to appropriate .10 cubic feet of water per second from one well approximately 4680 feet deep into the "Dakota Sandstone" Formation. The well will be located in the SW $\frac{1}{4}$ SW $\frac{1}{4}$, Section 22-T21N-R3E. Water will be used for an oil field water flood project.

Pursuant to SDCL 46-2A-2 the Chief Engineer of the Water Rights Division recommends **APPROVAL** of Application No. **1350-1** because 1) unappropriated water is available, 2) will be no unlawful impairment of existing rights, 3) is beneficial use of water and 4) is in the public interest.

This application will be considered by the Water Management Board at **Room 216, Joe Foss Building, 523 E. Capitol, Pierre, South Dakota, May 14 July 1 1986** at 10:00 am.

The recommendation of the Chief Engineer is not final or binding upon the Board and the Board is authorized to 1) approve, 2) approve with qualifications, 3) defer, or 4) deny this application after it reaches a conclusion based upon facts presented at the public hearing. Any interested person who may be affected by a Board decision and who intends to participate in the hearing before the Board and present evidence or cross-examine witnesses according to SDCL 1-26 must file a written petition with BOTH the applicant and the Chief Engineer by **May 2, 1986**. The petition may be informal, but it must include a statement describing the petitioners interest in the application, the reasons for the petitioner's opposition to or support of the application, and the signature and mailing address of the petitioner or his legal counsel if legal counsel is obtained. The applicant need not file a petition.

This application is made pursuant to the provisions of SDCL 46-1-1 thru 46-1-9, 46-1-12 thru 46-1-15; 46-2-3.1, 46-2-9, 46-2-11, 46-2-13, 46-2-17; 46-2A-1 thru 46-2A-10, 46-2A-12, 46-2A-14, 46-2A-15; 46-5-1 thru 46-5-11, 46-5-13 thru 46-5-15, 46-5-24, 46-5-25, 46-5-30.2 46-5-30.4, 46-5-31; ~~(ground)~~ 46-6-3, 46-6-3.1, 46-6-6.1, 46-6-10, 46-6-13, 46-6-14; ~~(future use)~~ 46-5-38 thru 46-5-40; ~~(transfer lands)~~ 46-5-30.4, 46-5-33 thru 46-5-35, (10,000 AFA) 46-5-20.1, 46-5-8.1; and Board Rules ARSD 74:02:01:01 thru 74:02:01:15; ~~(future use)~~ 74:02:01:24 thru 74:02:01:25; (10,000 AFA) 74:02:01:15:02 thru 74:02:01:15:05.

This hearing is an adversary proceeding. The applicant or any person, after filing a petition, has the right to be present or to be represented by a lawyer. These and other due process rights will be forfeited if they are not exercised. Decisions of the Board may be appealed to the Circuit Court and the State Supreme Court as provided by law.

Any person wishing a copy of the Chief Engineer's recommendation, further information on this application or to assure access to the hearing by the handicapped can contact the Water Rights Division, DWNR, Joe Foss Bldg, Pierre SD (605 773-3352) for assistance prior to the hearing date. The time of the hearing will be automatically extended for at least twenty days upon written request of the applicant or any person who has filed a petition to oppose or support the application. The request for extension must be filed with the Chief Engineer by **May 2, 1986**.

PROOF OF PUBLICATION

STATE OF SOUTH DAKOTA)
County Harding) ss.

I, Bonnie Glines hereby

certify that the annexed printed copy of Notice of Intent to Appropriate

Water was taken from the Nation's Center News

A newspaper which during the whole time of publication of said notice
herein after stated, has been and is printed and published in the

City of Buffalo

County of Harding and State of South Dakota;
that the said notice was published in said newspaper on the following
two dates:

April 30, 1986

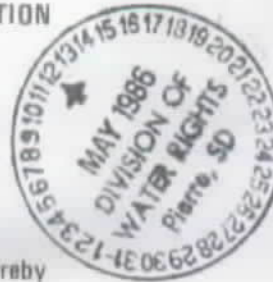
May 7, 1986

Bonnie Glines
(Signature)

Business Manager
(Title)

May 7, 1986
(Date Signed)

Cost of Printing: 105 lines @ .192
20.16 x 2 = \$40.32



NOTICE OF HEARING
ON APPLICATION NO. 1350-1
TO APPROPRIATE WATER

Notice is hereby given that
Harper Oil Company whose
mailing address is P.O. Box
5928, T.A., Denver, Colorado,
has made an application for a
permit to appropriate .10 cubic
feet of water per second from one
well approximately 4680 feet
deep into the "Dakota Sand-
stone" Formation. The well will
be located in the SW $\frac{1}{4}$ SW $\frac{1}{4}$,
Section 22-T21N-R3E. Water will
be used for an oil field water
flood project.

Pursuant to SDCL 46-2A-2 the
Chief Engineer of the Water
Rights Division recommends
APPROVAL of Application No.
1350-1 because 1) unappropri-
ated water is available, 2) will be
no unlawful impairment of ex-
isting rights, 3) is beneficial use
of water and 4) is in the public
interest.

This application will be con-
sidered by the Water Manage-
ment Board at Room 216, Joe
Foss Building, 523 E. Capitol,
Pierre, South Dakota, July 1,
1986 at 10:00 am. The rec-
ommendation of the Chief En-
gineer is not final or binding
upon the Board and the Board is
authorized to 1) approve, 2;
approve with qualifications, 3)
defer, or 4) deny this application
after it reaches a conclusion
based upon facts presented at
the public hearing. Any inter-
ested person who may be af-
fected by a Board decision and
who intends to participate in the
hearing before the Board and
present evidence or cross-examine
witnesses according to SDCL
1-26, must file a written petition
with BOTH the applicant and the
Chief Engineer by June 20, 1986.
The petition may be informal,
but it must include a statement
describing the petitioners inter-
est in the application, the rea-
sons for the petitioner's oppo-
sition to or support of the
application, and the signature
and mailing address of the pe-
titioner or his legal counsel if
legal counsel is obtained. The
applicant need not file a petition.

This application is made pur-
suant to the provisions of SDCL
46-1-1 thru 46-1-9, 46-1-12 thru
46-1-15; 46-2-3-1, 46-2-9, 46-2-11,
46-2-13, 46-2-17; 46-2A-1 thru
46-2A-10, 46-2A-12, 46-2A-14,
46-2A-15; 46-5-1 thru 46-5-11,

46-5-13 thru 46-5-15, 46-5-24,
46-5-25, 46-5-30.2, 46-5-30.4,
46-5-31; 46-6-3, 46-6-3.1,
46-6-6.1, 46-6-10, 46-6-13,
46-6-14; and Board Rules ARSD
74:02:01:01 thru 74:02:01:15.

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4-30, 5-7



Department of Water & Natural Resources

Joe Foss Building
523 East Capitol
Pierre, South Dakota 57501

Water Rights Division
605 773-3352

AUG 18 1986

Harper Oil Company
P.O. Box 5928 T.A.
Denver, Colorado 80217

Dear Sir:

Enclosed herewith is your Water Permit No. 1350-1 as approved by the Water Management Board authorizing you to construct your water diversion system and the water to beneficial use, not exceeding the limits as specified in said Water Permit No. 1350-1.

Also enclosed is Form 10, Notice of Completion of Works and Application of Water to Beneficial Use, which you are to complete and submit to the Chief Engineer when you have completed the system and/or have put the water to beneficial use. An inspection can then be scheduled so that your Water License may be issued to you, thus completing your acquisition of a Water Right.

Very truly yours,

A handwritten signature in cursive script, appearing to read "John Hatch".

JOHN HATCH, Chief Engineer
Water Rights Division

JH: ms

enclosure

PLEASE NOTE: Certain changes can be made in your permit within the five year construction period, usually without affecting the priority date provided an application to amend your permit is made within the five year period-i.e. changes in location or number of diversion points (wells) or location of land to be irrigated. Well locations for wells into the same aquifer can be moved up to 660 feet without application.

Applications to amend a permit after the five year construction period will be assigned a new priority date. Applications to change water sources, to add lands or increase original diversion rates, if approved will usually receive the date of the new application as a priority date regardless of the five year construction period.

WNR-809-5/83

NOTICE OF TRANSFER OF WATER RIGHTS



TO: Water Rights
Foss Building
Pierre, SD 57501

Date: December 12, 1986

This is to notify you that the title to the lands described as follows:

SW $\frac{1}{4}$ SW $\frac{1}{4}$ Section 22, T21N, R3E (well location)

formerly owned by Harper Oil Company, PO Box 5928, TA, Denver CO

has been transferred to Apache Corporation, 1700 Lincoln Street, Suite 4900, Denver, CO.
(please include complete mailing address) 80203-4549
together with any rights to the beneficial use of water thereon as evidenced by

Water Right Permit No. 1350-1 as provided for in SDCL 46-5-32 and 46-5-33.

You are therefore hereby requested to file this "Notice of Transfer of Water Permit" in its appropriate file at the Div. of Water Rights, Water Management Board as evidence of the change of ownership.

A fee of Two Dollars and Fifty Cents (\$2.50) is hereto attached to cover filing fees as required under SDCL 46-2-13.

COLORADO
STATE OF ~~SOUTH DAKOTA~~)
City and) ss.
County of Denver)

I, Patricia Foley, Attorney-in-Fact for Apache Corporation, being first duly sworn on my oath despose and say: That my relation to the above described undertaking is that of Owner, that I have read the above foregoing statement, and I know of my own personal knowledge that the information herein stated is true.

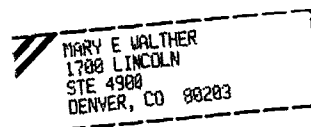
APACHE CORPORATION

Patricia Foley
(signed)
Patricia Foley, Attorney-in-Fact

Subscribed and sworn to before me this 15th Day of December, 1986.

Mary E. Walther
(Notary Public)

My Commission expires July 12, 1988



41 17

RECEIPT
Division of Water Rights
South Dakota Department of Water and Natural Resources

Pierre, December 17, 1986

RECEIVED OF Glenn A. Otness, 3956 S. Nucla St., Aurora, CO 80013

the following amount in fees for services rendered as provided for by law:

Fee for Application for Permit No. _____ to Appropriate Water, to construct works and to put water to beneficial use _____		
Fee for Application for Permit No. _____ to Appropriate Water for Future Use _____		
Fee to retain Future Use Permit No. _____ after period of seven years.		
Fee for Inspecting Constructed Works, confirming beneficial use and issuing Water License No. _____		
Fee for Filing Transfer Form <u>1350-1</u>	2	50
Fee for Filing Extension Request _____		
Fee for Certified Copy of _____		
Fee for Print Copy of Map _____		
Fee for Certifying _____		
Fee for _____		
(Any Other Work Provided by Law)	Total	2 50

By John Hatch
Chief Engineer JOHN HATCH/ms

1350-1

WATER RIGHTS DIVISION
(605) 773-3352

December 19, 1986

Glenn A. Otness
3956 South Nucla Street
Aurora, Colorado 80013

Dear Mr. Otness:

The transfer of Water Permit No. 1350-1 has been completed. The permit is now listed under Apache Corporation.

Thank you for taking the time to stop by our office to take care of this matter. If you have any questions, please contact our office.

Sincerely,

Genny McMath
Natural Resources Analyst

GM:ms
cc: Apache Corporation



Water & Natural Resources

Joe Foss Building
523 East Capitol
Pierre, South Dakota 57501-3181

July 29, 1987

D. H. Gibbons, Regional Operations Engineer
Suite 1900 One United Bank Center
1700 Lincoln Street
Denver CO 80203-4519

Dear Mr. Gibbons:

This letter is in response to your letter dated July 13, 1987 requesting changes in Water Permit No. 1350-1. The proposed changes can be made without amending Permit No. 1350-1. The well construction must still comply with the South Dakota Well Construction Standards.

Please contact us if you have any questions.

Very truly yours,

A handwritten signature in dark ink, appearing to read "John Hatch". The signature is written in a cursive, flowing style.

JOHN HATCH, Chief Engineer
Water Rights Division
605 773-3352



303/837-5000

File No. DES-935

July 13, 1987



South Dakota Department of Water & Natural Resources
Water Rights Division
Joe Foss Building
523 East Capitol
Pierre, South Dakota 57501-3181

Re: Water Permit #1350-1
Section 22, T21N, R3E
Harding County, South Dakota

Dear Sirs:

Apache Corporation, the title holder of Water Permit #1350-1, requests the following changes from the original application:

- 1) That the well be drilled in the SW SE of Section 22. Revised footages for the well are 1370' FWL and 730' FSL. This revision spots the well approximately 228' SE of the original location. This is requested so that interference with currently operating production equipment can be minimized. A plat map indicating the proposed location is attached for your files.
- 2) That the well be drilled to total depth with an 8 3/4" bit instead of the 7 7/8" that was originally proposed.
- 3) That 7" casing be ran in the 8 3/4" hole and cemented. Larger tubulars will result in more flexible operations of the well.

Please review the above request. If there are any questions, please call D. H. Gibbons at 303/837-5425. A prompt reply is requested as we would like to complete drilling and installation of the system.

Sincerely,

A handwritten signature in cursive script, appearing to read "D. H. Gibbons".

D. H. Gibbons
Regional Operations Engineer

DHG/tcb



303/837-5000

September 14, 1987

File No. DES-1253

South Dakota Department of Water & Natural Resources
Water Rights Division
Joe Foss Building
523 East Capitol
Pierre, South Dakota 57501-3181



Attention: John Hatch

RE: **Water Permit #1350-1**
Section 22-T21N-R3E
Harding County, South Dakota

Dear Mr. Hatch:

Apache Corporation, the title holder of Water Permit #1350-1, requests that the water well be drilled in the SE SE of Section 22. Revised footages for the well are 1120' FWL and 920' FSL. This revision spots the well approximately 142' SE of the original location. A plat indicating the location is attached.

Per our recent telephone conversation, it is Apache's understanding that moving the location is OK with Water and Natural Resources Division.

If there are any questions, please call D. H. Gibbons at 303/837-5425.

Sincerely

A handwritten signature in dark ink, appearing to read "D. H. Gibbons".

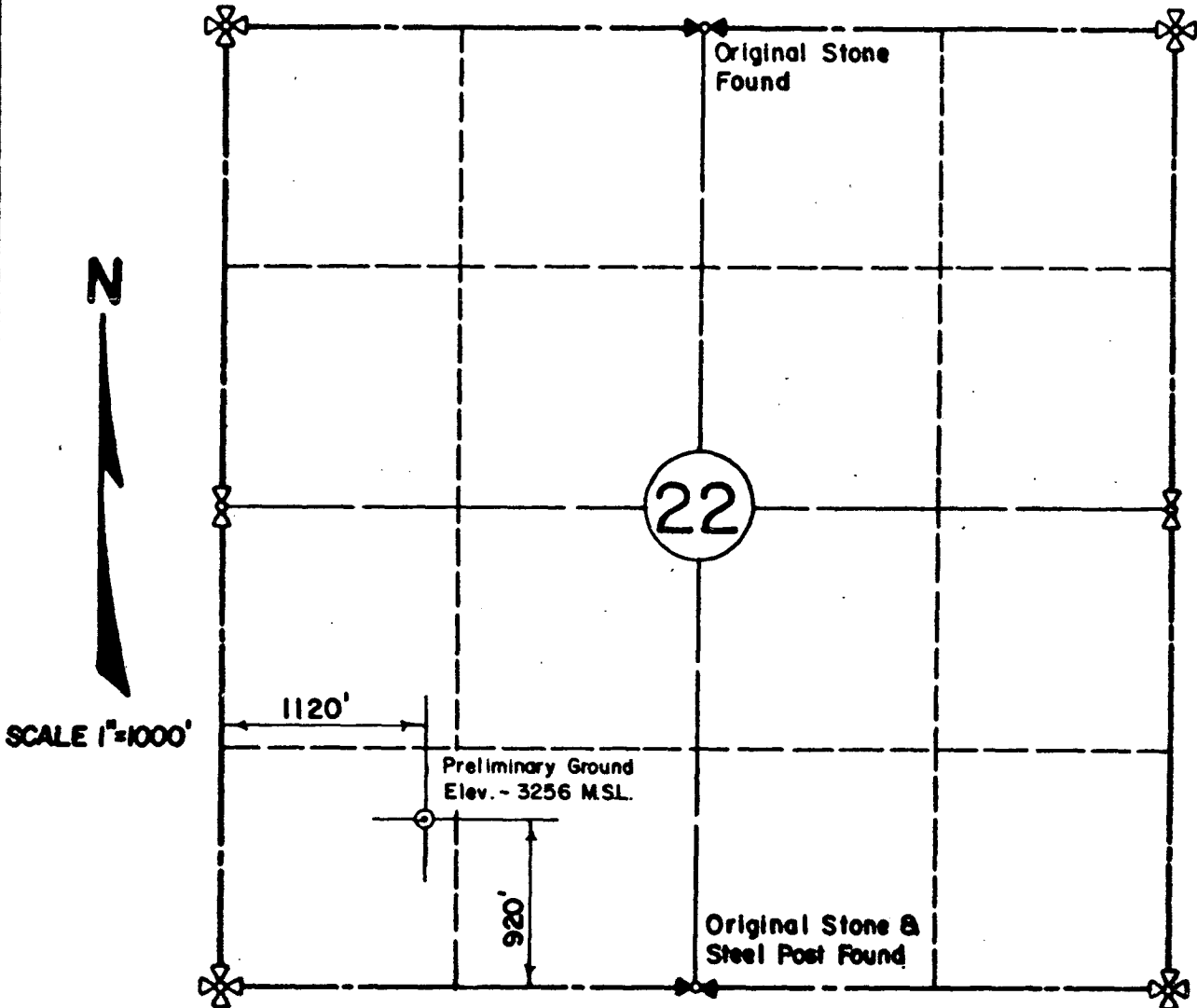
D. H. Gibbons
Regional Operations Engineer

DHG/alm

Enclosures

WELL LOCATION PLAT

Applicant Apache Corp.
Address 1660 Lincoln St., Suite 2300, Denver, Colorado 80264
Well Name & No. Clarkson 13-22W Source Well
920 feet from South Line and 1120 feet from West Line
Section 22, T. 21 N., R. 3 E
Harding County, South Dakota



I certify that this plat correctly represents work performed by me or under my responsible charge, and is true and correct to the best of my knowledge and belief.

NOTE: all land corners are assumed corners unless otherwise noted.

Leonard Goeres 8/20/87
Surveyed By Date

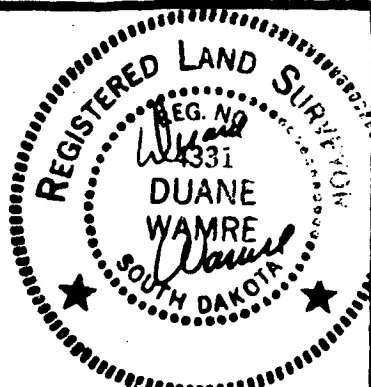
PROFESSIONAL CONSULTING ENGINEERS AND SURVEYORS
REGISTERED IN S. DAK., & DAK., MONTANA, MINNESOTA AND WYOMING

KADRMAS, LEE & JACKSON P.C.
VEIGEL ENGINEERING

Bus: 701-227-1284
P.O. Box 290
Dickinson, N.D. 58602-0290

Office in:
Bismarck, Valley City
Hazen, Bowman, Grafton

CERTIFICATE OF AUTHORIZATION # C-061



VERTICAL CONTROL
DATUM USED

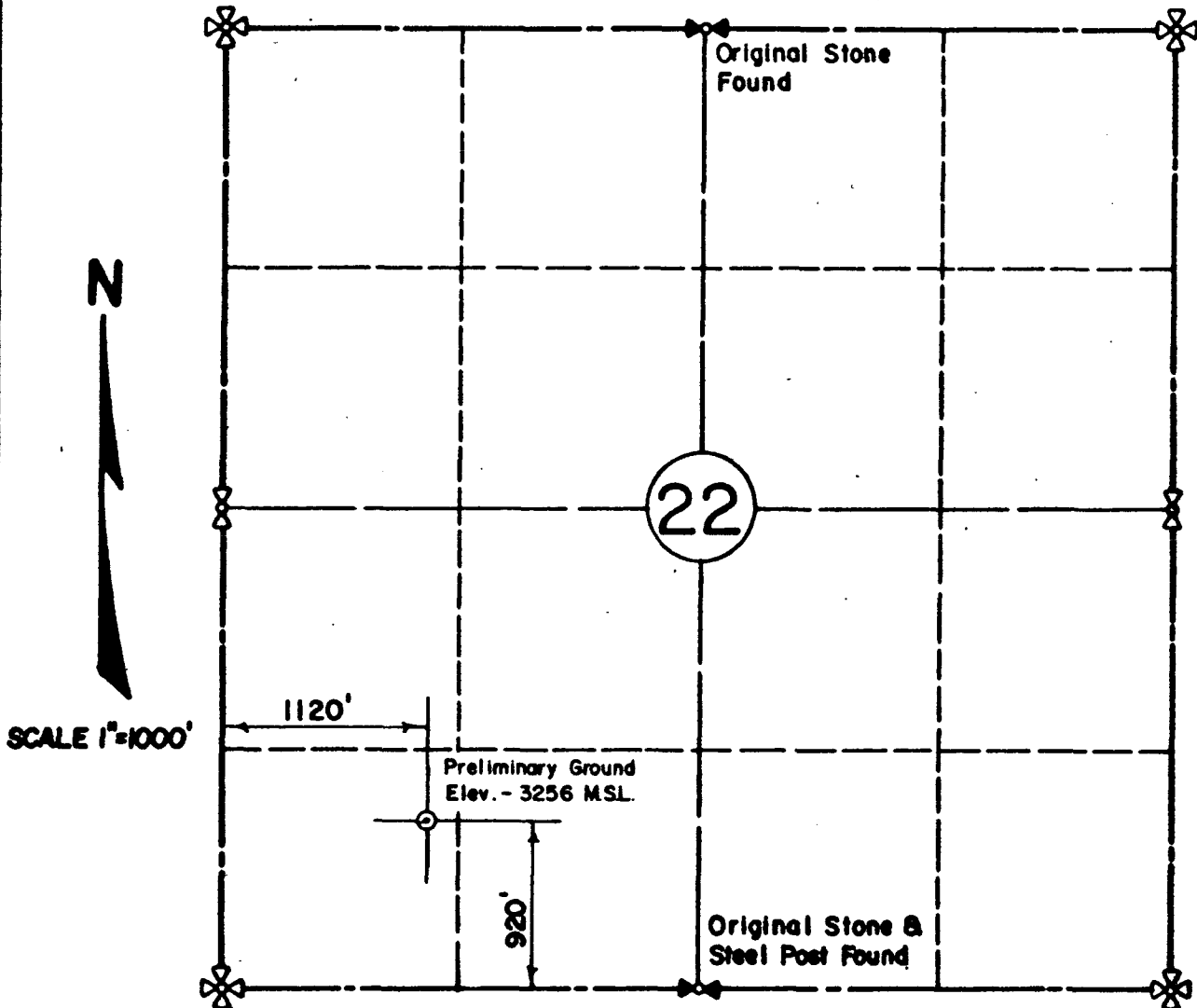
NW Corner of Section 22,
spot elevation - 3187 MSL

Proj. No. 48092 Restake

Book M293 Pg. 67 Staking
Book M293 Pg. 67 levels

WELL LOCATION PLAT

Applicant Apache Corp.
Address 1660 Lincoln St., Suite 2300, Denver, Colorado 80264
Well Name & No. Clarkson 13-22W Source Well
920 feet from South Line and 1120 feet from West Line
Section 22, T. 21 N., R. 3 E
Harding County, South Dakota



I certify that this plat correctly represents work performed by me or under my responsible charge, and is true and correct to the best of my knowledge and belief.

NOTE: all land corners are assumed corners unless otherwise noted.

Leonard Goeres 8/20/87
Surveyed By Date



VERTICAL CONTROL
DATUM USED

NW Corner of Section 22,
spot elevation - 3187 MSL

Proj. No. 48092 Restake

Book M293 Pg. 67 Staking
Book M293 Pg. 67 levels

PROFESSIONAL CONSULTING ENGINEERS AND SURVEYORS
REGISTERED IN N. DAK., S. DAK., MONTANA, MINNESOTA AND IOWA

KADRMAS, LEE & JACKSON P.C.
VEIGEL ENGINEERING

Bus.: 701-227-1284
P.O. Box 290
Dickinson, N.D. 58602-0290

Office in:
Bismarck, Valley City
Hazen, Bowman, Grafton

CERTIFICATE OF AUTHORIZATION # C-061

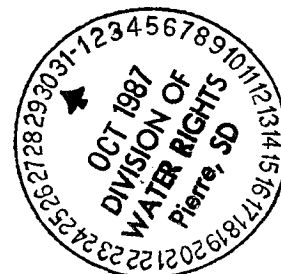


303/837-5000

October 29, 1987

File No. DES-1515

South Dakota Department of
Water and Natural Resources
Water Rights Division
Joe Foss Building
523 East Capitol
Pierre, South Dakota 57501-3181



RE: West Buffalo B Unit Waterflood
(Case 2-87)
Water Compatability Study and
Well Completion Report

Dear Sirs:

Attached is the completion report for the Clarkson 13-22 Source Well that was completed in the Dakota, Inyan-Kara formation.

The analysis of the source water and the produced water indicates the waters do have scale forming tendencies when combined, however chemical treatment of the source water will prevent scale formation. Attached for your review is a copy of the water analysis and the proposed chemical treating program.

Installation of injection facilities is near completion and injection is planned to begin in November. Your department will be notified so arrangements can be made to witness the well integrity tests on the injection wells. These tests will be conducted when the wells are converted from producer to injector.

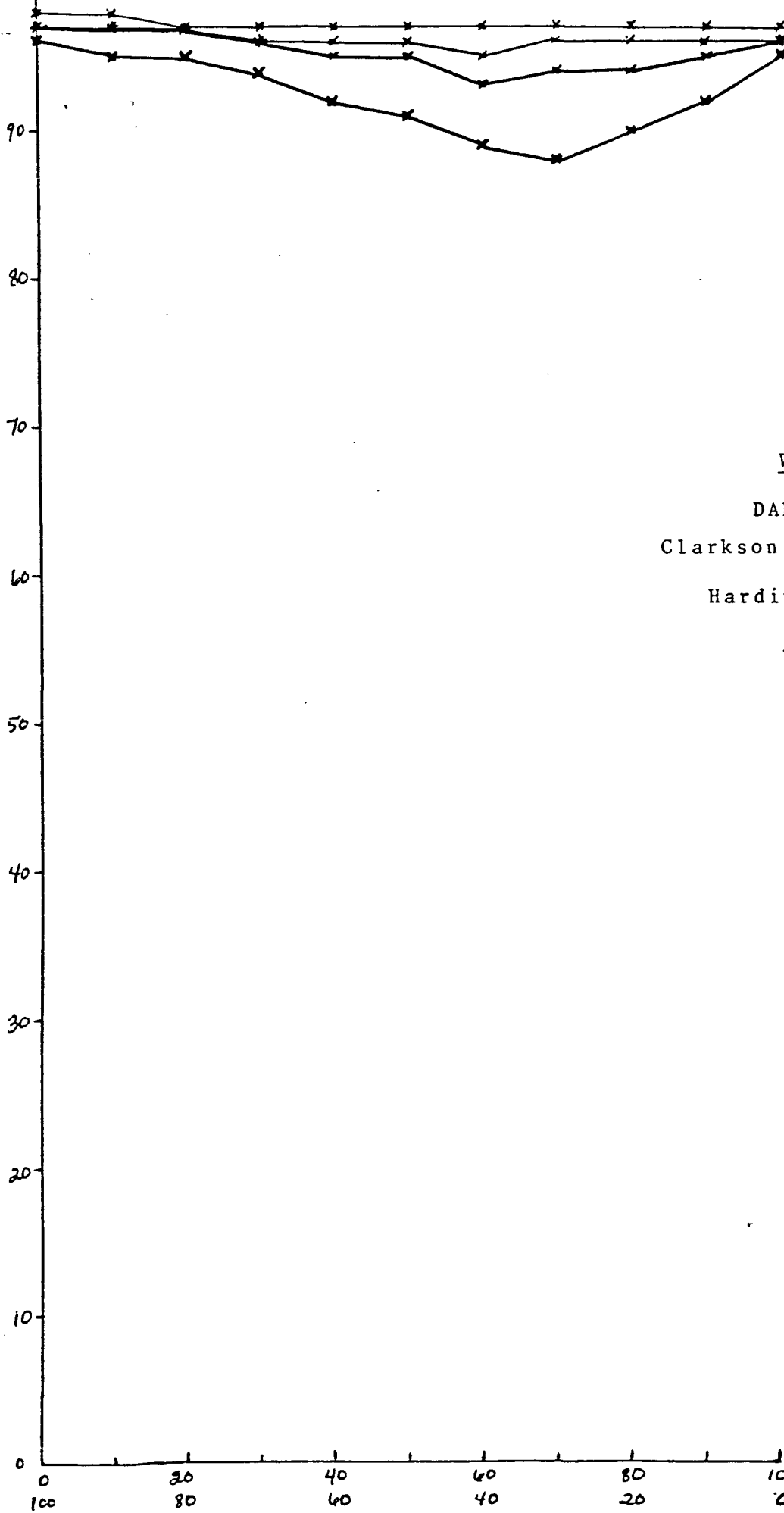
If there are questions concerning water compatibility or any other aspects of this flood, please contact Mr. Dave Gibbons at (303) 837-5425.

Sincerely,

A handwritten signature in dark ink, appearing to read "D. H. Gibbons".

D. H. Gibbons
Regional Operations Engineer

DHG/alm



0 HOUR _____
4 HOUR _____
8 HOUR _____
24 HOUR _____

Water Compatability (1568)
DAKOTA versus RED RIVER "C"
Clarkson 6-22 v.s. Clarkson 9-21
Harding County, South Dakota
APACHE CORPORATION
September 10, 1987

301 West 2nd Street

SATHE ANALYTICAL LABORATORY, INC.

Ph. 701-572-3632

Post Office Box 1527

WILLISTON, NORTH DAKOTA 58801

September 11, 1987

Apache Corporation
P.O. Box 1176
Dickinson, ND 58602
Attn: Jim Murphy

Dear Sir:

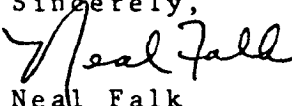
Analysis of the two water samples (enclosed) and their compatability results are outlined below:

CLARKSON 6-22 (Dakota fm.) versus CLARKSON 9-21 (Red River fm.)

- A) Slight iron oxidation in both waters due to dissolved oxygen (6 ppm) in Dakota formation. Recomend field oxygen test since air may have been admitted during transit.
- B) A higher ratio of sulfate in the Dakota formation will cause calcium as magnesium sulfate scaling due to the increased presence of calcium and magnesium in the Red River formation.
- C) Carbonates present in the Dakota formation will also cause carbonate scaling with the calcium and magnesium present in the Red River.
- D) Barium is present in both waters in small amounts and with cause scaling if untreated.
- E) Scaling is continual but not severe since all salt concentrations approach fresh water. Heat will accelerate scale development.

The compatability chart (enclosed) shows the scaling tendency with different blends over a period of time.

Thank you.

Sincerely,

Neal Falk
Sathe Analytical Lab

NF/nf
M-87-1568
encl: 3
cc: Dave Gibbons - Denver, CO
cc: Dick Brown - Nalco Chemicals

SATHE ANALYTICAL LABORATORY, INC.

301 W. 2ND STREET

P.O. BOX 1527
WILLISTON, ND. 58801

701-572-3632

WATER ANALYSIS REPORT

OPERATOR: APACHE CORPORATION

DATE: 9/9/87

WELL NO. CLARKSON 9-21

LAB NO.: W-87-1567

FIELD:

FORMATION: Red River "C"

COUNTY: Harding

INTERVAL: Production

STATE: SD

DST #:

LOC:

SAMPLE PRODUCED WATER

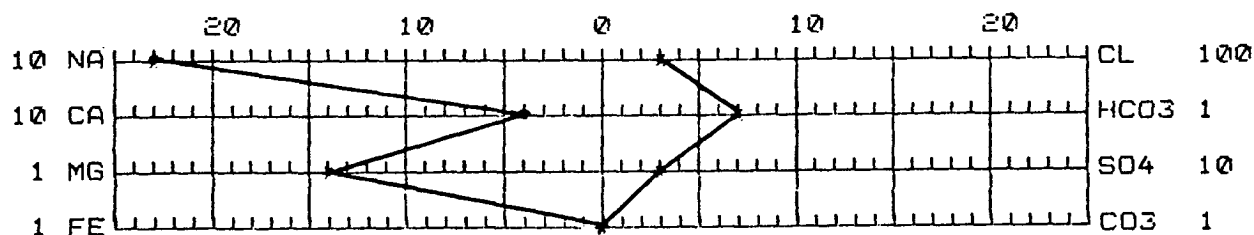
CATIONS	MG/L	MEQ/L	ANIONS	MG/L	MEQ/L
SODIUM	5340.0	232.3	CHLORIDE	9163.0	258.5
CALCIUM	842.6	42.0	CARBONATE	0.0	0.0
MAGNESIUM	166.5	13.7	BICARBONATE	439.3	7.2
IRON	0.4	0.0	SULFATE	1347.1	28.0
POTASSIUM	376.0	9.6	NITRATE	0.0	0.0
BARIUM	0.2	0.0			
CHROMIUM	0.1	0.0			

SPECIFIC GRAVITY @ 77°F 1.010 PH 6.69

RESISTIVITY @ 77°F, ohm-meters 0.388 NA CL (Calc.) 15109.6

TOTAL DISSOLVED SOLIDS (Calc.) MG/L 17675.2 HYDROGEN SULFIDE NEG

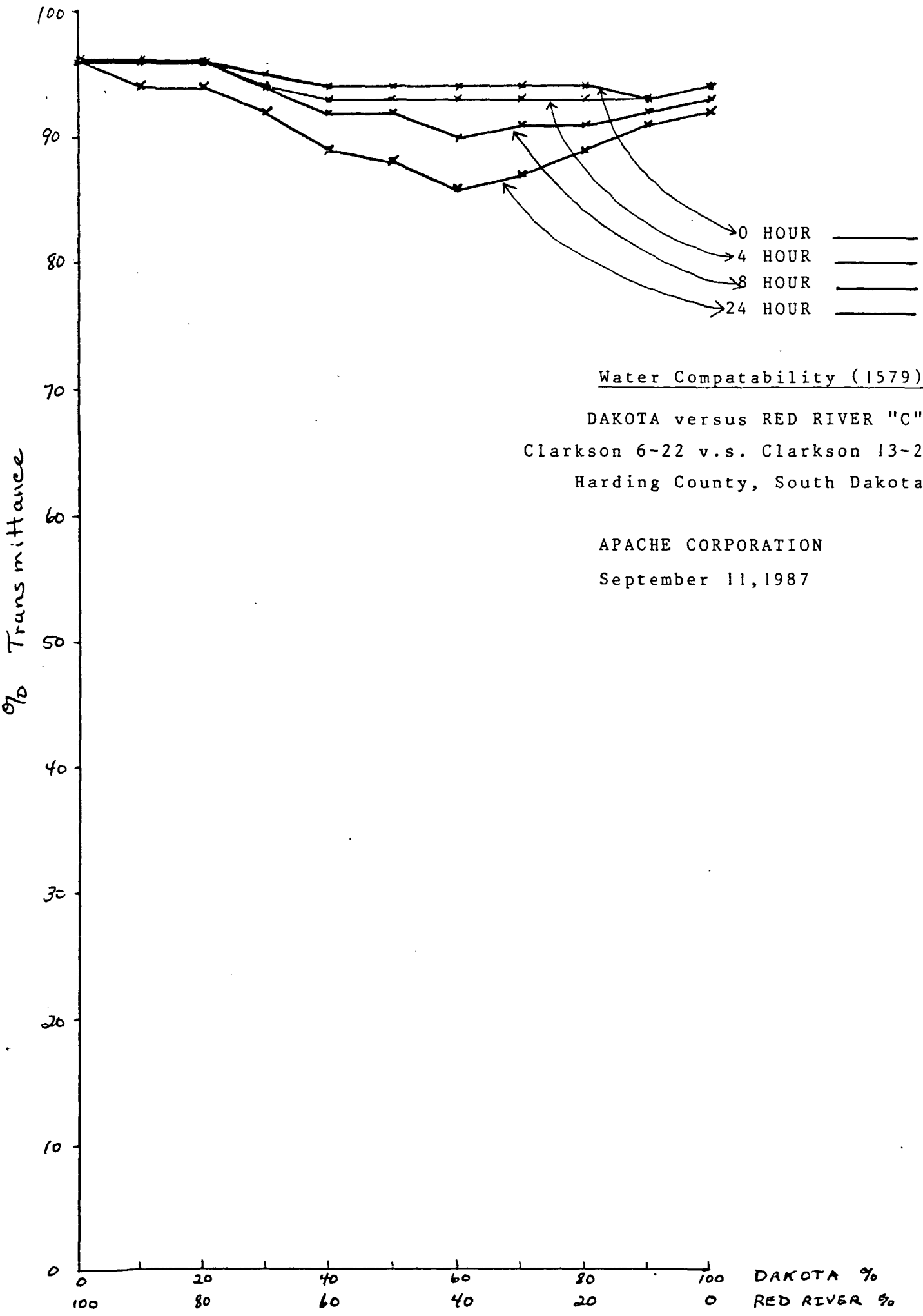
WATER ANALYSIS PATTERN - MEQ/L



REMARKS - Accompanying water compatability of RED RIVER "C" v.s. DAKOTA.

DISTRIBUTION OF RESULTS

Jim Murphy -- Dickinson ND - 1 copy
Dave Gibbons -- Denver CO - 1 copy



Water Compatability (1579)

DAKOTA versus RED RIVER "C"
Clarkson 6-22 v.s. Clarkson 13-22
Harding County, South Dakota

APACHE CORPORATION

September 11, 1987

**NALCO CHEMICAL COMPANY**

POST OFFICE BOX 1806

DICKINSON, NORTH DAKOTA 58602

AREA 701 264 7272

October 13, 1987

OCT 21 8

Mr. Jim Murphy
Apache Corporation
P.O. Box 1176
Dickinson, North Dakota 58602

SUBJECT: BUFFALO WATERFLOOD

Dear Mr. Murphy:

Nalco Chemical Company would like to submit the following recommendation to you for the treatment of the waterflood being started near Buffalo, South Dakota. The water analysis on the source well and the Red River water from the producing wells as provided by Sathe Analytical Lab indicate only a very slight natural scaling tendency of the source water. Scaling is very likely, however, if the source and produced waters are mixed at any ratio. The water analyses also indicate the presence of barium in both the produced and source waters and that barium sulfate scale is likely if the waters are mixed. For this reason, we would recommend using a scale inhibitor that is effective against all forms of scale that can be used at a cost effective dosage. The product that I would recommend is Visco 4988, a phosphonate scale inhibitor that is effective against all forms of scale including barium sulfate at a dosage of 15 ppm or one (1) quart per 400 barrels of water. The cost of this product is \$9.81 per gallon purchased in bulk.

Our experience in the field also indicates that the waters are not very corrosive unless bacteria are present. Bacteria in a waterflood are also very serious because of the problems with plugging that are caused on the injection wells. For this reason, we would recommend using Visco 3978, a water soluble corrosion inhibitor that is very similar to Visco 1153 biocide. Visco 3978 as a very high level of surfactancy to aid in lowering injection pressures and preventing solids buildup in the injection lines and it will also work as a biocide in this system. The recommended dosage of this product is 20 ppm or one (1) quart per 300 barrels of injection water per day. The price of this product purchased in bulk is \$8.79 per gallon. We would recommend injecting both chemicals at the wellhead of the source well to provide protection to the entire system and to minimize the number of injection points and chemical pumps that will be needed.

NALCO CHEMICAL COMPANY

Mr. Murphy
October 13, 1987
Page 2

RECOMMENDATION SUMMARY:

Product: Visco 4988 Scale Inhibitor

Price: per gallon

Dosage: One (1) quart per 400 barrels of water per day

Daily Cost: per 100 barrels of water

Product: Visco 3978 Biocide Corrosion Inhibitor

Price: per gallon

Dosage: One (1) quart per 300 barrels of water per day

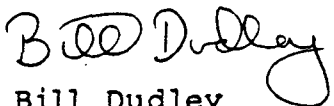
Daily Cost: per 100 barrels of water

Total Program Cost: \$ per 100 barrels of
injection water per day

I will discuss this recommendation with you personally as soon as you have had a chance to review it. If you have any questions, please feel free to contact me at your convenience.

Thank you for allowing Nalco Chemical Company the opportunity to be service to you.

Sincerely,



Bill Dudley
District Salesman
Dickinson, North Dakota

BD/mg

Enclosure: Lab Report

cc: D. Berry
D. Brown

SATHE ANALYTICAL LABORATORY, INC.

301 W. 2ND STREET

P.O. BOX 1527
WILLISTON, ND. 58801

701-572-3632

WATER ANALYSIS REPORT

OPERATOR: APACHE CORPORATION

DATE: 9/4/87

WELL NO. CLARKSON 6-22

LAB NO.: W-87-1530

FIELD: not listed

FORMATION: Dakota

COUNTY: Harding

INTERVAL: 4425

STATE: SD

DST #: 1

LOC: not listed

SAMPLE SAMPLE CHAMBER

CATIONS	MG/L	MEQ/L	ANIONS	MG/L	MEQ/L
SODIUM	2710.0	117.9	CHLORIDE	3708.3	104.6
CALCIUM	147.5	7.4	CARBONATE	12.0	0.4
MAGNESIUM	2.7	0.2	BICARBONATE	231.9	3.8
IRON	0.3	0.0	SULFATE	908.3	18.9
POTASSIUM	27.2	0.7	NITRATE	0.0	0.0
BARIUM	0.3	0.0			
CHROMIUM	0.0	0.0			

SPECIFIC GRAVITY @ 77°F

1.000 PH

7.28

RESISTIVITY @ 77°F, ohm-meters

0.871 NACL (Calc.)

6114.9

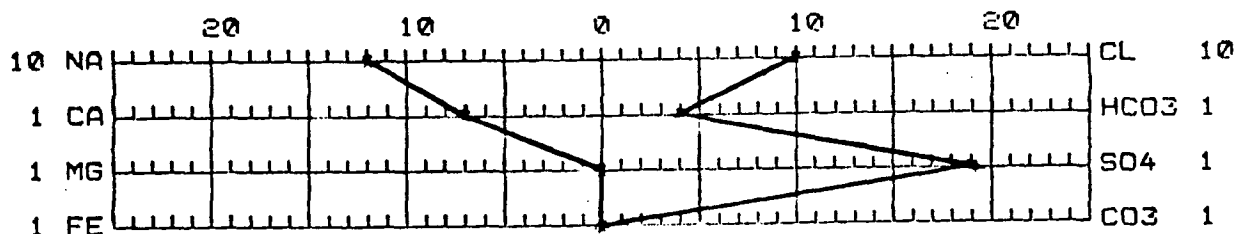
TOTAL DISSOLVED SOLIDS (Calc.) MG/L

7740.5

HYDROGEN SULFIDE

NEG

WATER ANALYSIS PATTERN - MEQ/L



REMARKS - No oil present.

Received from Flopetrol Testers - Williston ND

DISTRIBUTION OF RESULTS

Jim Murphy -- Dickinson ND - 2 copies.

SATHE ANALYTICAL LABORATORY, INC.

301 W. 2ND STREET

P.O. BOX 1527
WILLISTON, ND. 58801

701-572-3630

WATER ANALYSIS REPORT

OPERATOR: APACH CORPORATION

DATE: 9/10/87

WELL NO. Clarkson 13-22

LAB NO.: W-87-1578

FIELD:

FORMATION: Red River "C"

COUNTY: Harding

INTERVAL:

STATE: SD

DST #:

LOC:

SAMPLE PRODUCED WATER

CATIONS	MG/L	MEQ/L	ANIONS	MG/L	MEQ/L
SODIUM	4940.0	214.9	CHLORIDE	8861.2	250.0
CALCIUM	804.3	40.1	CARBONATE	0.0	0.0
MAGNESIUM	233.1	19.2	BICARBONATE	456.4	7.5
IRON	1.9	0.1	SULFATE	1183.1	24.6
POTASSIUM	290.0	7.4	NITRATE	0.0	0.0
BARIUM	0.5	0.0			
CHROMIUM	0.0	0.0			

SPECIFIC GRAVITY @ 77°F

1.010 PH

7.31

RESISTIVITY @ 77°F, ohm-meters

0.381 NAOL (Calc.)

14611.9

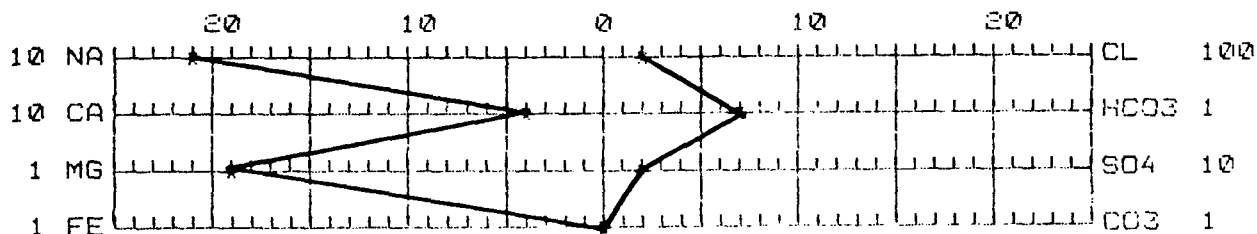
TOTAL DISSOLVED SOLIDS (Calc.) MG/L

16770.5

HYDROGEN SULFIDE

NEG

WATER ANALYSIS PATTERN - MEQ/L



REMARKS - Accompanying water compatability of Red River "C" v.s. Dakota.

DISTRIBUTION OF RESULTS

Jim Murphy--Dickinson ND - 1 copy

Dave Gibbons--Denver, CO - 1 copy

301 West 2nd Street

SATHE ANALYTICAL LABORATORY, INC.

Ph. 701-572-3632

Post Office Box 1527

WILLISTON, NORTH DAKOTA 58801

September 14, 1987

Apache Corporation
P.O. Box 1176
Dickinson, ND 58602
Attn: Jim Murphy

Dear Sir:

Analysis of the two water samples (enclosed) and their compatability results are outlined below:

CLARKSON 6-22 (Dakota fm.) versus CLARKSON 13-22 (Red River fm.)

A) Again we show slight iron oxidation in both waters due to dissolved oxygen (6 ppm) in the Dakota formation. A field oxygen test is recommended since air may have been admitted during transit.

B) A higher ratio of sulfate in the Dakota formation will cause calcium and magnesium sulfate scaling due the increased presence of calcium and magnesium in the Red River formation.

C) Carbonates present in the Dakota formation will also cause carbonate scaling with the calcium and magnesium present in the Red River.

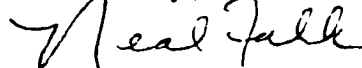
D) The presence of Barium in both waters in small amounts will cause scaling if untreated.

E) Again the scaling is continual but not severe. Heat will accelerate the scale development.

The compatability chart (enclosed) shows the scaling tendency with different blends over a period of 24 hours.

Thank you.

Sincerely,



Neal Falk

Sathe Analytical Lab

NF/nf

M-87-1579

cc: Dave Gibbons - Denver, CO

encl: 3



Department of Water & Natural Resources

Joe Foss Building
523 East Capitol
Pierre, South Dakota 57501

Division of Water Rights
605 773-3352

No. 1350-1

October 27, 1988

Apache Corporation
1700 Lincoln Street-Suite 4900
Denver, Colorado 80203-4549

Dear Sir:

The inspection of your water use system and inspection of the extent of the application of water to beneficial use, as developed under your Water Right No. 1350-1 has been completed. Your final water right document, the Water License, can now be issued.

Statutes require that we charge a \$50.00 fee for the inspection and issuing of the Water License. Upon receipt of the \$50.00 fee from you, your Water License will be sent to you.

South Dakota Water Law 46-5-30.1 requires that a permit holder may not divert water until this \$50.00 license fee has been paid. Please contact us if you have any questions.

Sincerely,

Maxine Stirling
Secretary

NOTE: On check or money order, please indicate the number of the water permit. This insures proper handling of the fee.

111508

RECEIPT
Division of Water Rights
South Dakota Department of Water and Natural Resources

Pierre, December 2, 19 68

RECEIVED OF Apache Corporation, Suite 1900 One, United Bank Center, 1700 Lincoln St.
the following amount in fees for services rendered as provided for by law: Denver CO 80203-4519

Fee for Application for Permit No. _____ to Appropriate Water, to construct works and to put water to beneficial use _____		
Fee for Application for Permit No. _____ to Appropriate Water for Future Use _____		
Fee to retain Future Use Permit No. _____ after period of seven years.		
Fee for Inspecting Constructed Works, confirming beneficial use and issuing Water License No. <u>1550-1</u>	50	00
Fee for Filing Transfer Form _____		
Fee for Filing Extension Request _____		
Fee for Certified Copy of _____		
Fee for Print Copy of Map _____		
Fee for Certifying _____		
Fee for _____		
(Any Other Work Provided by Law)	Total	50 00

By John Hatch
Chief Engineer JOHN HATCH 

Water District

TO: Chief Engineer, Division of Water Rights, DWR, Foss Bldg., Pierre, SD 57501

I have this day made a thorough examination of the water use system constructed by Harper Oil Company-X owner
Apache Corp. present owner of 1700 Lincoln Str. Suite 1900, Denver, Co. holder of
Permit No. 1350-1, bearing the priority of February 18 1986 80203 authorizing
the diversion of 0.1 cu. ft. per second of the waters of groundwater- Dakota well
for industrial purposes, in Harding County.

I have to report on the conditions of the same as follows:

A. Works used to divert the water:

A pump, 60 gallons per minute capacity.

A motor, 60 horse power. Both motor and the pump are submersible.

B. Works used to transport water to place of use:

A total of 26,000 feet of 3 inch fiber glass piping system. The pipe are connected to 5 injection wells.

C. Works used to apply water to beneficial use:

Water is used for a waterflood project in an oilfield.

The system is in the following condition good

The point of diversion is located approximately 1116 feet E., 754 feet N. from the Southwest corner
of Section 22, T21N-R3E (SW $\frac{1}{4}$ SW $\frac{1}{4}$)

The works are capable of diverting and conveying to the place of use 0.13

cu. ft. per second of water which is to be used for industrial purposes

Water has been put to beneficial use to the maximum extent as follows:

Water is used for a waterflood project in an oilfield. The well is connected to 5 injection wells and supplies water for the injection process whenever it is required.

comprising a total of NA acres of land and the license should be issued for 0.1 cfs

Applicable permit qualifications have been complied with X Yes No

Exceptions to compliance are: _____ Date 9/28/88

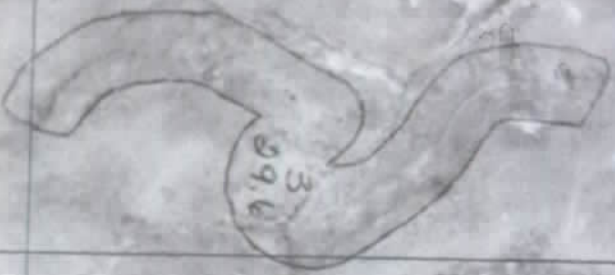
(signature)

21-3
J37

T3128
MT4210

T3194

T3168
MT4210



22

13713

T3126
MT4210

1116.6
254.6

⊗ well location

Not find

Natural Resources Company

10/25/88

Water Right No. 1350-1

LICENSE FOR PERMIT NUMBER 1350-1

1. Legal location of wells: SW $\frac{1}{4}$ SW $\frac{1}{4}$ Section 22, T21N-R3E

dams & structures: _____

2. Well Information: Well Drilling Firm Cardinal Drilling Company

No. of wells 1 Depth approximately 4740 feet

Casing a) diameter 9 5/8" to 1500 feet Screen a) type steel
b) length 5 1/2" to 4700 feet b) length 90 feet
c) type steel Static Water Level 2000 feet

Pump a) make submersible Motor a) make submersible
b) model _____ b) model no. _____
c) size _____ c) horsepower rating 60
d) capacity 60 GPM d) motor efficiency rating _____
e) turbine pump
no. of stages _____

3. Distribution lines:
a) size of lines 3 inches
b) type Fiberglass
c) length 26,000 feet

The pump runs 2-3 hours per day.

The lines from the well are connected
to 5 injection wells.

4. Dam information:
a) height to crest _____
b) height to spillway _____
c) crest width _____
d) crest length _____
e) spillway length _____
f) spillway width _____
g) approx. storage _____
h) Distribution lines or canals:
1) size _____
2) type _____
3) length _____

i) Outlet tubes:
1) diameter _____
2) type _____
3) valued (Y/N) _____
4) valve type _____
5) location on structure _____

5. System Type: a) sideroll:
1) length _____ feet
2) diameter of pipe _____
3) make, model & number of sprinklers _____
4) spacing of sprinklers _____
5) nozzle size _____

b) towline:
1) length _____ feet
2) make, model & number of sprinklers _____
3) spacing of sprinklers _____
4) nozzle size _____

5. System Type: c) center pivot

- 1) make _____
- 2) number of towers _____
- 3) distance between towers _____
- 4) overall length _____
- 5) End gun (Y/N) _____
- 6) high or low pressure _____
- 7) make & size of nozzles _____
- 8) PSI reading while system is running _____
- 9) GPM _____

g) Gun

- 1) make _____
- 2) serial number _____
- 3) nozzle size _____
- 4) capacity (GPM) _____
- 5) PSI _____
- 6) hose size _____
- 7) hose length _____

d) Gate Pipe

- 1) length _____
- 2) diameter _____
- 3) spacing of gates _____

e) Siphons

- 1) number _____
- 2) size _____

f) Portable boom

- 1) make _____
- 2) serial number _____
- 3) nozzle size _____
- 4) capacity (GPM) _____
- 5) PSI _____

h) Hydromatic

- 1) make _____
- 2) model _____
- 3) serial number _____
- 4) length _____
- 5) nozzle size _____
- 6) spacing _____
- 7) PSI _____
- 8) capacity (GPM) _____

YES

NO

Check Items

____ NA ____

X ____

X ____

1. Soil and water permit lands agree with lands being irrigated and lands listed on permit.

2. Special Qualifications to permit being abided by.

3. All Structures, wells and lands on map.

REMARKS:

STATE OF SOUTH DAKOTA

WATER LICENSE NO. 1350-1

(1) Harper Oil Company of P.O. Box 5928, Denver, Colorado 80217 made Application No. 1350-1, February 18, 1986 for a water permit to appropriate 0.10 cubic feet of water per second from groundwater (one well), Harding County, South Dakota for industrial purposes. Permit No. 1350-1 with a priority date of February 18, 1986 was approved July 1, 1986 and issued to applicant(s) for diversion of water with construction of the described water supply system to be completed on or before July 1, 1991 and for the application to beneficial use of said water on or before July 1, 1995.

On December 17, 1986, Water Permit No. 1350-1 was transferred to Apache Corporation, 1700 Lincoln Street, Suite 4900, Denver, Colorado 80203-4549.

(2) It is certified that the applicant has complied with the provisions of South Dakota State Law relating to completion of the construction of the water supply system and is entitled to divert 0.10 cubic feet of water per second for beneficial use. The location of the diversion point is: approximately 1116 feet east and 754 feet north from the SW corner of Section 22, T21N, R3E (SW1/4 SW1/4).

(3) The applicant has complied with the provisions of South Dakota State Law relating to the application of water to beneficial use in an oilfield water flood project. The well is connected to five injection wells and supplies water for the injection process whenever required.

(4) Pursuant to Section 46-5-30.1 Apache Corporation of 1700 Lincoln Street, Suite 4900, Denver Colorado 80203-4549 the holder(s) and/or owner(s) of Water Permit No. 1350-1 is issued a license to appropriate water, the right to use 0.10 cubic feet of water per second from groundwater (one well) with a priority date of February 18, 1986 from the location specified in (2) of this license. The water is used for the purpose of industrial use. This license is subject to any limitations or qualifications listed in Water Permit No. 1350-1 and subject to South Dakota State Law.



JOHN HATCH, Chief Engineer
Water Rights Division
Department of Water and Natural
Resources

SEP 14 1989



Department of Water & Natural Resources

Joe Foss Building
523 East Capitol
Pierre, South Dakota 57501-3181

1350-1

SEP 14 1989

Jill Henderson
Apache Corporation
Suite 4900
1700 Lincoln St.
Denver CO 80203-4549

Dear Ms. Henderson:

Enclosed is Water License No. 1350-1. This is the final water right document completing your process of obtaining a Water Right. Enclosed is Receipt No. 411536 in the amount of \$50.00 which you paid for the inspection and issuance of the Water License.

For your information SDCL 46-6-27 requires that if the owner of an existing well, such as the well authorized by Water Right No. 1350-1, constructs a replacement well and does not plan to use the old well, the old well is considered abandoned and must be plugged. Also, any well that is being used or is not considered abandoned must be valved and controlled, if flowing, or sealed and capped so that no leaking occurs either underground or at the surface.

As long as you use the water beneficially, as stated in the Water License, the State Water Laws provide that you have a continuing right to use the water. If you have any questions, please contact our office.

Very truly yours,

JOHN HATCH, Chief Engineer
Water Rights Division
(605) 773-3352

enclosures





**DEPARTMENT of ENVIRONMENT
and NATURAL RESOURCES**

JOE FOSS BUILDING
523 EAST CAPITOL
PIERRE, SOUTH DAKOTA 57501-3181

October 22, 1996

No. 1350-1

Sharon Ward
Citation Oil & Gas Corp.
8223 Willow Pl. S, Suite 250
Houston, TX 77070

Dear Ms. Ward:

Enclosed is a partially completed "Notice of Transfer" form for use in filing an ownership change on Water Right No. 1350-1. The water right is currently listed in the name of Apache Corporation.

The transfer form should be checked over for accuracy and signed by the new owner in the presence of a notary public. Upon completion, return the form to our office with a required filing fee of \$2.50.

South Dakota Water Law 46-5-30.3 requires Notice of any sale, grant, lease, conveyance or other transfer of a water permit or water right to appropriate water to be filed with this office within ninety days.

If you have any questions, please contact me.

Sincerely,

Cheryl F. Frost
Secretary
Water Rights Program
(605) 773-3352

enclosure

NOTICE OF TRANSFER OF OWNERSHIP

No. 1350-1

TO: Chief Engineer
Water Rights Division, DWR
523 East Capitol
Pierre, SD 57501-3181

Date: 11-1-96I/We request that Water ~~Permit~~ Right No. 1350-1formerly owned by: Apache Corporation, 1700 Lincoln St., Suite 4900, Denver, CO 80203-4549be transferred to: (name & address) Citation Oil & Gas Corp.8223 Willow Place South Ste 250 Houston, TX 77070-5623 (telephone No.) 713-469-9664

Title to the following described land(s)/property has been transferred as described above:

Approximately 1116 feet east & 754 feet north from the SW corner of Section 22, T21N,R3E (SW 1/4 SW 1/4).

I/We understand that the validity of Water Permit/Right No. 1350-1 has not been determined by this transfer action. If I/We have any questions on validity, I/We understand that only the Water Management Board has the authority to determine if a water permit/right is valid (see note).

You are requested to file this "Notice of Transfer" in the appropriate file at the Division of Water Rights, as evidence of the change of ownership.

A fee of Two Dollars and Fifty Cents (\$2.50) is attached to cover the filing fees as required under SDCL 46-2-13.

STATE OF SOUTH DAKOTA)

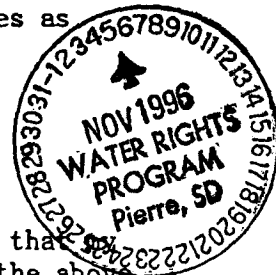
County of Harding)

I/We Sharon Ward being first duly sworn on my oath depose and say that my relation to the above described undertaking is that of Owner, that I have read the above foregoing statement, and that I know of my own personal knowledge that the information herein stated is true.

Sharon Ward
(Signed)

Subscribed and sworn to before me this 1st day of November, 19 96.

Renee Harrell
(Notary Public)



NOTE: Water permits may be cancelled for nonconstruction within the five year construction period. Once a water permit is developed and the water used, the permit becomes a water right. A water right may be lost for three reasons:

1. Abandonment - no intent to use water and use is abandoned.
2. Forfeiture - no use of water for three year period without legal excuse.
3. For a third violation of a condition of a water permit/right.

RECEIPT

415175

Division of Water Rights

South Dakota Department of Environment and Natural Resources

Pierre, _____ November 5, 19 96

RECEIVED OF Citation Oil & Gas Corp., 8223 Willow Pl. S, Ste. 250, Houston, TX 77070-5623

the following amount in fees for services rendered as provided for by law:

Fee for Application for Permit No. _____ to Appropriate Water, to construct and to put water to beneficial use _____		
Fee for Application for Permit No. _____ to Appropriate Water, for Future Use _____		
Fee to retain Future Use Permit No. _____ after period of seven years.		
Fee for Inspecting Constructed Works, confirming beneficial use and issuing Water License No. _____		
Fee for Filing Transfer Form <u>Water Right No. 1350-1</u>	2	50
Fee for Filing Extension Request _____		
Fee for _____		

(Any Other Work Provided by Law)	Total	2 50

By

Chief Engineer

John Harris



**DEPARTMENT of ENVIRONMENT
and NATURAL RESOURCES**

JOE FOSS BUILDING
523 EAST CAPITOL
PIERRE, SOUTH DAKOTA 57501-3181

December 5, 1996

No. 1350-1

Sharon Ward
Citation Oil & Gas Corp.
8223 Willow Place South, Suite 250
Houston, TX 77070-5623

Dear Ms. Ward:

Enclosed is a receipt in the amount of \$2.50 which you paid for the transfer of Water Right No. 1350-1.

Our records now show Citation Oil & Gas Corp. as the owner of Water Right No. 1350-1.

Sincerely,

Cheryl F. Frost
Secretary
Water Rights Program
(605) 773-3352

enclosure